Confronting Existential Angst **(8 Oct 2018)**
Paul Pietroski, Rutgers University
[don't worry…the *talk* is much shorter than the handout]

1. First Clues: Miss Scarlet, Colonel Mustard, and Davidsonian Adjuncts

(1) Scarlet poked Mustard with a pencil in the library.
(2) Scarlet poked Mustard with a pencil.
(3) Scarlet poked Mustard in the library.
(4) Scarlet poked Mustard.
(5) Scarlet poked Mustard in the kitchen.
(6) Scarlet poked Mustard with a spoon.
(7) Scarlet poked Mustard in the kitchen with a spoon.
(8) *Scarlet poked Mustard with a pencil in the kitchen.*
(9) *Scarlet poked Mustard in the library with a spoon.*
(10) Scarlet poked Mustard with a pencil, and
Scarlet poked Mustard in the library.

(1) ➔ (2) & (3)
⬋ ⬊
(2) (3)
⬈ ⬊ ⬋ ⬉
(8) (4) (9)
⬊ ⬈ ⬉ ⬋
(5) (6)
⬉ ⬈
(7) ➔ (5) & (6)

The conjunction of (1) and (7) doesn't imply (8) or (9). But the conjunction of (8) and (9) implies (2-6). And while (1) implies (10), (10) doesn't imply (1).

(11) There was a banker from Dallas who wore a hat.
(12) There was a banker from Dallas.
(13) There was a banker who wore a hat.
(14) There was a banker.
(15) There was a banker who wore suspenders.
(16) There was a banker from Manhattan.
(17) There was a banker from Manhattan who wore suspenders.
(18) *There was a banker from Dallas who wore suspenders.*
(19) *There was a banker from Manhattan who wore a hat.*
(20) There was a banker from Dallas, and
there was a banker who wore a hat.

(11) ➔ (12) & (13)
⬋ ⬊
(12) & (13)
⬈ ⬊ ⬋ ⬉
(18) (14) (19)
⬊ ⬈ ⬉ ⬋
(15) (16)
⬉ ⬈
(17) ➔ (15) & (16)

The conjunction of (11) and (17) doesn't imply (18) or (19).
But the conjunction of (18) and (19) implies (12-16), And while (11) implies (20), (20) doesn't imply (11).

(11a) ∃e[Banker(e) & From-Dallas(e) & Wore-a-hat(e)]
(12a) ∃e[Banker(e) & From-Dallas(e)]
(13a) ∃e[Banker(e) & Wore-a-hat(e)]
(14a) ∃e[Banker(e)]

(1a) ∃e[Past-poke-by-of(e, Scarlet, Mustard) & With-a-pencil(e) & In-the-library(e)]
(2a) ∃e[Past-poke-by-of(e, Scarlet, Mustard) & With-a-pencil(e)]
(3a) ∃e[Past-poke-by-of(e, Scarlet, Mustard) & In-the-library(e)]
(4a) ∃e[Past-poke-by-of(e, Scarlet, Mustard)]

Maybe speakers *understand* (1-4) as existential generalizations like (1a-4a),
and *recognize* the indicated inferences as instances of a corresponding valid form:

$$\frac{\exists e[\Phi(e) \,\&\, \Psi(e)]}{\exists e[\Phi(e)]}$$

2. More Existentials: H∃r∃, Th∃r∃ & ∃v∃rywh∃r∃

(21) a spy poked a soldier

(21a) $\exists e \exists x \exists y[\text{Spy}(x)\ \&\ \text{Past-poke-by-of}(e, x, y)\ \&\ \text{Soldier}(y)]$

(21b) $\exists e[\mathit{PastSimple}(e)\ \&\ \exists x \exists y[\text{Spy}(x)\ \&\ \text{Poke-by-of}(e, x, y)\ \&\ \text{Soldier}(y)]\}$

Factoring out tense highlights further complexity (see, e.g., Reichenbach 1947 Hornstein 1990)

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

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

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

$\mathit{FutureSimple}(e) \equiv \exists\pi[\text{SpeechTime}(\pi)\ \&\ \text{After}(e, \pi)]$

$\equiv \exists\pi[\text{ReferenceTime}(\pi)\ \&\ \exists\pi'[\text{After}(\pi, \pi')\ \&\ \text{SpeechTime}(\pi')]\ \&\ \text{At}(e, \pi)]$

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

---

(22) a soldier was poked

(22a) $\exists e \exists y[\text{Past-poke-of}(e, y)\ \&\ \text{Soldier}(y)]$

(22b) $\exists e\{\mathit{PastSimple}(e)\ \&\ \exists y[\text{Poke-of}(e, y)\ \&\ \text{Soldier}(y)]\}$

(23) a spy poked a soldier with a pencil

(i) $\exists e \exists x \exists y\{\mathit{PastSimple}(e)\ \&\ \text{Spy}(x)\ \&\ \text{Poke-by-of}(e, x, y)\ \&\ \text{Soldier}(y)\ \&\ \exists\pi[\text{With}_{\text{poss}}(\mathbf{y}, \pi)\ \&\ \text{Pencil}(\pi)]\}$

#(ii) $\exists e \exists x \exists y\{\mathit{PastSimple}(e)\ \&\ \text{Spy}(x)\ \&\ \text{Poke-by-of}(e, x, y)\ \&\ \text{Soldier}(y)\ \&\ \exists\pi[\text{With}_{\text{poss}}(\mathbf{x}, \pi)\ \&\ \text{Pencil}(\pi)]\}$

(iii) $\exists e \exists x \exists y\{\mathit{PastSimple}(e)\ \&\ \text{Spy}(x)\ \&\ \text{Poke-by-of}(e, x, y)\ \&\ \text{Soldier}(y)\ \&\ \exists\pi[\text{With}_{\text{instr}}(\mathbf{e}, \pi)\ \&\ \text{Pencil}(\pi)]\}$

(i′) $\exists e\{\mathit{PS}(e)\ \&\ \exists\pi[\text{By}(e, \pi)\ \&\ \text{Spy}(\pi)]\ \&\ \exists y[\text{Poke-of}(e, y)\ \&\ \text{Soldier}(y)\ \&\ \exists\pi[\text{With}_{\text{poss}}(y, \pi)\ \&\ \text{Pencil}(\pi)]]\}$

(iii′) $\exists e\{\mathit{PS}(e)\ \&\ \exists\pi[\text{By}(e, \pi)\ \&\ \text{Spy}(\pi)]\ \&\ \exists y[\text{Poke-of}(e, y)\ \&\ \text{Soldier}(y)]\ \&\ \exists\pi[\text{With}_{\text{inst}}(e, \pi)\ \&\ \text{Pencil}(\pi)]\}$

(24) a tailor saw a tinker with a tool

(i) $\exists e\{\mathit{PastSimple}(e)\ \&\ \exists x \exists y[\text{Tailor}(x)\ \&\ \text{See-by-of}(e, x, y)\ \&\ \text{Tinker}(y)\ \&\ \exists\pi[\text{With}_{\text{poss}}(\mathbf{y}, \pi)\ \&\ \text{Tool}(\pi)]]\}$

#(ii) $\exists e\{\mathit{PastSimple}(e)\ \&\ \exists x \exists y[\text{Tailor}(x)\ \&\ \text{See-by-of}(e, x, y)\ \&\ \text{Tinker}(y)\ \&\ \exists\pi[\text{With}_{\text{poss}}(\mathbf{x}, \pi)\ \&\ \text{Tool}(\pi)]]\}$

(iii) $\exists e\{\mathit{PastSimple}(e)\ \&\ \exists x \exists y[\text{Tailor}(x)\ \&\ \text{See-by-of}(e, x, y)\ \&\ \text{Tinker}(y)\ \&\ \exists\pi[\text{With}_{\text{instr}}(\mathbf{e}, \pi)\ \&\ \text{Tool}(\pi)]]\}$

(iv) $\exists x \exists y[\text{Tailor}(x)\ \&\ \text{Saw-by-of}(e, x, y)\ \&\ \text{Tinker}(y)\ \&\ \exists\pi[\text{With}_{\text{poss}}(\mathbf{y}, \pi)\ \&\ \text{Tool}(\pi)]]$

#(v) $\exists x \exists y[\text{Tailor}(x)\ \&\ \text{Saw-by-of}(e, x, y)\ \&\ \text{Tinker}(y)\ \&\ \exists\pi[\text{With}_{\text{poss}}(\mathbf{x}, \pi)\ \&\ \text{Tool}(\pi)]]$

(vi) $\exists x \exists y[\text{Tailor}(x)\ \&\ \text{Saw-by-of}(e, x, y)\ \&\ \text{Tinker}(y)\ \&\ \exists\pi[\text{With}_{\text{instr}}(\mathbf{e}, \pi)\ \&\ \text{Tool}(\pi)]]$

(21) a spy poked a soldier

(21a) $\exists e \exists x \exists y[\text{Spy}(x)\ \&\ \text{Past-poke-by-of}(e, x, y)\ \&\ \text{Soldier}(y)]$

(21b) $\exists e[\mathit{PastSimple}(e)\ \&\ \exists x \exists y[\text{Spy}(x)\ \&\ \text{Poke-by-of}(e, x, y)\ \&\ \text{Soldier}(y)]\}$

(21c) $\exists e\{\mathit{PastSimple}(e)\ \&\ \exists\pi[\text{By}(e, \pi)\ \&\ \text{Spy}(\pi)]\ \&\ \exists\pi[\text{Poke-of}(e, \pi)\ \&\ \text{Soldier}(\pi)]\}$ cp. Castañeda 67

$\exists\pi[\ldots\&\ \exists\pi'[\ldots e\ldots]]$ Parsons 90, Schein 93

Chomsky 95, Kratzer 96

(25) a soldier was poked by a spy

(26) a guest heard **a scream** in the hall — Higginbotham 1983; Vlach 1983

$\exists e\{\textit{PastSimple}(e) \ \& \ \exists\pi[\text{By}(e, \pi) \ \& \ \text{Guest}(\pi)] \ \&$

(i) $\exists\pi[\text{Hearing-of}(e, \pi) \ \& \ \text{Scream}(\pi) \ \& \ \text{In-the-hall}(\pi)]\}$

(ii) $\exists\pi[\text{Hearing-of}(e, \pi) \ \& \ \text{Scream}(\pi)] \ \& \ \text{In-the-hall}(e)\}$

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

$\exists e\{\textit{PastSimple}(e) \ \& \ \exists\pi[\text{By}(e, \pi) \ \& \ \text{Guest}(\pi)] \ \&$

(i) $\exists\pi[\text{Hearing-of}(e, \pi) \ \& \ \exists\pi'[\text{Scream-by}(\pi, \pi') \ \& \ \text{Soldier}(\pi')] \ \& \ \text{In-the-hall}(\pi)]\}$ — *two '∃'s*

(ii) $\exists\pi[\text{Hearing-of}(e, \pi) \ \& \ \exists\pi'[\text{Scream-by}(\pi, \pi') \ \& \ \text{Soldier}(\pi')]] \ \& \ \text{In-the-hall}(e)\}$ — *one 'a'*

(28) guest hears soldier scream in hall

(29) spy pokes soldier in library with pencil

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*).

'a spy' **'a soldier'**

$\exists e\{\textit{PastSimple}(e) \ \& \ \exists\pi[\text{By}(e, \pi) \ \& \ \text{Spy}(\pi)] \ \& \ \exists\pi[\text{PokeOf}(e, \pi) \ \& \ \text{Soldier}(\pi)] \ \&$

$\exists\pi[\text{In}(e, \pi) \ \& \ \text{Library}(\pi)] \ \& \ \exists\pi[\text{With}(e, \pi) \ \& \ \text{Pencil}(\pi)]\}$

'a library' **'a pencil'**

maybe <u>*no*</u> '∃' *is due to 'a'*

---

(30) guests heard **screams**

$\exists E\{\textit{PastSimple}(E) \ \& \ \exists\Pi[\text{By}(E, \Pi) \ \& \ \text{Guests}(\Pi)] \ \& \ \boldsymbol{\exists\Pi}[\text{Hearings-of}(E, \boldsymbol{\Pi}) \ \& \ \textbf{Screams}(\boldsymbol{\Pi})]\}$

(31) guests heard **guests scream**

$\exists E\{\textit{PastSimple}(E) \ \& \ \exists\Pi[\text{By}(E, \Pi) \ \& \ \text{Guests}(\Pi)] \ \& \ \boldsymbol{\exists\Pi}[\text{Hearings-of}(E, \boldsymbol{\Pi}) \ \& \ \textbf{Guests-Scream}(\boldsymbol{\Pi})]\}$

(32) guests heard **noise**

$\exists E\{\textit{PastSimple}(E) \ \& \ \exists\Pi[\text{By}(E, \Pi) \ \& \ \text{Guests}(\Pi)] \ \& \ \boldsymbol{\exists\Pi}[\text{Hearings-of}(E, \boldsymbol{\Pi}) \ \& \ \textbf{Noise}(\boldsymbol{\Pi})]\}$

(33) three guests ate **beef**

$\exists E\{\textit{PastSimple}(E) \ \& \ \exists\Pi[\text{By}(E, \Pi) \ \& \ \text{Three}(\Pi) \ \& \ \text{Guests}(\Pi)] \ \& \ \boldsymbol{\exists\Pi}[\text{Eatings-of}(E, \boldsymbol{\Pi}) \ \& \ \textbf{Beef}(\boldsymbol{\Pi})]\}$

It is often assumed that (30-33) have existential implications of another kind. But let's come back to this.

(30) guests heard screams

(30a) $\exists P\exists P'[\text{Guests}(P) \ \& \ \text{Heard}(P, P') \ \& \ \text{Screams}(P')]$

(30b) $\exists P\exists P'\{\text{Plurality}(P) \ \& \forall x{:}x\in P[\text{Guest}(x)] \ \& \ \text{Heard}(P, P') \ \& \ \text{Plurality}(P') \ \& \ \forall x{:}x\in P'[\text{Scream}(x)]\}$

(34) the dogs surrounded the cats

(34a) $\exists P\exists P'[\text{The-dogs}(P) \ \& \ \text{Surrounded}(P, P') \ \& \ \text{The-cats}(P')]$

(34b) $\exists P\exists P'\{\text{Plurality}(P) \ \& \ \forall x[(x\in P) \equiv \text{Dog}(x)] \ \& \ \text{Surrounded}(P, P') \ \&$
$\text{Plurality}(P') \ \& \ \forall x[(x\in P) \equiv \text{Cat}(x)]\}$

3. Two Common Patterns…Who ordered these?

$\Phi(\_) \ \& \ \Psi(\_)$ — *entity/event*

$\exists[\Delta(\_, \_) \ \& \ \Pi(\_)]$ — *participant*

Caveat: if the goal is to *characterize natural phenomena* regarding linguistic understanding, then we'll probably have to tweak formalism that was *invented for different purposes*

More specifically: Davidson used Tarski's ampersand and existential quantifier, which allow for expressions like '∃x[Rxy & Syzw]', in which a two-place sentence is conjoined with a three-place sentence to form a four-place sentence that is converted to a three-place sentence by existential closure

Davidsonians (in the 21st century) need a *"natural logic analog"* of the schema: $\frac{\exists e[\Phi(e) \ \& \ \Psi(e)]}{\exists e[\Phi(e)]}$

---

(35) Some professors watched brown cows eat green grass.

∃E{*PastSimple*(E) & ∃π[By(E, Π) & Professors(Π)] & Watch-brown-cows-eat-green-grass(E)}

(A) The common patterns reflect logically substantive *covert constituents*

Watch-brown-cows-eat-green-grass(_) ➔

[watch [(*sm-events*) [[(*by*) [(sm) [brown (nd) cows]]] (*nd*) [eat [(sm) [green (nd) grass]]]]]] ➔

∃F[Watch-of(_, F) & ∃Π[By(F, Π) & Brown(Π) & Cows(Π)] &
∃M[Eat-of(F, M) & Green(M) & Grass(M)]

(B) The common patterns reflect logically substantive *modes of combination*

'green' + 'grass' ➔ Green(_) & Grass(_)

'eat' + [green grass] ➔ ∃M[Eat-of(_, M) & Green(M) & Grass(M)]

'brown' + 'cows' ➔ Brown(_) & Cows(_)

('*by*') + [brown cows] ➔ ∃Π[By(_, Π) & Brown(Π) & Cows(Π)]

[(*by*) [brown cows]] + [eat [brown grass]] ➔ ∃Π[By(_, Π) & Brown(Π) & Cows(Π)] &
∃M[Eat-of(_, M) & Green(M) & Grass(M)]]

'watch' + [[(*by*) [brown cows]] [eat [brown grass]]] ➔ ∃F[Watch-of(_, F) &
∃Π[By(F, Π) & Brown(Π) & Cows(Π)] &
∃M[EatOf(F, M) & Green(M) & Grass(M)]]

It's a very old idea that negating, disjoining, and conditionalizing are exceptions to a default principle that *lengthening*—in a discourse, or within a sentence—is a way of *strengthening*.

It's also a very old idea that universal quantification is a logically special case, and that *existential* quantification is the default way of converting a predicate into a thought.

If we grant that modes of combination can be logically substantive, it's no big leap to allow for existential closure as a default clausal operation.

So we should at least consider the following hypothesis (Pietroski 2005, 2018); see Appendix A.

```
                           ____________
                           |          |
  Φ(_) & Ψ(_)             ∃[Δ(_, _) & Π(_)]
    |______|                    |______|
  entity/event               participant
```

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

On this view…

—the patterns reflect modes of combination that are employed at an *early stage of computing meanings*
—this leaves room for *later stages* of computation (cp. Chomsky 57, Marr 82)
—but not even verb-noun combination is logically innocent

4. Sidebar: Neo-Montagovian Minimalism

It is sometimes assumed/asserted/avowed that *natural* modes of composition are *no more* logically substantive than Function Application

---

Caveat: distinguish Function Application from Fregean Saturation…

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

here, all the implications reflect atomic expressions

But for good reasons, Church didn't want to rely on Fregean Saturation.

SOMETHING[Φ(_)] + PRECEDES(_, _) ➔ ???   *cp.* ∃X[PRECEDES(X', X)]
<**et**, **t**> + <e, e**t**> ➔ ???   ∃X[PRECEDES(X, X')]

'∃' is syncategorematic for Tarski

λX.λX'.T ≡ PRECEDES(X', X) + OSCAR ➔ λX'.T ≡ PRECEDES(X', OSCAR)   *cp.* PRECEDES(_, OSCAR)]
denoter + *denoter* ➔ *denoter*   *'_' is unsaturated for Frege*

If *natural* composition is "logically spare" in this sense,
then the logically substantive patterns presumably reflect lexical items

—Covert Constituents (see page 4 above)

—Type Shifting (lexical items are flexible in ways that mimic covert constituents)

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

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

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

$$= \lambda e.\lambda x.\mathbf{Cow}(x)(e) \;\&\; \mathbf{Brown}(e)$$

$$= \lambda e.\quad \mathbf{Cow}(e) \quad \&\; \mathbf{Brown}(e)$$

||tall banker from Dallas who wore a hat|| = ???

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

$$||\text{poked Mustard with a pencil}|| = \boldsymbol{\lambda\Phi}.\textbf{With-a-pencil}(\boldsymbol{\Phi})(\lambda x.\textbf{Poked}(x, \textbf{Mustard}))$$

$$||\text{poked Mustard in the library}|| = \boldsymbol{\lambda\Phi}.\textbf{In-the-library}(\boldsymbol{\Phi})(\lambda x.\textbf{Poked}(x, \textbf{Mustard}))$$

Massachusetts Variation: natural modes of composition are *no more* logically substantive than
Predicate Modification and Function Application

$$||\text{brown}_{<et>}\ \text{cow}_{<et>}|| = \lambda e.||\text{brown}_{<et>}||(e) \;\&\; ||\text{cow}_{<et>}||(e)$$

$$= \lambda e.\lambda x.\mathbf{Brown}(x)(e) \;\&\; \lambda x.\mathbf{Cow}(x)(e) = \lambda e.\mathbf{Brown}(e) \;\&\; \mathbf{Cow}(e)$$

$$||[\text{with a pencil}]_{<et>}|| = \lambda e.\exists x[\mathbf{With}(e, x) \;\&\; \mathbf{Pencil}(x)]$$

$$||[\text{poke}_{<e,\, et>}\ \text{Mustard}_{<e>}]_{<et>}|| = \lambda x.\lambda e.\textbf{Poke-of}(e, x)(\text{Mustard}) = \lambda e.\textbf{Poke-of}(e, \text{Mustard})$$

$$||[\text{poke Mustard}]_{<et>}\ [\text{with a pencil}]_{<et>}|| = \lambda e.||[\text{poke Mustard}]_{<et>}||(e) \;\&\; ||[\text{with a pencil}]_{<et>}||(e)$$

$$= \lambda e.\textbf{Poke-of}(e, \text{Mustard}) \;\&\; \exists x[\mathbf{With}(e, x) \;\&\; \mathbf{Pencil}(x)]$$

But how much work does this leave for appeal to Functions and Application, as opposed to just…

```
                          _____________
                          |           |
Φ(_) & Ψ(_)            ∃[Δ(_, _) & Π(_)]
  |______|                    |______|
entity/event                participant
```

Don't forget article-free languages, or Kamp-Heim accounts of English indefinites; see page 3 above.

$$\exists\pi[\text{PokeOf}(e, \pi) \;\&\; \text{Mustard}(\pi)] \;\&\; \exists\pi[\text{With}(e, \pi) \;\&\; \text{Pencil}(\pi)]\}$$

'a Mustard' **'a pencil'**

5. Logical Neutrality, Ontological Price

(30) guests heard screams

(30a) $\exists P\exists P'[Guests(P) \,\&\, Heard(P, P') \,\&\, Screams(P')]$

(30b) $\exists P\exists P'\{Plurality(P) \,\&\forall x{:}x{\in}P[Guest(x)] \,\&\, Heard(P, P') \,\&\, Plurality(P') \,\&\, \forall x{:}x{\in}P'[Scream(x)]\}$

(30c) $\exists E\exists P\exists P'\{\mathit{PastSimple}(E) \,\&\, Plurality(P) \,\&\forall x{:}x{\in}P[Guest(x)] \,\&$
$\qquad Hear\text{-}by\text{-}of(E, P, P') \,\&\, Plurality(P') \,\&\, \forall x{:}x{\in}P'[Scream(x)]\}$

Really? Is (30) understood as implying that a plurality of guests heard a plurality of screams?
Davidsonians offer arguments that (30) is understood as implying past events of guests hearing screams.
But does this imply—for ordinary speakers—
that some collection of events was a hearing of a collection of screams by a collection of guests?

(34) the dogs surrounded the cats

(34a) $\exists P\exists P'[The\text{-}dogs(P) \,\&\, Surrounded(P, P') \,\&\, The\text{-}cats(P')]$

(34b) $\exists P\exists P'\{Plurality(P) \,\&\, \forall x[(x{\in}P) \equiv Dog(x)] \,\&\, Surrounded(P, P') \,\&$
$\qquad Plurality(P') \,\&\, \forall x[(x{\in}P) \equiv Cat(x)]\}$

(36) the logicians specified the sets

(36a) $\exists P\exists P'[The\text{-}logicians(P) \,\&\, Specified(P, P') \,\&\, The\text{-}Sets(P')]$

(36b) $\exists P\exists P'\{Plurality(P) \,\&\, \forall x[(x{\in}P) \equiv Logician(x)] \,\&\, Specified(P, P') \,\&$
$\qquad Plurality(P') \,\&\, \forall x[(x{\in}P') \equiv Set(x)]\}$

6. Capitalized Variables ***Don't Require*** Bigger Domains: Boolos 1998

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 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*.

			abcd						0001	0010	0011
	abc	**abd**	acd	bcd				0100	0101	0110	0111
ab	ac	ad	bd	bc	cd			1000	1001	1010	**1011**
a		b		c		d		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 *one of* the *one or more assigned values*: d, yes; c, no; b, yes; a, yes.

<u>Truism</u>: the interpretations differ, even if for many purposes, we can talk either way.

(37) $\exists X \forall x[Xx \equiv (x \notin x)]$ — *stipulated domain*: Fred, Bert (and nothing else)
facts: Fred ∉ Fred; Bert ∉ Bert; Fred ≠ Bert

Given the stipulated domain and the set-theoretic construal, (37) is **false**.
But given the same domain and the Boolos construal, (37) is **true**.
While nothing in this domain includes Fred and Bert, there are some thing*s*—viz., Fred and Bert—such that each thing (in the domain) is one of *them* if and only if it isn't selfelemental.
Now suppose that Fred = ∅, Bert = {∅}, and
the domain is extended to include all of the other pure Zermelo-Frankl sets (but nothing else).
Given the Boolos construal, (37) is still **true**, while (37) is still **false** on the set-theoretic construal.

(38) $\exists x(Fx) \equiv \exists X \forall x(Xx \equiv Fx)$ — (*trivial* on the Boolos construal)
(39) $\forall X {\sim} \exists x(Xx \;\&\; {\sim}Xx)$ — (fully *general* on the Boolos construal)
(40) ${\sim}\exists X \exists x(Xx \;\&\; {\sim}Xx)$
(41) ~∃✋∃☝[OneOf(☝, ✋) ≡ ~OneOf(☝,✋)]

(42) ${\sim}\exists \underline{s} \exists x[(x \in \underline{s}) \;\&\; {\sim}(x \in \underline{s})]$ — (trivial, but not fully general)
(43) ${\sim}\exists y \exists x[\text{In}(x, y) \;\&\; {\sim}\text{In}(x, y)]$

Empirical Question: is either interpretation better than the other for purposes of characterizing how expressions of English (and other natural languages) are understood?

(44) every set is a set — *Seems <u>trivial</u>, even if you think that nothing includes every set.*
(45) $\{x\text{: x is a set}\} \subseteq \{x\text{: x is a set}\}$ — *Seems <u>wrong</u> if you think that nothing includes every set.*

So prima facie, (45) <u>mis</u>characterizes the logical form of (44), even if this characterization is <u>useful</u> for many purposes.

(46) Some barber shaves all and only the barbers who do not shave themselves. — *Seems <u>wrong</u> once you realize what it implies.*

Even if many speakers of English don't (or can't) work out the implications of (46), semanticists should not posit a barber who does so much shaving. And even if semantics is a branch of cognitive science, semanticists don't get to *posit* impossible barbers (or square circles).

(47) every one of the sets is a set — *Seems trivial, at least if there are some sets*
(48) $\exists Y\{\forall x[Yx \equiv \text{Set}(x)] \;\&\; \forall x{:}Yx[\text{Set}(x)]\}$ — *Seems as trivial as (47)*
(49) $\exists Y{:}\forall x[Yx \equiv \text{Set}(x)]\{\forall x{:}Yx[\text{Set}(x)]\}$

Positing settish implications that speakers *can't* recognize requires justification; see Schein (1993).

Thought Experiement: imagine a Fregean semanticist sent to Planet Tarski, where (50) implies no function from cows to truth values—and then to Planet Boolos, where (51) doesn't imply any sets.

(50) every dot is blue

(51) most of the cows are blue

7. No Fact of the Matter Hypotheses: Insert Friday's talk ("Meaning, *Most*, and Mass") here

—weak version: if a theory Θ pairs each expression of language L with a logical form λ,
and a theory Θ* pairs each expression of L with a *logically equivalent* logical form λ*,
then Θ and Θ* provide equally good specifications of what the expressions of L mean

—stronger versions: … and in some cases, *logically inequivalent* specifications are equally good

(52) every cow is brown
(52a) $\forall x{:}Cow(x)[Brown(x)]$
(52b) $\forall x[Cow(x) \supset Brown(x)]$
(52c) $\sim\exists x[Cow(x)\ \&\ \sim Brown(x)]$
(52d) $\{x{:}\ Cow(x)\} \subseteq \{x{:}\ Brown(x)\}$
…

(53) most of the dots are blue
(53a) $\#\{x{:}\ Dot(x)\ \&\ Blue(x)\} > \#\{x{:}\ Dot(x)\ \&\ \sim Blue(x)\}$
(53b) $\#\{x{:}\ Dot(x)\ \&\ Blue(x)\} >$
$\#\{x{:}\ Dot(x)\} - \#\{x{:}\ Dot(x)\ \&\ Blue(x)\}$
…

(21) a spy poked a soldier
(21a) $\exists e\exists x\exists y[Spy(x)\ \&\ Past\text{-}poke\text{-}by\text{-}of(e, x, y)\ \&\ Soldier(y)]$
(21b) $\exists e[\mathit{PastSimple}(e)\ \&\ \exists x\exists y[Spy(x)\ \&\ Poke\text{-}by\text{-}of(e, x, y)\ \&\ Soldier(y)]\}$
(21c) $\exists e\{\mathit{PastSimple}(e)\ \&\ \exists\pi[By(e, \pi)\ \&\ Spy(\pi)]\ \&\ \exists\pi[Poke\text{-}of(e, \pi)\ \&\ Soldier(\pi)]\}$
…

Why think there's (often) a fact of matter when the alternatives are logically *in*equivalent, but not when the alternatives are *logically* equivalent? Why is *logic* special with regard to *meaning*?

With regard to *meaning*, why think that *logic* is more important than *psychology*?
(If you're an externalist, why think *logic* is more important than *metaphysical* possibility?)

How could *logic* tell us whether or not—or even if there is a fact of the matter about whether or not—(53) is *understood* in terms of comparing the number of blue dots to the number of dots that *aren't* blue, as opposed to comparing the number of blue dots to *that number subtracted from* the number of dots?

How could *logic* tell us whether or not—or even if there is a fact of the matter about whether or not—(53) is *understood* in terms of numbers, as opposed to one-to-one correspondence (and leftovers)?

(53c) $OneToOnePlus[\{x{:}\ Dot(x)\ \&\ Blue(x)\}, \{x{:}\ Dot(x)\ \&\ \sim Blue(x)\}]$

How could *logic* tell us whether or not—or even if there is a fact of the matter about whether or not—(52) and (53) are *understood* in terms of sets and truth values, as opposed to some sparer Boolos-y way?

(52e) $\lambda\boldsymbol{\Psi}.\lambda\boldsymbol{\Phi}.\mathsf{T} \equiv \{x{:}\boldsymbol{\Psi}(x) = \mathsf{T}\} \subseteq \{x{:}\boldsymbol{\Phi}(x) = \mathsf{T}\}(\lambda x.\mathbf{Cow}(x))(\lambda x.\mathbf{Brown}(x))$
(52f) $\exists Y\{\forall x[Yx \equiv Cow(x)]\ \&\ \forall x{:}Yx[Brown(x)]\}$

(53d) $\exists Y\{\forall x(Yx \equiv Dot(x))\ \&\ \exists X[\forall x(Xx \equiv Yx\ \&\ Blue(x))\ \&\ \{\#(X) > \#(Y) - \#(X)\}]\}$

Empirical Questions: does (53) imply cardinalities, sets, truth values, events/states, …

8. Two ways of hearing "Does S1 imply S2"?

(i) Do competent speakers of the relevant language *understand* S1 and S2 in ways that let these speakers *recognize* that an inference from (the logical form of a thought expressed with) S1 to (the logical form of a corresponding thought expressed with) S2 is valid?

(ii) Is *every world* at which (the content of a thought expressed with) S1 is true a world at which (the content of a corresponding thought expressed with) S2 is true?

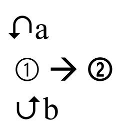
Does 'Scarlet poked Mustard in the library with a pencil' imply that there was a poking of Mustard?
(i) Yes. It has something to do with conjunct reduction.
(ii) Yes. But the sentence also implies that there are infinitely many prime numbers.

Does 'Sadie is a mare' imply that Sadie is a horse? (Short form: does 'mare' imply 'horse'?)
(i) Probably. And if so, it probably has something to do with conjunct reduction.
(ii) Yes. But 'mare' also implies 'mammal such that there are infinitely many prime numbers'.

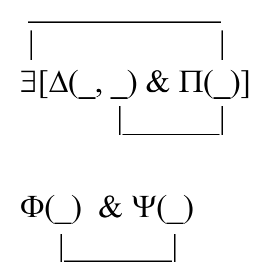
Does 'Some odd number precedes every prime number' have two readings, with distinct implications?
(i) Yes. And speakers should reject the "surface" reading if they think that 1 is a prime number.
(ii) No. The two grammatical structures are equivalent given that 2 is the smallest prime.

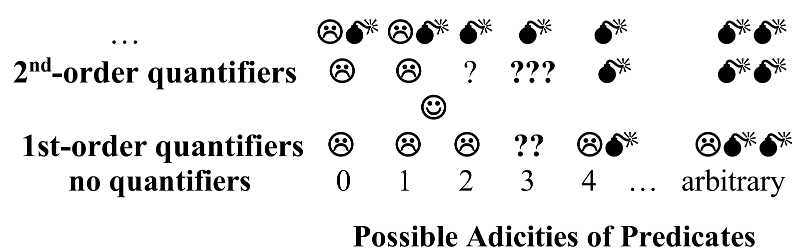
(54) $\exists x{:}Odd(x)\{\forall y{:}Prime(y)[Precedes(x, y)]\}$ (55) $\forall y{:}Prime(y)\{\exists x{:}Odd(x)[Precedes(x, y)]\}$

It's been 50+ years since Davidson got a ball rolling by trying to describe semantic properties of English sentences by using off-the-shelf technology—Tarski's first-order fragment of Frege's *Begriffsschrft*—in clever ways (e.g., by allowing for event variables and putting them to work). Montague and Lewis quickly adopted more powerful technology—Church's lambda calculus—which got put to use in many clever ways. But 60 years ago, Chomsky taught us that there is more than one kind of recursion, and that adopting powerful technology is not always the way forward in the study of cognition. Recall that the problem with "finite state automata" was not that they didn't permit description of every string of lexical items. On the contrary, it is all too easy to describe *every* string of lexical items in these terms.



So if the goal is to *explain* why a system recursively generates *some strings but not others*, one needs a different vocabulary that lets one capture the right *constraints*. Talking about phrase structure grammars and transformations was far from perfect, but it got a ball rolling. So we might ask what would generate the patterns discussed here *without* generating *a lot more*; see Pietroski (2018).





Appendix A: Typology in Pietroski (2018)

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

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

entity/event *participant*

Core Operations:

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

Example: 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(_)]

Main Idea: 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 *atomic dyadic* concepts, but the system only *generates monadic* concepts.

Appendix B: Limited Quantification, not Generalized Quantifiers (numbers from another handout)

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

(32) {x: Cow(x)} ⊆ {x: Ran(x)} *equivalent for '⊆' but not for '⊇'* or '='
(33) {x: Cow(x)} ⊆ {x: Cow(x) & Ran(x)}

(34) ∃Y{∀x(Yx ≡ Cow(x)) & ∃X[∀x(Xx ≡ Ran(x)) & ∀x:Yx(Xx)]}
(35) ∃Y{∀x(Yx ≡ Cow(x)) & ∃X[∀x(Xx ≡ Yx & Ran(x)) & ∀x:Yx(Xx)]}

(13d) ∃Y{∀x(Yx ≡ Dot(x)) & ∃X[∀x(Xx ≡ Yx & Blue(x)) & {#(X) > #(Y) – #(X)}]}

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

(39) Finn chased every cow
(40) ∃Y{∀x(Yx ≡ Cow(x)) &
∃X[∀x(Xx ≡ Yx & Chased(Finn, x)) & ∀x:Yx(Xx)]}

But how do we get (40) from (39)?

First Step: Treat Sentences as Polarized Predicates

(41) Finn chased Bess

(42) $\|[_S$ 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) $\|which_1$ $[_S$ Finn chased $t_1]\|^{\mathcal{A}} = \lambda x. \top$ iff CHASED(FINN, x)

But (47) is no *simpler* than (46). Relative to any assignment $\mathcal{A}$, '$\lambda x. \top$ iff CHASED(FINN, x)' is shorthand for the following mouthful: the smallest function that maps each entity *e* to $\top$ or $\bot$ 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) $\exists$e{SIMPLE-PAST(E) & CHASE(E, FINN, $\mathcal{A}[1]$)}

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

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

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

where $\Uparrow\{\Phi(\_)\}$ is a polarized predicate that applies to everything or nothing, depending on whether or not $\Phi(\_)$ applies to something.

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

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

3. $\text{Val}(\alpha, [\ldots_{\text{Q}} \ldots_{\text{N}}]_{\text{Q}i})^{\mathcal{A}}$ iff $\exists\beta[\text{Val}(<\alpha, \beta>, \ldots_{\text{Q}})^{\mathcal{A}} \;\&\; \beta = \{x: \text{Val}(x, \ldots_{\text{N}})^{\mathcal{A}}\}]$ [*axiom*]

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

5. $\text{Val}(\_, [_{\text{S}} [\ldots]_{\text{Q}i} [_{\text{S}} \ldots t_i \ldots]])^{\mathcal{A}}$ iff

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

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

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

<u>Second Step: Treat Quantifiers as Plural Predicates</u>

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

For any ordered pair $<e, i>$—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.

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

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

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

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

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

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

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

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

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

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

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

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

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

$\exists X[\text{EXTERNALS}(\text{O}, X) \;\&\; \forall x(Xx \equiv \exists\mathcal{A}^*[\mathcal{A}^*[1] = x \;\&\; \mathcal{A}^* \approx_1 \mathcal{A}^* \;\&\; \text{CHASED}(\text{FINN}, \mathcal{A}^*[1])])]\}$ [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. $\text{Val}(\_, [_{\text{S}} [\text{every}_{\text{Q}}\ \text{cow}_{\text{N}}]_{\text{Q1}} [_{\text{S}}\ \text{Finn chased}\ t_1]])^{\mathcal{A}}$ iff

$\exists\text{O}\{\text{EVERY}(\text{O}) \;\&\; \iota Y{:}\text{Cows}(Y)[\text{INTERNALS}(\text{O}, Y)] \;\&\; \iota X{:}\text{CHASED}(\text{FINN}, X)[\text{EXTERNALS}(\text{O}, X)]\}$ [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 $\langle e\mathbf{t}, \mathbf{t}\rangle$. 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 $[_S$ Finn chased $t_1]$.

(48) $[_S\ [every_Q\ cow_N]_{Q1}\ [_S$ 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) $[_{\langle \mathbf{t}\rangle}\ [every_{\langle e\mathbf{t}, \langle e\mathbf{t}, \mathbf{t}\rangle\rangle}\ cow_{\langle e\mathbf{t}\rangle}]_{\langle e\mathbf{t}, \mathbf{t}\rangle}\ [_{\langle e\mathbf{t}\rangle}\ 1\ [_{\langle \mathbf{t}\rangle}$ Finn chased $t_1]]]$

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

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

… *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) $Val(O, [\ldots_Q \ldots_N]_{Qi})^{\mathcal{A}}$ iff
$Val(O, \ldots_Q)^{\mathcal{A}}\ \&\ \exists Y[Internals(O, Y)\ \&\ \forall y(Yy \equiv Val(y, \ldots_N)^{\mathcal{A}})\ \&\ \mathbf{ExternalsAreInternals(O)}]$

(53) $Val(\_, [_S\ [\ldots_Q \ldots_N]_{Qi}\ [_S \ldots t_i \ldots]], \mathcal{A})$ iff
$\exists O\{Val(O, [\ldots]_{Qi})^{\mathcal{A}}\ \&\ \exists X[Externals(O, X)\ \&$
$\forall x(Xx \equiv \exists \mathcal{A}^*{:}x = \mathcal{A}^*[i]\ \mathbf{\&\ Val(\mathcal{A}^*[\mathit{i}], \ldots_N)^{\mathcal{A}^*}}\ \&\ \mathcal{A}^* \approx_i \mathcal{A}\ \&\ \{Val(\mathcal{A}^*[1], [_S \ldots t_i \ldots])^{\mathcal{A}^*}\})\}$

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.

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

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

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

Appendix C: Comparing Axioms and Derivations for ‘Finn chased it’

a. $\text{Val}(\_, \text{-d}_{T})^{\mathcal{A}}$ iff PAST-SIMPLE(_) a. $\|\text{-d}_{T}\|^{\mathcal{A}} = \lambda e.\top$ iff PAST-SIMPLE(e)

b. $\text{Val}(\_, \Phi\text{-Finn}_{N})^{\mathcal{A}}$ iff =(_, R-FINN) b. $\|\Phi\text{-Finn}_{N}\|^{\mathcal{A}} =$ R-FINN

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

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

d. $\text{Val}(\_, [\text{chase}_{V} \ldots])^{\mathcal{A}}$ iff $\exists[\text{CHASE-OF}(\_, \_) \wedge \text{Val}(\_, \ldots)^{\mathcal{A}}]$ d. $\|\text{chase}_{V}\|^{\mathcal{A}} = \lambda x.\lambda e.\top$ iff CHASE-OF(e, x)

e. $\text{Val}(\_, [by_{v} \ldots])^{\mathcal{A}}$ iff $\exists[\text{BY}(\_, \_) \wedge \text{Val}(\_, \ldots)^{\mathcal{A}}]$ e. $\|by_{v}\|^{\mathcal{A}} = \lambda\Phi.\lambda x.\lambda e.\top$ iff BY(e, x) & $\Phi(e) = \top$

f. $\text{Val}(\_, [\ldots_{<M>} \ldots_{<M>^*}])^{\mathcal{A}}$ iff $\text{Val}(\_, [\ldots_{<M>}])^{\mathcal{A}} \wedge \text{Val}(\_, \ldots_{<M>^*})^{\mathcal{A}}$ f. $\|[\ldots_{<et>} \ldots_{<et>^*}]\|^{\mathcal{A}} = \lambda x.\top$ iff $\|\ldots_{<et>}\|^{\mathcal{A}} = \top$ & $\|\ldots_{<et>^*}\|^{\mathcal{A}} = \top$

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

h. $\text{Val}(\_, [_{\Sigma} [\ldots]])^{\mathcal{A}}$ iff for some e, $\text{Val}(e, \ldots)^{\mathcal{A}}$ h. $\|[_{\Sigma} [\ldots]]\|^{\mathcal{A}} = \top$ iff for some e, $\|\ldots\|^{\mathcal{A}}(e) = \top$

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

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

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

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

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

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

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

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

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

$\|1\|^{\mathcal{A}} = \mathcal{A}[1]$

$\|2\|^{\mathcal{A}} = \lambda x.\lambda e.\top$ iff CHASE-OF(e, x)

$\|3\|^{\mathcal{A}} = \lambda e.\top$ iff CHASE-OF(e, $\mathcal{A}[1]$)

$\|4\|^{\mathcal{A}} = \lambda\Phi.\lambda x.\lambda e.\top$ iff BY(e, x) & $\Phi(e) = \top$

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

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

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

$\|8\|^{\mathcal{A}} = \lambda e.\top$ iff PAST-SIMPLE(e)

$\|9\|^{\mathcal{A}} = \lambda e.\top$ iff PAST-SIMPLE(e) & $\|7\|^{\mathcal{A}}(e) = \top$

$\|10\|^{\mathcal{A}} =$ for some e, $\|9\|^{\mathcal{A}}(e) = \top$

You can blame <u>*tense*</u> for the matrix ∃-closure: $\|\text{-d}_{T}\|^{\mathcal{A}} = \lambda\Phi.\exists e\{PastSimple(e) \& \Phi(e)\}$.
But this assigns two jobs to one morpheme: quantification <u>*and*</u> restriction.
And the restriction is already complicated. Moreover, (6-9) suggest that ∃-closure doesn’t require tense.

Appendix D: 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)

Barwise, J. and Cooper, R. (1981). Generalized Quantifiers and Natural Language. *Linguistics and Philosophy* 4:159-219.
Boolos, G. (1998). *Logic, Logic, and Logic*. Cambridge, MA: Harvard University Press.
Cartwright, H. (1965). Classes, Quantities, and Non-Singular Reference. Dissertation, University of Michigan
Chomsky, N. (1957). *Syntactic Structures*. The Hague: Mouton.
—(1995): *The Minimalist Program*. Cambridge, MA: MIT Press.
Davidson, D. (1967a). The Logical Form of Action Sentences. Reprinted in Davidson 1980.
—(1980). *Essays on Actions and Events*. Oxford: Oxford University Press.
Heim, I. (1982). The Semantics of Definite and Indefinite Noun Phrases. Dissertation, U-Mass Amherst.
Heim, I. & Kratzer, A. (1998). *Semantics in Generative Grammar*. Oxford: Blackwell.
Higginbotham, J. (1983). The Logical form of Perceptual Reports. *Journal of Philosophy* 80:100-27.
Hornstein, N. (1990). *As Time Goes By: tense and universal grammar*. Cambridge, MA: MIT Press.
Kamp, H. (1981). A Theory of Truth and Semantic Representation.
Kratzer, A. (1996). Severing the External Argument from its Verb. In J. Rooryck and L. Zaring (eds.), Phrase Structure and the Lexicon. Dordrecht (Kluwer Academic Publishers)
Lidz, J. et.al. (2011). Interface Transparency and the Psychosemantics of 'Most'. *Natural Language Semantics* 19:227-56.
Pietroski, P. (2005). *Events and Semantic Architecture*. Oxford: Oxford University Press.
—(2018). *Conjoining Meanings: Semantics without Truth Values*. Oxford: Oxford University Press.
Ramsey, F. (1927). Facts and Propositions. *Proceedings of the Aristotelian Society* (supp) 7:153-170.
Reichenbach, H. (1947). *Elements of Symbolic Logic*. New York: Macmillan & Co.
Rescher, N. (1962). Plurality Quantification. *Journal of Symbolic Logic* 27:373-4.
Schein, B. (1993). *Plurals and Events*. Cambridge, MA: MIT Press.
—(2017). *And: Conjunction Reduction Redux*. Cambridge, MA: MIT Press.
Taylor, B. (1985). *Modes of Occurrence*. Oxford: Blackwell.
Vlach, F. (1983). On Situation Semantics for Perception. *Synthese* 54:129-52.
Williams, A. (2015). *Arguments in Syntax and Semantics*. Cambridge: CUP.