Constraining (shifting) types at the interface

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1 Introduction

- ***A problem of types***
  Natural language does not use the full range of possible types, given the standard recursive definition:

(1) a. e and t are types;
    b. If σ and τ are types, then $\langle\sigma,\tau\rangle$ is a type;
    c. Nothing else is a type.

⇒ I will argue that one way that types are restricted is in what constitutes a POSSIBLE TRACE, i.e. the λ-bound variables that movement can map onto.

⁎ ***Main claim* #1**

- Traces only range over individual semantic types:

  (2) TRACE INTERPRETATION CONSTRAINT
  $^*[\ \mathrm{DP}_1\ \lambda f_\sigma \ldots [\ \ldots [\ f_\sigma\ ]_1 \ldots\ ]\ ]$, where σ is not an individual type

- Even though natural language has expressions over higher types, these expressions cannot be represented as traces.
- Predecessors: Chierchia (1984), Romero (1998), Fox (1999), Landman (2006)

⁎ ***Main claim* #2**

- The Trace Interpretation Constraint cannot be circumvented by type shifting an individual-type trace into a higher type:

  (3) TRACE RIGIDITY PRINCIPLE
  Traces cannot be type shifted.

- Predecessors: Landman (2004)

- These constraints conspire to force movement either to map onto a trace over an individual type or to reconstruct. All other representations are ill-formed.

(4) $[\ \mathrm{DP}_1\ \lambda x_e \ldots [\ \ldots [\ x_e\ ]_1 \ldots\ ]\ ]$

(5) $[\ \_\__1 \ldots [\ \ldots [\ \mathrm{DP}\ ]_1 \ldots\ ]\ ]$ *reconstruct*

- Thus, the interpretation of movement is tightly restricted, which in turn constrains the actively used semantic types.

. . . .

- ***Why should we care about traces?***
  Addressing constraints on permissible semantic types might seem to belong to the domain of lexical items, namely what the semantic types of possible lexical items are.
  - However, a theory of possible lexical items does not automatically translate into a theory about possible traces, and vice versa.
  - For instance, theories about possible lexical items might explain:
    ✓$\langle e,t\rangle$ ✓$\langle et,t\rangle$ ✗$\langle\langle et,t\rangle,t\rangle$
  - But this does not necessarily extend to blocking $\langle e,t\rangle$ traces:

    (6) $^*[\ \mathrm{DP}_1\ [\ \lambda f_{\langle e,t\rangle} \ldots [\ \ldots [\ f_{\langle e,t\rangle}\ ]_1 \ldots\ ]\ ]_{\langle et,t\rangle}\ ]$

  - Especially because $\langle e,t\rangle$, the type of the variable, and $\langle et,t\rangle$, minimally the type of the λ-function created by movement, are both possible types for lexical items.

⇝ Constraints on types = Possible traces + possible lexical items

2 Trace Interpretation Constraint

- ***Semantic types of DPs***
  DPs come in three semantic guises (Partee 1986):[1]

(7)

e	Entity	*(individual type)*
$\langle e,t\rangle$	Property	*(sets)*
$\langle et,t\rangle$	Generalized quantifier	*(sets of sets)*

✓ ***Entity traces***
We have abundant evidence that entity traces exist. These are the canonical traces left by movement types like QR:

(8) $[\ \text{DP}_1\ \lambda f_e \ldots [\ \ldots [\ f_e\ ]_1 \ldots]\ ]$

✗ ***Generalized-quantifier traces***

- Romero (1998) and Fox (1999) show that generalized-quantifier traces are unavailable (contra Rullmann 1995; Cresti 1995) based on evidence from the correlation between Condition C connectivity and scope reconstruction:

  (9) $^*[\ \text{DP}_1\ \lambda f_{\langle et,t\rangle} \ldots [\ \ldots [\ f_{\langle et,t\rangle}\ ]_1 \ldots]\ ]$

- In Poole (2017), I also provide additional arguments against generalized-quantifier traces based on ACD, extraposition, and parasitic gaps. One of these arguments, we will see today.

. . . .

⁎ ***What about property traces?***
No one has yet addressed whether property traces exist.[2] Thus, a central contribution of this project is an empirically motivated argument against property traces:

(10) $^*[\ \text{DP}_1\ \lambda f_{\langle e,t\rangle} \ldots [\ \ldots [\ f_{\langle e,t\rangle}\ ]_1 \ldots]\ ]$

[1] Properties are intensional, i.e. $\langle s, \langle e, t\rangle\rangle$, but throughout this talk, I will treat them in purely extensional terms for the sake of simplicity. This reduces them to sets of entities.

[2] Chierchia (1984) argues that property variables exist based on anaphora like *such* and *do so*. However, Landman (2006) shows that these cases should be reanalyzed as reference to kinds and thus do not involve property variables. These arguments are couched in terms of variables, but we will see that traces are likely more than just variables, but rather definite descriptions.

⇒ ***Completing the "triangle"***
This investigation supplies the crucial final piece of the argument that the constraint on possible traces is against **any higher-type trace**. This is an important advance in our understanding of the syntax–semantics interface.

- ***Empirical base: Π-positions***
  The crucial motivation comes from a series of original observations about what I call **Π-POSITIONS**. These are syntactic environments where a DP denotes a property:

(11) a. **Existential constructions**
There is [**a potato**]$_{\langle e,t\rangle}$ in the pantry.

b. **Change-of-color verbs**
Megan painted the house [**magenta**]$_{\langle e,t\rangle}$.

c. **Naming verbs**
Irene called the cat [**Snowflake**]$_{\langle e,t\rangle}$.

d. **Predicate nominals**
Erika became [**a teacher**]$_{\langle e,t\rangle}$.

- I will not review the arguments that DPs in these positions denote properties. It would take us too far afield. The arguments mainly come from the existing literature:
  - Existential constructions: McNally (1992, 1997, 1998)
  - Change-of-color verbs: Resultatives
  - Naming verbs: Matushansky (2008)
  - Predicate nominals: Standard analysis

- ***Bibliographic note***
  - I use "Π-positions" as a theory-neutral term because these positions belong to a larger syntactic puzzle observed by Postal (1994)
  - He has a different analysis of these positions (also Stanton 2016), so the term "Π-positions" is intended to be theory-neutral.
  - My account derives all of Postal's observations, but I will not discuss this here today explicitly; see Poole (2017).

- ***Section outline***
  1. I set the stage by showing that movement types in English differ with respect to whether they shift scope.
  2. I then apply these movement types to Π-positions, showing that only movement that reconstructs can target them. This categorically precludes some movement types.
  3. The Trace Interpretation Constraint derives this pattern, from which I conclude that property traces do not exist.
  4. To further illustrate the logic behind the Trace Interpretation Constraint, I give an argument from ACD against generalized-quantifier traces.

2.1 Movement and scope shifting

- ***What does it mean for movement to shift scope?***
  - For movement to shift scope means that, at LF, the moved DP takes scope in the position achieved by movement, which for all overt forms of movement, will be the DP's surface syntactic position.

    (12) **Movement that shifts scope**
    [✓$_1$ . . . [. . . ___$_1$ . . .]]

  - A check mark will be used to indicate where a DP takes scope at LF.
  - If movement does not shift scope, the scope of the moved DP at LF mismatches its surface position in that it takes scope in its position prior to movement, i.e. it reconstructs into its base-generated position.

    (13) **Movement that does not shift scope**
    [___$_1$ . . . [. . . ✓$_1$ . . .]]

2.1.1 Topicalization

⁎ ***Generalization***
Topicalization obligatorily shifts the scope of the moved DP.
⇝ Topicalization cannot reconstruct for scope.

- ***Baseline sentence***
Consider the possible interpretations of the baseline sentence, which has narrow-scope and wide-scope readings of *some student* w.r.t. *every teacher*:

(14) *Every teacher* likes **some student** in the first week.

a. **Narrow-scope reading** — every ≫ some
For every teacher x, there is some student y such that x likes y.

b. **Wide-scope reading** — some ≫ every
There is some student y such that for every teacher x, x likes y.

- Crucially, in a scenario where the student is a different student for each teacher, only the narrow-scope reading is true.

- ***Target sentence***
Topicalizing *some student* in (14) bleeds the narrow-scope reading:

(15) [**Some student**]$_1$, *every teacher* likes ___$_1$ in the first week.
*every ≫ some; ✓some ≫ every

- The only interpretation of (15) is the wide-scope reading. Consequently, (15) is true iff there is a single student that every teacher likes. It is false if the student is a different student for each teacher.

2.1.2 *Wh*-movement

⁎ ***Generalization***
Wh-movement optionally shifts the scope of the moved DP.
⇝ *Wh*-movement can reconstruct for scope.

- ***How many-questions***
In order to probe scope in constituent questions, we will use *how many*-questions. In addition to the *wh*-meaning component, *how many* independently carries its own existential quantification that can vary in scope (Kroch 1989; Cinque 1990; Cresti 1995; Rullmann 1995; Frampton 1999):

(16) [**How many books**]$_1$ should Nina read ___$_1$ this summer?

a. **Wide-scope reading** — how many ≫ should

i. For what number n: There are n-many particular books x such that Nina should read x this summer.

ii. $[\![(16)]\!](w_0) = \{p : \exists n \in \mathbb{N}[p = \lambda w\ .\ \exists X[\textsc{book}^*_w(X) \wedge \#X = n \wedge \textsc{should}_w(\lambda w'\ .\ \textsc{read}^*_{w'}(X)(\text{Nina}))]]\}$

iii. Possible answer: 'Three books, namely *Aspects*, *LGB*, and *The Minimalist Program*.'

b. **Narrow-scope reading** should ≫ how many

i. For what number n: It is necessary for there to be n-many books x such that Nina reads x this summer.

ii. $[\![(16)]\!](w_0) =$
$$\{p : \exists n \in \mathbb{N}[p = \lambda w \,.\, \text{SHOULD}_w(\lambda w' \,.\, \exists X[\text{BOOK}^*_{w'}(X) \wedge \#X = n \wedge \text{READ}^*_{w'}(X)(\text{Nina})])]\}$$

iii. Possible answer: 'Three books, any three.'

- The wide-scope and narrow-scope readings of (16) can be paraphrased as the questions in (17a) and (17b) respectively.

(17) a. **Wide-scope paraphrase of (16)**
How many books are there that Nina should read this summer?

b. **Narrow-scope paraphrase of (16)**
What is the number such that Nina should read that many books this summer?

- The scope ambiguity in (16) is the result of the fact that *wh*-movement only optionally shifts scope.

2.1.3 Summary

⁎ Topicalization cannot reconstruct, while *wh*-movement can reconstruct. To this, we can add that QR also cannot reconstruct (by definition):

(18) **Topicalization**
$[_{\text{TopicP}}\ \overset{\checkmark}{\_\_}_1$ Topic [. . . [. . . $\overset{*}{\_\_}_1$ . . .]]]
topic

(19) **Quantifier Raising**
[$\overset{\checkmark}{\_\_}_1$ [. . . [. . . $\overset{*}{\_\_}_1$ . . .]]]
QR

(20) ***Wh*-movement**

a. **Reconstructed derivation**
[Q $\_\__1$ . . . [. . . $\overset{\checkmark}{\_\_}_1$ . . .]]
wh

b. **Scope-shifted derivation**
[Q $\overset{\checkmark}{\_\_}_1$ . . . [. . . $\_\__1$ . . .]]
wh

- ***Qualification***
We are only interested in the **scope-shifting functionality of QR**.
  - This functionality ordinarily coalesces with QR for interpreting quantifiers, but we will see that even though quantificational DPs can occur in Π-positions, they do not enjoy the scopal mobility that QR would afford.
  - For reasons of time, I will not discuss today how to interpret quantificational DPs in Π-positions. However, it is essentially an open question; see Poole (2017) for discussion and some possible solutions.

2.2 Π-positions

⁎ ***Predictions***
The Trace Interpretation Constraint makes the following predictions:

1. ***Scope prediction***
If movement targets a Π-position, it must reconstruct, because an entity trace is type-incompatible with a property-denoting DP.

2. ***Movement-type prediction***
If a movement type cannot reconstruct, it can never target Π-positions.

2.2.1 Existential constructions

- ***Movement types***
Wh-movement can target the PIVOT of an existential construction, but topicalization and QR cannot:[3]

(21) a. **Baseline**
There is **a potato** in the pantry.

b. ***Wh*-movement**
✓**What**$_1$ is there $\_\__1$ in the pantry?

c. **Topicalization**
*[**A potato**]$_1$, there is $\_\__1$ in the pantry.

d. **QR**
There *must* be **someone** in his house. ✓must ≫ ∃; *∃ ≫ must

⇒ **This confirms the movement-type prediction.**

[3] The observation that QR cannot target the pivot of an existential comes from Williams (1984).

- ***Scope and wh-movement***
  Even though *wh*-movement can ordinarily shift scope, when it targets the pivot of an existential construction, scope shifting is rendered impossible:

(22) [**How many questions**]$_1$ *should* there be ___$_1$ on the exam?
*how many ≫ should; ✓should ≫ how many

- To appreciate this fact, let us compare the existential construction in (22) with its corresponding copula construction in (23), where *how many* is able to scope above or below *should*:

(23) **Copula equivalent of (22)** ✓h.m. ≫ should; ✓should ≫ h.m.
[**How many questions**]$_1$ *should* ___$_1$ be on the exam?

(24) a. **Narrow-scope paraphrase** ✓existential (22); ✓copula (23)
What is the number such that it is necessary that that many questions be on the exam?

b. **Wide-scope paraphrase** *existential (22); ✓copula (23)
How many questions are there such that it is necessary that they be on the exam?

- Consider the appropriateness of (22) and (23) in two different scenarios where I am a TA and the professor is preparing the final exam:
  - ***Scenario* #1**
    The professor wants to know the number of questions that I think the exam should have so that the grading is manageable on my end.
    ✓existential (22); ✓copula (23)
  - ***Scenario* #2**
    The professor has asked me to pick out from a workbook some questions that I think would be good exam questions. She wants to know the number of questions that I have selected so that she can gauge the amount of time that the exam room should be reserved for.
    #existential (22); ✓copula (23)

⇒ This difference follows from the fact that *wh*-movement must reconstruct when it targets a Π-position—here the pivot of an existential construction—thereby forcing a narrow-scope reading of *how many*.

⇒ **This confirms the scope prediction.**

2.2.2 Change-of-color verbs

- ***Movement types***
  Wh-movement can target the COLOR TERM of a change-of-color verb, e.g. *paint*, *turn*, and *dye*, but topicalization cannot:

(25) a. **Baseline**
Megan painted the house **magenta**.

b. ***Wh*-movement**
✓[**What color**]$_1$ did Megan paint the house ___$_1$?

c. **Topicalization**
***Magenta**$_1$, Megan painted the house ___$_1$.

- Topicalization can target color terms where they do not denote properties:

(26) {**Green / that color**}$_1$, he never discussed ___$_1$ with me.

- QR cannot target the color term, which we can compare with QR targeting the object, which is indeed possible:

(27) a. **Color term** ✓a ≫ every; *every ≫ a
A (#different) contractor painted the house **every color**.

b. **Object** ✓a ≫ every; ✓every ≫ a
A (different) contractor painted **every house** that ugly green.

- (27a) is true iff there is a single contractor, who incidentally did lots of painting, but not if there is a different contractor for each color.

⇒ **This confirms the movement-type prediction.**

- ***Scope and wh-movement***
  When *wh*-movement targets the color term, it must reconstruct:

(28) [**How many colors**]$_1$ *should* Nina paint the house ___$_1$?

a. **Narrow-scope paraphrase** ✓should ≫ how many
✓What is the number such that it is necessary that Nina paint the house that many colors?

b. **Wide-scope paraphrase** *how many ≫ should
*How many colors are there such that it is necessary that Nina paint the house those colors?

⇒ **This confirms the scope prediction.**

2.2.3 Naming verbs

- ***Movement types***
  Wh-movement can target the NAME ARGUMENT of a naming verb, e.g. *name*, *call*, and *baptize*, but topicalization and QR cannot:

(29) a. **Baseline**
Irene called the cat **Snowflake**.

b. ***Wh*-movement**
✓[**What name**]$_1$ did Irene call the cat ___$_1$?

c. **Topicalization**
***Snowflake**$_1$, Irene called the cat ___$_1$.

d. **QR** ✓a ≫ every; *every ≫ a
A (#different) child called the cat **every nickname**.

- As with color terms, there is no general prohibition against topicalization targeting names:

(30) **Raphael**$_1$, we never discussed ___$_1$ as a possible name for him.

- ***Scope and wh-movement***
  When *wh*-movement targets the name argument, it must reconstruct:

(31) [**How many nicknames**]$_1$ *should* Nina call the cat ___$_1$?
*how many ≫ should; ✓should ≫ how many

2.2.4 Predicate nominals

- ***Movement types***
  Wh-movement can target PREDICATE NOMINALS, but topicalization and QR cannot:

(32) a. **Baseline**
Erika became **a teacher**.

b. ***Wh*-movement**
✓[**What (kind of teacher)**]$_1$ did Erika become ___$_1$?

c. **Topicalization**
*[**A math teacher**]$_1$, Erika became ___$_1$.

d. **QR** ✓a ≫ every; *every ≫ a
A (#different) student became **every kind of teacher**.

- ***Scope and wh-movement***
  When *wh*-movement targets a predicate nominal, it must reconstruct:

(33) [**How many kinds of teacher**]$_1$ *should* Nina become ___$_1$?
*how many ≫ should; ✓should ≫ how many

2.3 Putting together the pieces

✓ ***Predictions***
The previous section confirmed the predictions of the Trace Interpretation Constraint:

1. ***Scope prediction***
   If movement targets a Π-position, it must reconstruct, because an entity trace is type-incompatible with a property-denoting DP.

2. ***Movement-type prediction***
   If a movement type cannot reconstruct, it can never target Π-positions.

. . . .

⇒ What Π-positions reveal is that the semantic representation of scope-shifting movement is incompatible with property positions.

- According to the standard mechanism of interpreting movement (e.g Heim & Kratzer 1998) and the Trace Interpretation Constraint, this representation involves movement leaving an entity trace:

  – ***Scope shifting ⇏ Π-positions***
  Leaving a type-*e* trace would shift scope, but such a trace does not furnish the property meaning required by Π-positions, yielding ungrammaticality:

(34) $^*[\ \mathrm{DP}_1\ \lambda x_e \ldots [\ \ldots [\ x_e\ ]_{\Pi\text{-pos}} \ldots]\ ]$
type *e* trace

  – ***Reconstruction ⇒ Π-positions***
  Reconstruction obviates this problem by placing the moved expression back in the launching site of movement at LF. If a DP would not ordinarily violate the property requirement of Π-positions, then it will not do so under reconstruction either:

(35) ✓$[\ \_\_\__1 \ldots [\ \ldots [\ \mathrm{DP}_1\ ]_{\Pi\text{-pos}} \ldots]\ ]$
reconstruct

⁎ ***Implications***

The ungrammaticality of scope-shifting movement targeting Π-positions indicates that movement cannot map onto a trace ranging over properties, where the moved DP denotes either a property or a generalized quantifier over properties:

(36) **Property traces are ungrammatical**

a. $*[\ \mathrm{DP}_{\langle e,t\rangle}\quad \lambda f_{\langle e,t\rangle}\ [\ \ldots f \ldots\ ]\ ]$

b. $*[\ \mathrm{DP}_{\langle\langle et,t\rangle,t\rangle}\ \lambda f_{\langle e,t\rangle}\ [\ \ldots f \ldots\ ]\ ]$

- Were either option available, scope-shifting movement could then be salvaged when targeting Π-positions, and we would not observe ungrammaticality.
- We further know that (36b) is unavailable because even in instances that involve quantification over properties, these quantifiers over properties cannot take scope over other scope-bearing elements in the sentence:

(37) a. There was*n't* **every kind of doctor** at the convention.
✓not ≫ every; *every ≫ not

b. There was*n't* **only one kind of doctor** at the convention.
✓not ≫ only one; *only one ≫ not

- This unavailability of wide-scope is expected if (36b), where a generalized quantifier over properties has undergone QR, is unavailable:

(38) *[**every kind of doctor**]$_{\langle\langle et,t\rangle,t\rangle}$ $\lambda f_{\langle e,t\rangle}$ [there be $f_{\langle e,t\rangle}$ at the convention]
(QR)

- Moreover, if a λ-abstraction over properties is unavailable in (36b), then we can generalize that it is also unavailable in (36a), which completely rules out property traces.

⇒ **The syntax–semantics mapping does not permit movement to map onto traces ranging over properties, in accordance with the Trace Interpretation Constraint**.

(39) Trace Interpretation Constraint
$*[\ \mathrm{DP}_1\ \lambda f_\sigma \ldots [\ \ldots [\ f_\sigma\ ]_1 \ldots\ ]\ ]$, where σ is not an individual type

2.4 Generalized-quantifier traces and ACD

- ***Preliminaries***
Ellipsis is resolved in ACD configurations by moving the object covertly to a VP-external position (Sag 1976; Larson & May 1990; Fox 2002). The resulting representation satisfies the parallelism requirement on ellipsis and avoids the infinite-regress problem:

(40) $[\ \text{Subj}\ [\ \lambda_1\ \underbrace{[_{\text{VP}}\ \text{V}\ t_1]}_{\text{antecedent VP}}\ ]\ [_{\text{DP}}\ \text{NP}\ [_{\text{RC}}\ \lambda_2 \ldots \underbrace{\langle \text{V}\ t_2\rangle}_{\text{elided VP}}\ ]\ ]_1\ ]$

- This analysis is independently motivated by the observation in Sag (1976) and Larson & May (1990) that the object in ACD configurations obligatorily takes scope above the VP:

(41) **ACD forces scope shifting**

a. **Baseline** ✓want ≫ every; ✓every ≫ want
Katia wanted every painting that Sakshi painted.

b. **ACD** *want ≫ every; ✓every ≫ want
Katia wanted every painting that Sakshi did Δ.

c. **No ellipsis** ✓want ≫ every; ✓every ≫ want
Katia wanted every painting that Sakshi wanted.

- This scope pattern follows if the movement of the object to a VP-external position leaves a trace of type *e*, i.e. is QR.
- Thus, covert movement of the object leaving a type-*e* trace not only creates a suitable antecedent for ellipsis, it also makes a nontrivial, correct prediction about the scope of the object.

. . . .

⇒ Now, consider if the covert movement step instead mapped onto a generalized-quantifier trace. This would still provide a suitable antecedent for ellipsis:

(42) **ACD derivation with GQ-traces**

$[\ \text{Subj}\ [\ \lambda_1\ \underbrace{[_{\text{VP}}\ \text{V}\ \text{T}_1]}_{\text{antecedent VP}}\ ]\ [_{\text{DP}}\ \text{DP}\ [_{\text{RC}}\ \lambda_2 \ldots \underbrace{\langle \text{V}\ \text{T}_2\rangle}_{\text{elided VP}}\ ]\ ]_1\ ]$

- However, a generalized-quantifier trace would not derive the scope pattern in (41).
  - Crucially, QR is not done in ACD configurations in order to give the object a certain scope.
  - This can be done without ACD (41c). Rather, QR is done to provide a suitable antecedent for ellipsis, for which at least type-e and type-$\langle et, t\rangle$ traces would suffice.

✓ ***With the Trace Interpretation Constraint***

- If the only possible trace that movement can map onto is type e, in accordance with the Trace Interpretation Constraint, the scope facts in (41) follow directly.

⇝ Logic: If movement must be used to achieve some means, the only trace available to that movement ranges over an individual type.

✗ ***Without the Trace Interpretation Constraint***
If there are higher-type traces, then they would have to be blocked in ACD in a fairly ad hoc manner.

- A parallel argument can be made based on extraposition (Williams 1974; Fox & Nissenbaum 1999).

3 Trace Rigidity Principle

(43) TRACE RIGIDITY PRINCIPLE
Traces cannot be type shifted.

- ***Preview...***
  - I will show that anaphoric definite descriptions, a superset of traces under Trace Conversion, cannot occur in property positions, but their nonanaphoric counterparts can. This provides independent support for trace rigidity.
  - I then develop a syntactic analysis of this incompatibility in terms of the weak–strong definite distinction (in the sense of Schwarz 2009).

⇝ Under this proposal, trace rigidity follows from how DPs are constructed in the syntax.

- The point of departure is the observation that at first glance, seemingly type-e elements appear to be able to occur in Π-positions:

(44) a. **Color verbs**
Megan painted the house **that hideous shade of purple**.

b. **Naming verbs**
Irene called the cat **that dumb nickname**.

c. **Predicate nominals**
Erika became **that kind of teacher**.

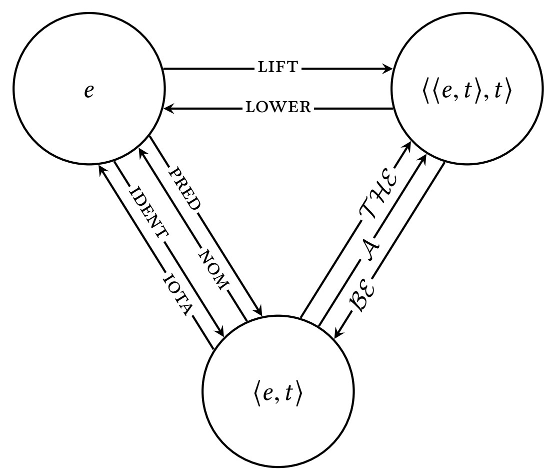
- Given the fact that Π-positions require property-denoting expressions, why are the examples in (44) grammatical?

3.1 Type shifting to property

⁎ ***Answer in a nutshell***
DPs can obtain a property denotation via nominal type shifting.

- ***Partee Triangle***
  - Partee (1986) argues that DPs have three types of denotations: entities (e), properties ($\langle e, t\rangle$), and generalized quantifiers ($\langle et, t\rangle$).
  - She proposes a set of semantic type shifters that allow DPs to flexibly shift from one type to another:

(45) PARTEE TRIANGLE



- The type shifters that are important for us are IDENT, PRED, and $\mathcal{BE}$.

⇒ ***Entity → Property***
IDENT maps any element onto its singleton set, e.g. x to $[\lambda y\,.\,x = y]$.

⇒ ***Entity → Property***
PRED maps the entity-correlate of a property onto the corresponding property, e.g. ⟦green⟧ the noun into ⟦green⟧ the adjective (Chierchia 1984).

– Not every property has an entity correlate, and not every entity corresponds to a property, so PRED is of limited use.

⇒ ***Generalized quantifier → Property***
$\mathcal{BE}$ is a homomorphism between $\langle et,t\rangle$ and $\langle e,t\rangle$. It applies to a generalized quantifier, finds all of the singleton sets therein, and collects the elements of these singleton sets into a set:

(46) $\mathcal{BE} = \lambda\mathcal{P}_{\langle et,t\rangle}\,\lambda x_e\,.\,\mathcal{P}([\lambda y\,.\,y = x])$
$= \lambda\mathcal{P}_{\langle et,t\rangle}\,\lambda x_e\,.\,\{x\} \in \mathcal{P}$

• To briefly illustrate, consider the extensions of some quantificational DPs below, where the singleton sets are boxed; s, m, n are cats; and o is a dog.

(47) a. ⟦every cat⟧ = $\{\{s,m,n,o\},\{s,m,n\}\}$

b. ⟦some cat⟧ = $\{\{s,m,n,o\},\{s,m,n\},\{s,m\},\boxed{\{s\},\{m\},\{n\}},\ldots\}$

c. ⟦two cats⟧ = $\{\{s,m,n,o\},\{s,m,n\},\{s,m\},\boxed{\{s\oplus m\},\{m\oplus n\}},\ldots\}$

d. ⟦most cats⟧ = $\{\{s,m,n,o\},\{s,m,n\},\{s,m\},\{s,n\},\{m,n\},\ldots\}$

⁂ ***Proposal***
DPs never start out denoting properties. A property-type denotation is always achieved by nominal type shifting from an individual denotation (e) or a generalized quantifier denotation ($\langle et,t\rangle$):

(48) a. **Existential constructions**
There is [$\mathcal{BE}$(**a potato**)] in the pantry.

b. **Color verbs**
Megan painted the house [PRED(**magenta**)].

c. **Naming verbs**
Irene called the cat [$\mathcal{BE}$(**Snowflake**)].

d. **Predicate nominals**
Erika became [$\mathcal{BE}$(**a teacher**)].

⇒ Π-positions require a type shifter for the structure to semantically compose.

• This might also explain why property-type DPs (at least in English) are marked in comparison to type e and $\langle et,t\rangle$; see Poole (2017) for discussion.

• ***Taking stock and looking ahead...***

– We now have an explanation for why seemingly type-e (and technically type $\langle et,t\rangle$) elements can occur in Π-positions: they are type shifted into property meanings.

– However, thus far, nothing prevents these same type shifters from applying to traces, circumventing the Trace Interpretation Constraint.

– The next subsection introduces another generalization about Π-positions: they prohibit anaphoric definite descriptions.

– I argue that the ban on anaphoric definites and the ban on scope-shifting movement from Π-positions are one and the same under the hypothesis of Trace Conversion, wherein traces are in fact anaphoric definites.

– I then propose a syntactic account of the complementarity of type shifting and the anaphoric definite determiner.

3.2 Π-positions prohibit anaphoric definites

⁂ It is not the case that Π-positions allow all type-e elements (via type shifting). They only allow a proper subset of them. In particular, they prohibit definite descriptions that are anaphoric in nature:

(49) DEFINITE GENERALIZATION
Π-positions prohibit anaphoric definite descriptions.

• To motivate this, I use the diagnostics from Schwarz (2009).

• ***Reference to an indefinite***
For example, a definite description in a Π-position cannot refer to a previously mentioned indefinite:

(50) Blanche picked out *a shade of red* for the living room.

a. ✓But Dorothy thought that **the shade** was too dark.

b. #And Dorothy painted the room [**the shade**]$_{\Pi\text{-pos}}$.

⇒ ***Covariance with a quantifier***
More convincingly, a definite description in a Π-position cannot covary with an indefinite in a quantificational context:

(51) **Existential constructions**
In every hotel room with *an ugly lamp*, . . .

a. ✓**the lamp** is on the dresser.

b. #there is [**the lamp**]$_{\Pi\text{-pos}}$ on the dresser.

(52) **Change-of-color verbs**
Every time Irene picks out *a new color* for the bathroom, . . .

a. ✓Helen complains that **the color/shade** is too bright.

b. #Helen has to paint the room [**the color/shade**]$_{\Pi\text{-pos}}$.

(53) **Naming verbs**
Every time that my mom found *a new puppy name*, . . .

a. ✓my dad vetoed **the name**.

b. #she nicknamed the family dog [**the name**]$_{\Pi\text{-pos}}$.

- While anaphoric definites are prohibited in Π-positions, ordinary definites satisfied purely by uniqueness are okay:

(54) A: What did you like about the fridge?
B: Well, there was [**the spacious vegetable crisper**]$_{\Pi\text{-pos}}$.

- ***Two generalizations***
We now have two generalizations about what is not allowed in Π-positions:

(55) a. ***Scope generalization***
Π-positions cannot be targeted by movement that shifts scope.

b. ***Definite generalization***
Π-positions prohibit anaphoric definite descriptions.

⁎ ***Proposal***
These two generalizations are one and the same because "traces" are in fact anaphoric definite descriptions.

- The idea that traces are related to anaphoric definite descriptions is quite old; see Engdahl's (1980, 1986) early work on the semantics of questions.

- ***Trace Conversion***
  - However, the idea is probably best known now as the independently motivated copy-theoretic hypothesis of Trace Conversion (Sauerland 1998, 2004; Fox 1999, 2002, 2003).
  - Trace Conversion is an LF rule that renders the lower copies of a movement chain interpretable by inserting a variable, which is bound by the λ-abstraction created by movement, and replacing the determiner with a definite determiner.

(56) Trace Conversion

a. **Variable Insertion**
(Det) Pred → (Det) [Pred [$\lambda y\ .\ y = g(n)$]]

b. **Determiner Replacement**
(Det) [Pred [$\lambda y\ .\ y = g(n)$]] → the [Pred [$\lambda y\ .\ y = g(n)$]]
[Fox 1999, 2002, 2003]

⇒ The result of Trace Conversion is that traces are anaphoric definite descriptions, which allows the scope generalization to be subsumed under the definite generalization. We can also revise our understanding of trace rigidity:

(57) Trace Rigidity Principle *(revised)*
Traces cannot be type shifted.
⇝ Anaphoric definite descriptions cannot be type shifted.

3.3 Anaphoric definites and type shifting

- ***Question***
Why can anaphoric definite descriptions not be type shifted into property-type denotations so that they can occur in Π-positions?

- One possibility that can be set aside is linking the incompatibility directly to anaphoricity, as all of the previous infelicitous examples improve with *that*:

(58) Blanche picked out *a shade of red* for the living room.

a. #But Dorothy thought that **the shade/color** was too dark.

b. ✓But Dorothy thought that **that shade/color** was too dark.

⁎ ***Proposal in a nutshell***
Nominal type shifters and the (strong) definite determiner used in anaphoric definite descriptions are in **complementary distribution** such that a derivation can either apply Trace Conversion or apply a type shifter.

- ***Weak vs. strong definites***
  - Anaphoric definites live under another name: STRONG DEFINITES.
  - Schwarz's (2009) argues that there are two definite determiners:

(59) **Schwarz's (2009) weak and strong definite determiners**

a. $[\![\text{the}_{\text{WEAK}}]\!] = \lambda s\, \lambda P\, .\, \iota x[P(x)(s)]$

b. $[\![\text{the}_{\text{STRONG}}]\!] = \lambda s\, \lambda P\, \lambda y\, .\, \iota x[P(x)(s) \wedge x = y]$ [Schwarz 2009]

  - The strong definite determiner is anaphoric because it has access to an index which can be bound or valued contextually.

- In some languages, the weak and strong definite determiners have unique realizations. For example, in German, the weak definite determiner contracts with prepositions, but the strong one does not:

(60) **Weak and strong definites in German**

In jeder Bibliothek, die ein Buch über Topinambur hat, sehe
in every library that a book about topinambur has look
ich {**#im** / ✓**in dem**} Buch nach, ob man
I in.the$_{\text{WEAK}}$ in the$_{\text{STRONG}}$ book PART whether one
Topinambur grillen kann.
topinambur grill can

'In every library that has a book about topinambur I check in the book whether one can grill topinambur.' [Schwarz 2009:33]

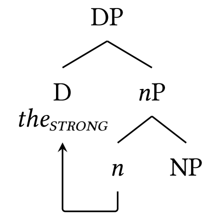
⇒ ***Trace Conversion → Strong definite***
Crucially, Trace Conversion requires the strong definite determiner in order to establish a connection between the upstairs moved DP and the downstairs definite description.

⁎ ***Proposed nominal structure***
I propose that the strong definite determiner and nominal type shifters are in complementary distribution because they compete for the same syntactic slot in the functional structure of a nominal:

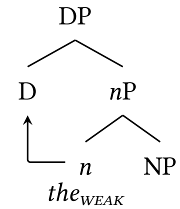
- *the*$_{\text{STRONG}}$ occupies D^0.
- *the*$_{\text{WEAK}}$ occupies some lower functional head, say n^0.
- Nominal type shifters occupy D^0 as well.

- For one stipulation, this complementarity derives both the definite generalization and the scope generalization.

(61) **Strong definite**



(62) **Weak definite**



(63) **English Vocabulary Items**

a. $[D + \sqrt{\text{THE}}_{\text{WEAK}}] \leftrightarrow$ /the/

b. $[\sqrt{\text{THE}}_{\text{STRONG}} + n] \leftrightarrow$ /the/

⇒ ***Type-shifted definite → Weak definite***
First, a definite that has been type shifted is necessarily a weak definite, thereby deriving the definite generalization:

(64) a. $[_{\text{DP}}$ (SHIFTER) $[_{n\text{P}}$ the$_{\text{WEAK}}$ NP]] ⇝ Weak def.; ✓type shifting

b. $[_{\text{DP}}$ the$_{\text{STRONG}}$ $[_{n\text{P}}$ n^0 NP]] ⇝ Strong def.; ✗type shifting

⇒ ***No Trace Conversion and type shifting***
Second, Trace Conversion and type shifting cannot apply to one and the same DP. Thus, in a Π-position, it is a lose-lose situation: either there is no binding (vacuous quantification) or there is no property-type denotation:

(65) *DP$_1$ λx . . . [$[_{\text{DP}}$ $\mathcal{BE}$ $[_{n\text{P}}$ the$_{\text{WEAK}}$ NP]]$_1$]$_{\Pi\text{-pos}}$ ✓Property ✗Quantification
?? *no variable to bind*

(66) *DP$_1$ λx . . . [$[_{\text{DP}}$ the$_x^{\text{STRONG}}$ $[_{n\text{P}}$ n^0 NP]]$_1$]$_{\Pi\text{-pos}}$ ✗Property ✓Quantification

- This incompatiblity derives the scope generalization.

⁎ Moreover, under this proposal, trace rigidity follows from how DPs are constructed in the syntax; see Poole (2017) for exploration of this idea.

4 Conclusion

- I have argued for the two following constraints on interpreting movement from the domain of property-denoting DPs:

(67) TRACE INTERPRETATION CONSTRAINT
$^{*}[\ \mathrm{DP}_1\ \lambda f_\sigma \ldots [\ \ldots [\ f_\sigma\ ]_1 \ldots\ ]\ ]$, where σ is not an individual type

(68) TRACE RIGIDITY PRINCIPLE
Traces cannot be type shifted.

- These constraints on possible traces are one way in which the range of permissible semantic types is constrained in natural language.

- According to this view, while semantic types are in principle unconstrained, at least in the eyes of the semantics, syntax provides a level of restriction on the semantic types that are actively used.

⁎ ***Recommendation***
For more details, see Poole (2017), *Movement and the semantic type of traces.*

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