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(Im)possible traces

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1 Introduction

⁎ ***The big question***
What are the kinds of semantic representations (i.e. LFs) that a movement dependency can map onto?

- ***Interpreting movement***
  - One of the pivotal discoveries about movement is that when an expression moves, it leaves behind something in its launching site.
  - Chomsky (1973) proposed that what is left behind is a TRACE, but since Chomsky (1993, 1995), it has been standardly assumed that the launching site is instead occupied by a COPY.
  - The shift to copy-theoretic conceptions of movement gives rise to an immediate semantic puzzle: a structure that contains two copies of a moved expression cannot be straightforwardly composed semantically.
  - There are two available and readily employed options:

(1) [**Which book**] did Nina read [**which book**]?

a. **Convert to a λ-bound variable ("leaving a trace")**
[**Which book**] [λx [did Nina read x]]?

b. **Reconstruct**
[~~which book~~] did Nina read [**which book**]?

⁎ ***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, like $\langle e,t\rangle$ and $\langle et,t\rangle$, these expressions cannot be represented as traces.
- Predecessors: Chierchia (1984), Romero (1998), Fox (1999), Landman (2006)

- This constraint forces movement either to map onto a trace over an individual type or to reconstruct. All other representations are ill-formed.

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

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

⇒ Thus, the interpretation of movement is tightly restricted, and higher-type expressions generally reconstruct when they move.

⁎ ***Main claim #2***

- Traces are not simple variables, but **bound anaphoric definite descriptions**, à la Trace Conversion (e.g. Engdahl 1980, 1986; Fox 1999, 2002, 2003):

(5) $[\ \mathrm{D\ NP}\ ]_1 \ldots [\ \mathrm{D\ NP}\ ]_1 \rightsquigarrow [\ \mathrm{D\ NP}\ ]\ \lambda x\ [\ldots [\ \text{the NP}\ [\lambda y\ .\ y = x]\ ] \ldots]$

- Anaphoric definite descriptions are only type e because they cannot be type shifted to $\langle e,t\rangle$ and $\langle et,t\rangle$. This blocks movement dependencies from utilizing higher-type traces.
- Under this hypothesis, the restrictions on possible traces reduce to the syntax and semantics of definite descriptions.

2 Trace Interpretation Constraint

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

(6)

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:

(7) $[\ \mathrm{DP}_1\ \lambda f_e \ldots [\ldots [\ f_e\ ]_1 \ldots]\ ]$

✗ ***Generalized-quantifier traces***

- Romero (1998) and Fox (1999) show that generalized-quantifier traces are unavailable (contra Rullmann 1995 and Cresti 1995):

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

- The argument is based on the correlation between Condition C connectivity and scope reconstruction. Generalized-quantifier traces would incorrectly allow for scope reconstruction without reconstruction for Condition C:

  (9) [How many pictures that **John**$_2$ took in Sarajevo]$_1$ does **he**$_2$ want the editor to publish ___$_1$ in the Sunday Special?

  a. **Wide-scope reading**
  ✓For what *n*: There are *n*-many particular pictures *x* that John took in Sarajevo such that John wants the editor to publish *x*.

  b. **Narrow-scope reading**
  *For what *n*: John wants the editors to publish in the Sunday Special (any) *n*-many pictures that John took in Sarajevo.

  [Romero 1998:96]

- In Poole (2017:122–126), I provide additional arguments against generalized-quantifier traces based on ACD, extraposition, and parasitic gaps.

[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.

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

⇒ ***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** ("Π" for property). 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**]$_{\langle e,t\rangle}$.

- In the interest of time, 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

[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.

- ***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.

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**
    $[\ \underline{\ \checkmark\ }_1 \ldots [\ \ldots \underline{\quad\ }_1 \ldots]\,]$

  - 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**
    $[\ \underline{\quad\ }_1 \ldots [\ \ldots \underline{\ \checkmark\ }_1 \ldots]\,]$

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

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

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**
$[_{\text{TopicP}}\ \overset{\checkmark}{\rule{1em}{0.4pt}}_1\ \text{Topic}\ [\ \ldots\ [\ \ldots\ \overset{*}{\rule{1em}{0.4pt}}_1 \ldots\ ]\,]\,]$
topic

(19) **Quantifier Raising**
$[\ \overset{\checkmark}{\rule{1em}{0.4pt}}_1\ [\ \ldots\ [\ \ldots\ \overset{*}{\rule{1em}{0.4pt}}_1 \ldots\ ]\,]\,]$
QR

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

a. **Reconstructed derivation**
$[\ \text{Q}\ \rule{1em}{0.4pt}_1 \ldots [\ \ldots\ \overset{\checkmark}{\rule{1em}{0.4pt}}_1 \ldots\ ]\,]$
wh

b. **Scope-shifted derivation**
$[\ \text{Q}\ \overset{\checkmark}{\rule{1em}{0.4pt}}_1 \ldots [\ \ldots\ \rule{1em}{0.4pt}_1 \ldots\ ]\,]$
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 (2017:83–87) 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.[3]

2.2.1 Existential constructions

- ***Movement types***
Wh-movement can target the PIVOT of an existential construction, but topicalization and QR cannot:[4]

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

b. ***Wh*-movement**
✓**What**$_1$ is there $\rule{1em}{0.4pt}_1$ in the pantry?

c. **Topicalization**
*[**A potato**]$_1$, there is $\rule{1em}{0.4pt}_1$ in the pantry.

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

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

[3] Postal (1994) was the first to observe that Π-positions cannot be targeted by some movement types, though he has a different explanation; see Poole (2017:88–90) for a comparison of the two accounts.
[4] 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.**

- ***Negative islands***
  Further confirmation of the scope prediction comes from negative islands, which independently block reconstruction (e.g. Rullmann 1995).

(25) [**How many books**]$_1$ did Nina not read ___$_1$?

a. **Wide-scope reading** how many ≫ not
For what number n: There are n-many particular books x such that Nina did not read x.

b. **Narrow-scope reading** not ≫ how many
*For what number n: It is not the case that Nina read n-many books.

– Since negative islands force *how many* to take wide scope and Π-positions force *how many* to take narrow scope, the two should be mutually exclusive.
– This prediction is borne out:[5]

(26) a. *[**How many books**]$_1$ aren't there ___$_1$ on the table?
b. ✓[**How many tables**]$_1$ aren't there books on ___$_1$?

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:

(27) 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:

(28) {**Green / that color**}$_1$, he never discussed ___$_1$ with me.
[Postal 1994:164]

[5] The same fact can be shown with *wh*-islands; see Poole (2017:56–59).

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

(29) 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.

- (29a) 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:

(30) **Narrow scope forced**
[**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?

(31) **No extraction from negative islands**

a. *[**How many colors**]$_1$ did no one paint their house ___$_1$?

b. ✓[**How many houses**]$_1$ did no one paint ___$_1$ lime green?

⇒ **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:

(32) 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:

(33) **Raphael**$_1$, we never discussed ___$_1$ as a possible name for him.
[Postal 1994:164]

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

(34) [**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:

(35) 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:

(36) [**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:

  (37) $^*[\ \mathrm{DP}_1\ \lambda x_e \ldots [\ \ldots [\ x_e\ ]_{\Pi\text{-pos}} \ldots]\ ]$
  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:

  (38) $^{\checkmark}[\ \_\__1 \ldots [\ \ldots [\ \mathrm{DP}_1\ ]_{\Pi\text{-pos}} \ldots]\ ]$
  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:

(39) **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 (39b) 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:

(40) 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 (39b), where a generalized quantifier over properties has undergone QR, is unavailable:

(41) *[**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 (39b), then we can generalize that it is also unavailable in (39a), 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.**

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

3 Traces are strong definite descriptions

- ***Interpreting copies as variables***
  – Recall from above that one way in which a movement chain is rendered interpretable is by converting the lower copy into a variable.

  – However, the lower copy does not inherently provide a representation corresponding to a bound variable.

  – Fox (2002) proposes that the bound-variable interpretation is arrived at by converting the lower copy into a **bound definite description** (see also Engdahl 1980, 1986; Sauerland 1998, 2004; Fox 1999, 2003).

  – This process is known as Trace Conversion, which involves an LF rule that inserts a variable that is then bound by the λ-abstraction created by movement and replaces the determiner with a definite determiner:[6]

(43) TRACE CONVERSION [Fox 1999, 2002, 2003]

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

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

⇒ ***Prediction***
  – If the lower copies of movement chains are definites, they would have to be definites of a special kind, namely STRONG (=anaphoric) definites.

  – This in turn predicts that traces and strong definites should have similar distributions, but traces and WEAK (=nonanaphoric) definites should not.

⁕ ***This section...***
  – I show that strong definites cannot occur in Π-positions, but weak definites can occur in Π-positions.

  – This supports the prediction made by Trace Conversion, which I take as evidence that traces are indeed strong definites.

  – I develop a syntactic analysis of the incompatibility of strong definites (and by extension traces) with Π-positions, building on Schwarz's (2009) analysis of the weak–strong definite distinction.

[6] In support of Johnson (2012, 2014), Poole (2017) argues that Trace Conversion should be recast as part of how a movement dependency is built up in the syntax, which in turn requires multidominant representations, rather than as an LF rule. Everything that I say in this talk is compatible with either implementation.

⇒ ***Upshot***
Under this proposal, the Trace Interpretation Constraint is **derived** from how DPs are constructed in the syntax.

3.1 Type shifting to property

- 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**.

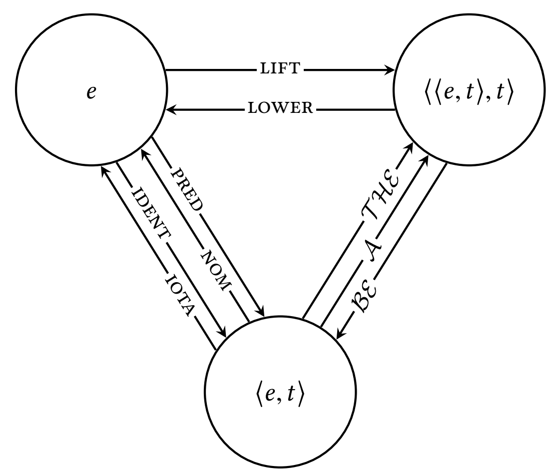
c. **Predicate nominals**
Erika became **that kind of teacher**.

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

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

- ***Partee's nominal type shifting***
Partee (1986) proposes a set of semantic type shifters that allow DPs to shift between their three types of denotations (e, $\langle e,t\rangle$, and $\langle et,t\rangle$):

(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).

⇒ ***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) $$\begin{aligned}\mathcal{BE} &= \lambda\mathcal{P}_{\langle et,t\rangle}\,\lambda x_e \,.\, \mathcal{P}([\lambda y \,.\, y = x])\\ &= \lambda\mathcal{P}_{\langle et,t\rangle}\,\lambda x_e \,.\, \{x\} \in \mathcal{P}\end{aligned}$$

- 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. $[\![\text{every cat}]\!] = \big\{\{s,m,n,o\},\{s,m,n\}\big\}$

b. $[\![\text{some cat}]\!] = \big\{\{s,m,n,o\},\{s,m,n\},\{s,m\},\boxed{\{s\},\{m\},\{n\}},\ldots\big\}$

c. $[\![\text{two cats}]\!] = \big\{\{s,m,n,o\},\{s,m,n\},\{s,m\},\boxed{\{s\oplus m\},\{m\oplus n\}},\ldots\big\}$

d. $[\![\text{most cats}]\!] = \big\{\{s,m,n,o\},\{s,m,n\},\{s,m\},\{s,n\},\{m,n\},\ldots\big\}$

∗ ***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. $\langle et,t\rangle \to \langle e,t\rangle$

b. **Change-of-color verbs**
Megan painted the house [PRED(**magenta**)]. $e \to \langle e,t\rangle$

c. **Naming verbs**
Irene called the cat [$\mathcal{BE}$(**Snowflake**)]. $\langle et,t\rangle \to \langle e,t\rangle$

d. **Predicate nominals**
Erika became [$\mathcal{BE}$(**a teacher**)]. $\langle et,t\rangle \to \langle e,t\rangle$

⇒ 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 (2017:203–204) for discussion.

- ***Taking stock…***
  - We now have an explanation for why seemingly type-e (and technically type $\langle et,t\rangle$) expressions 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.

3.2 Π-positions prohibit strong definites

- It is not the case that Π-positions permit **all** type-e and $\langle et,t\rangle$ expressions. This means that not all expressions can type shift into property denotations.
  - This section observes that Π-positions prohibit strong definites:

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

  - Thus, it must be the case that strong definites cannot be shifted to type $\langle e,t\rangle$.
  - Following Schwarz's (2009) terminology, I refer to anaphoric definite descriptions as STRONG DEFINITES and nonanaphoric definite descriptions as WEAK DEFINITES.

- ***Testing for the felicity of strong definites***
  - We can create contexts where only a strong definite would be felicitous.
  - Two properties distinguish strong definites from weak definites, which can be used to create such contexts (Schwarz 2009):
    1. Strong definites must have an antecedent.
    2. Strong definites do not have to satisfy the standard uniqueness requirement of (weak) definites.
  - When these two conditions are satisfied and controlled for, definites become unacceptable in Π-positions.
  - Because definites can occur in Π-positions, but not in contexts that allow only strong definites, we can reason that it must be the case that the definites in Π-positions are necessarily weak definites.

⇒ ***Reference to an indefinite***
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/color** was too dark.

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

⇒ ***Covariance with a quantifier***
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**]$_{\Pi\text{-pos}}$.

- These two pieces of evidence show that strong definites are **ungrammatical** in Π-positions. In the above examples, the definite description in the Π-position is infelicitous because it must be a weak definite, whose uniqueness requirement is not satisfied in the context.

⇒ ***Part–whole bridging contexts***
The inverse can likewise be observed: weak definites are **grammatical** in Π-positions. There are certain contexts that require a weak definite, and in such contexts, definites are felicitous in Π-positions:

(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.
⇝ No traces, only reconstruction.

b. ***Definite generalization***
Π-positions prohibit strong (=anaphoric) definite descriptions.

⁎ ***Back to Trace Conversion***

– Under Trace Conversion, these two generalizations are one and the same because "traces" are in fact strong definites.

– Π-positions reveal that traces and strong definites have the same distribution, to the exclusion of weak definites.

– This confirms the prediction made by Trace Conversion and thus provides novel evidence in favor of traces being (strong) definite descriptions.

3.3 Strong definites and type shifting

⇒ ***Question***
Why can strong definites not be type shifted into property-type denotations so that they can occur in Π-positions?

- ***Not anaphoricity***
One possibility that can be set aside is linking the incompatibility directly to anaphoricity, as all of the previous infelicitous examples improve with *that*:

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

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

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

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

- ***Weak and strong definite determiners***
  - Schwarz (2009) proposes that the weak–strong definite distinction results from having two separate definite determiners:

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

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

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

  - The strong definite determiner is anaphoric because it has access to an index which can be bound or valued contextually, thereby picking out a particular referent rather than relying on uniqueness alone.

- 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:

(58) **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$_{\textsc{weak}}$ in the$_{\textsc{strong}}$ 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]

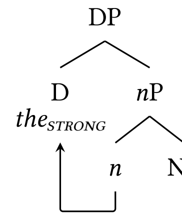
⇒ ***Trace Conversion → Strong definite***
Crucially, Trace Conversion requires the strong definite determiner in order to establish a connection between the upstairs moved DP and the downstairs definite description.

⁎ ***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:

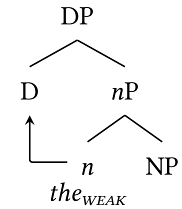
- *the*$_{\textsc{strong}}$ occupies D^0.
- *the*$_{\textsc{weak}}$ occupies some lower functional head, say n^0.
- Nominal type shifters occupy D^0 as well.

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

(59) **Strong definite**



(60) **Weak definite**



(61) **English Vocabulary Items**

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

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

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

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

b. $[_{\text{DP}}$ the$_{\textsc{strong}}$ $[_{n\text{P}}$ 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:

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

(64) *DP$_1$ λx … [$[_{\text{DP}}$ $\text{the}^{\textsc{strong}}_{x}$ $[_{n\text{P}}$ n^0 NP]]$_1$]$_{\Pi\text{-pos}}$ ✗Property ✓Quantification

⁎ ***What we have gained***
  - This incompatibility derives both the definite and scope generalizations about Π-positions.
  - Moreover, under this proposal, the ban on property traces is derived from **how DPs are constructed in the syntax**.

3.4 Generalizing to generalized quantifiers

⁎ ***Proposal***

The Trace Interpretation Constraint as a whole is an artefact of the syntax and semantics of DPs, in particular strong definites.

– The ban on property traces already follows from the proposal in the previous subsection.

⇝ The ban on generalized-quantifier traces follows from strong definites never being born as generalized quantifiers, only as type-e expressions.

⇝ As strong definites cannot be type shifted, there is no means for them to obtain a generalized-quantifier denotation, thereby preventing generalized-quantifier traces.

- ***Prediction***
  - This proposal that strong definites are always type e should be independently observable in nonmovement contexts.
  - Admittedly, this is somewhat hard to test because we need environments that **require** generalized-quantifier denotations.

⇒ ***Test case: Conjunction***

– One possible test case is conjunction with expressions that are bona fide generalized quantifiers, as a type e expression would need to be type lifted to conjoin with such expressions (Partee & Rooth 1983).

– The prediction is that only weak definites may conjoin with generalized quantifiers because only weak definites can be type shifted.

– In a context requiring a strong definite, a definite description conjoined with a generalized quantifier should be infelicitous because the conjunction forces it to be a weak definite, whose uniqueness requirement is not satisfied in the context.

– This prediction is borne out:[7]

(65) a. In every library with *a book about topinambur*, I look in **the book (??and every encyclopedia)** to see whether one can grill topinambur.

b. In every library with *a book about topinambur*, I look in **that book (and every encyclopedia)** to see whether one can grill topinambur.

[7] I should note that the judgements in this section have not been as rigorously tested.

– Conversely, in contexts where the uniqueness requirement of a weak definite is satisfied, a definite description should be able to conjoin with a generalized quantifier because weak definites can be type shifted.

– This prediction is also borne out:

(66) *The town* was so big that **the church (and every municipal building)** was impossible to find.

⁎ ***Upshots***

– The Trace Interpretation Constraint need not be stated as an extrinsic constraint in the syntax, but can be derived from the syntax and semantics of DPs, i.e. the properties of the moving expression.

– There is the clear prediction that movement (i.e. traces) and strong definites should form a natural class. We have seen evidence confirming this prediction from property-type DPs and now from conjunction. This gives us a new tool to probe the properties of movement dependencies.

- ***Crosslinguistic extensions***
  - Strong definites in other languages may have different properties from their counterparts in English. This analysis predicts that these differences should be reflected in the restrictions on movement.
  - This might be able to capture the purported crosslinguistic variation in the availability of generalized-quantifier traces (Lechner 1998, to appear; Keine & Poole 2017) as differences with the syntax and semantics of strong definites in the respective language.

4 Conclusion

- I proposed the following constraint on interpreting movement, based on novel evidence 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

- The Trace Interpretation Constraint forces movement to either map onto a trace over an individual semantic type or to reconstruct, thereby tightly restricting the interpretation of movement.
- I then argued that this constraint follows from (i) treating traces as strong definites, à la Trace Conversion, and (ii) the syntax and semantics of said strong definites.

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