The great mathematician Bill claims to be:
potential theoretical interest and implications

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Equational Intensional 'Reconstruction' Relative (EIRR)
[1] a. [The **great mathematician** *Bill* <u>claims</u> to be __] {should have solved this trivial
     problem with greater ease, should have no difficulty with this easy problem}. **[EIRR]**
   b. [The great mathematician *you* claim to be __] has just walked in,
     and is about to strangle you. **[straightforward relative]**

1. <u>Two issues of general theoretical interest</u>

How do EIRRs relate (i) to other relative constructions in which the external NP appears to be interpreted in a position lower than the observable one (e.g., [2]-[6]), and (ii) to superficially similar predicate DPs (e.g., [7])?

<u>**Pronoun binding into the head**</u>
[2] [The **relative of his**$_i$ that <u>every boy</u>$_i$ invited __ to his birthday party]
    invited him$_i$ in turn to hers.
<u>**Idiom chunks**</u>
[3] The **headway** that they <u>made</u> __ on this project was impressive.
<u>**Ordinal/superlative scope (Bhatt 2002)**</u>
[4] [The **first/longest book** that John said that Mary claimed that Tolstoy wrote __]
    is *War & Peace*.
   a. The first book of which John said that Mary claimed that Tolstoy wrote it is
     War & Peace.'
   b. 'John said that the first book that Mary claimed Tolstoy wrote is *War and Peace.'*
   c. 'John said that Mary claimed that the first book Tolstoy wrote is *War and Peace.'*
<u>**Dependency on a CP-internal intensional operator**</u>
[5] [The **perfect wife** that John has been <u>looking for</u> __ for ages] might be hard to find.
<u>**Concealed EIRR**</u>
[6] *[Context: you hired Bill, and you claim he is a great mathematician]*
    [The great mathematician you claim to have hired __] should have solved this easy
    problem with greater ease.

<u>**Predicative DPs**</u>
[7] a. Ahmed his finally [the naturalized American citizen that his father has been __
    since 1995].
   b. Being [the idiot he is __], John failed to understand Mary's hint.

The 'reconstruction' problem

Two major approaches: [i] The LF approach, which assumes that in the input to semantics, the external NP assumes a lower position, due to the prior cyclic formation of a chain of identical copies, with the option of interpreting any copy and ignoring the others, and [ii] The Surface Interpretation approach, which utilizes variables of varying types for the 'gap', and type-shifting operations in the course of the derivation.

The central *credo* of the LF approach is that the element on which NP is in some way dependent must c-command it in the input to semantics. This approach therefore has a problem when the desired c-command configuration cannot be achieved. There are two known situations of this kind, which concern the constructions in [2]-[3].

[8] The assignment that **every** (male) student gave *her* that **every** (female) phonology
    professor most praised *him* for was the last one he handed in to her.
[9] [What they **made** __ on this project] isn't *(all that) impressive headway.*

For the Surface Interpretation approach, the principal hope is that the correct meaning will always be achievable from the surface representation. The particular techniques need not be identical in each and every case, since there is no reason for assuming that all 'reconstruction' effects constitute a unified phenomenon. Since this approach recognizes only NP and the gap as inputs to semantics, intermediate readings like [4b] constitute a *prima facie* problem. Heycock (2005) solved this problem by treating expressions like *John said* as evidentials, something that correctly predicts the impossibility of 'reconstruction' into factives:

[10] The first book that Mary {regretted, was upset} that Tolstoy wrote. *[unambiguous]*

We will outline an analysis of EIRRs based on Surface Interpretation, which exploits mechanisms developed for data like [2].

(Argumental) EIRRs and predicative DPs

The two constructions exhibit a striking shared property: they allow only the definite article (see [11]-[12]). This is different from other relatives with 'definiteness effects', which are limited the way E-type anaphora is: to definites and universals (see [13]-[14]).

[11] a. {The, #every, #a, #one} great mathematician that Bill is said to be __
        should have solved this easy problem with less effort.
     b. {The, #all the, #most, #two} great mathematicians that Bill and Mary claim
        to be __ should have solved this problem with greater ease.
[12] a. Bill is {the, #every, #a} great mathematician that his father was.
     b. Bill and Mary are {the, #all the, #several, #most, #two} great mathematicians
        that their parents were.

[13] Bill stole {#few, #three, the (few/three), all the, every} book(s) that there had been __
     on this desk.   ← *Carlson's "amount" relatives*
[14] [jo laRke khaRe hai], merii teacher   sochtii   hEN   ki
      WH boys standing are   my.f teacher.f thinks.f is.FPl that
     {ve,   dono, sab, *do, *kuch, *adhiktam} lambe haiN.   ← *Hindi correlatives*
      they both all two   few   most   tall   are
     'Which boys are standing, my teacher thinks that
     {those, both, all, *two, *few, *most} are tall.'

While the shared property in [11]-[12] needs to be trace to a common cause (and this will be done later on), the two constructions cannot share a common derivation, for the following reason: While the DPs in [12] denote a property that is possessed by the

copular subject, the DPs in [11] do not merely denote an individual endowed with such a property, but the very individual(s) denoted by the copular subject. This may not be entirely obvious in these examples, where the matrix predicate allows a generic subject, but emerges quite clearly from [15], where generic subjects are excluded.

[15] The gifted mathematician that Bill incontrovertibly is __ has just solved a most
difficult problem.

Preliminary characterization and *raison d'être* of EIRRs

[16] The *raison d'être* of EIRRs is to denote a 'version' of the (sum) entity defined by the copular subject which possesses the property denoted by NP at a proper subset of the full set of indices that is contextually taken into account.

The crucial factor that licenses the felicity of EIRRs is the fact that certain intensional indices are taken into account at which entities defined by the EIRR may fail to have the property denoted by NP. In [1a], e.g., this condition is satisfied: the DP denotes Bill as a great mathematician at the indices of his claims, but not necessarily at those of the speaker's beliefs. This requirement ensures that the EIRR is not trivially equivalent to its copular subject role (note that everything is identical to itself, but *asserting* this truism – or anything viewed as obvious – is felt to be odd), and its violation results in infelicity, as illustrated in [17]. The infelicity of [17] is of essentially the same kind as that of TFRs without an intensional operator (see [18]), and of the full version of [19].

[17] a. #The doctor that Bill is works for this hospital.
b. #The hospital has just hired the doctor that Bill is.
c. The unspeakable atrocity that female circumcision is should be stamped out from
this world.
[18] Bill is eating his soup with what {seems to be, #is} your fork.
[19] Mary, I love (#someone who is) you!

OTHER PROPERTIES;
--- The copular subject may exhibit every form of quantification, so long as it is possible to satisfy the EIRR's *raison d'être,* i.e., so long as the the subject may be viewed as defined independently of the NP property. In general, satisfaction is ensured by the copular subject having higher scope than some intensional operator with (understood) scope over the EIRR, but this is not absolutely necessary, if the denotatum of the copular subject can be defined independently of the NP property.

[20] a. [The brave fighters that ({all, most of, at least some of}) these soldiers (clearly) were
__] will (undoubtedly) be decorated by the queen. **← definite/universal/existential**
b. [The boring individuals that pompous professors typically are __]
are usually disliked by students.   **← generic**
c. [The good fathers that none of these guys were __] may have saved
their sons from committing suicide.   **← negative existential**
d. [The revolutionary physicists that at most three individuals in this country
apparently are __] will undoubtedly receive a Nobel Prize. **← downward entailing**
e. [The heroic fighter that each soldier in this unit incontrovertibly was __]
will undoubtedly receive a medal for his bravery.   **← distributive universal**

[21] a. [The gifted mathematician that the head of {our, any} mathematics department
      certainly is __] should manage to solve this problem effortlessly. ← *de dicto* **reading**
    b. [The brave fighter that one of you certainly is __] will undoubtedly be
      rewarded by the queen.
    b.#[The brave fighter that someone or other possibly is __] might well receive
      a medal of honor.

--- The EIRR needs to be defined at the indices of evaluation of the matrix.

[22] a. #[The good father that {nobody was, Bill wasn't} prevented his son from
      making a fatal mistake.
    b. #[The gifted mathematician that Bill possibly is __] {has just solved, seems to be
      working on} a tough problem.
    b. [The competent mathematician that Bill seemed to be __] is in fact a reality.
    c. [The competent mathematician that Bill may become __ some day] might well
      subsequently manage to prove the Riemann Hypothesis.

Three important issues:
  [i] The copular structure: predicative or equative?
  [ii] How to account for the 'reconstruction' effect?
  [iii] What is the source of the 'strong' definiteness requirement?

[i'] Since the property denoted by NP needs to be predicated of the EIRR's denotatum, one's knee-jerk reflex is to assume that this predication is implement via the copular construction, the gap being construed as a property variable. This turns out not to be feasible. The property variable tack is fine for the DPs in [12], where the CP is construed as λP.P(his father), NP is lifted by IDENT to λP.P = GM, and after intersection and Det application, the DP is interpreted as ιP. P = GM ∧ P(his father). But if we use this derivation for EIRRs, trying to shift to an individual denotation, we do not capture the fact that the EIRR denotatum needs to be a 'version' of the copular subject. It follows that the copular structure must be equative, and that NP must restrict the EIRR in another way.

[i''] <u>Surface Interpretation Approach</u>:
    Since the gap is in the scope of the intensional operator, it must be an intensional category, at the very least, an individual concept (of type <s,e>). In [1a], the relative CP is a set of individual concepts (see [23]), and NP needs to be lifted to the same type to allow intersection, as in [24]. Variable-restricting predication is thus part of the interpretation of NP, and intersection extends it to the variable within CP, as in [25].

[23] $\lambda f_{<s,e>} \forall i' \in \text{BILL'S CLAIMS } [B(i') = f(i')]$
[24] $\lambda f_{<s,e>} \forall i \in \text{DOM}(f) [GM(i) f(i)]$
[25] $\lambda f_{<s,e>} \forall i \in \text{DOM}(f) [GM(i) f(i)] \wedge \forall i' \in \text{BILL'S CLAIMS } [B(i') = f(i')]$

The set in [25] is too large, since it allows individual concepts to be defined at indices other than those of Bill's claims. To restrict the set in the desired way, we apply a Min(imality) operator to [25], which reduces the domain of f to Bill's claims. Application of the iota yields the following interpretation for the EIRR:
[26] $\iota(\text{Min}(\lambda f_{<s,e>} \forall i \in \text{DOM}(f) [GM(i) f(i)] \wedge \forall i' \in \text{BILL'S CLAIMS } [B(i') = f(i')]))$

<u>**LF Interpretation Approach**</u>
The LF representation of the EIRR in [1a] will have a copy of NP instead of the gap. This predicate of individuals needs to be lifted to a predicate of individual concepts restricting an individual concept variable. The effect of Min is achieved by stipulating that the external copy is left uninterpreted. The result is [27], whose 'cost' is comparable to that of the alternative approach. In essence, lower-copy lifting and application do the work of external-NP lifting and intersection with CP, and Min does the work of higher-copy deletion.

  [27] ι(λf $_{<s,e>}$ ∀i∈BILL'S CLAIMS [GM(i) f(i) ∧ B(i) = f(i)])

  <u>**Interpretation of a full sentence**</u>
[28] The gifted mathematician that Bill is supposed to be should be able to solve this problem.
[29]∀i'''∈EXPECT(i)[ABLE TO SOLVE THIS PROBLEM(i'')
    (ι(min(λx[∀i'∈DOM(x)[GIFTED MATH(i')(x(i'))]∧∀i''∈SUPPOSED(i)[BILL(i'') = x(i'')]))(i''')]

[iii] <u>**The strong definiteness effect in EIRRs and predicative DPs ([11]-[12])**</u>

  We start with predicative DPs, noting that this effect does not arise when the external NP is a predicate of properties and CP and NP can straightforwardly intersect, as in [30a], one version of which has the semantics in [31b]. It only arises when NP is a property, and requires lifting with IDENT, as in [31a], with the translations in [31b-d].
  [30] a. John is today [{everything, all the (admirable) things, most/three things} that his
        mother always wanted him to be __].
     b. ∀P [(ADMIRABLE) THING(P) ∧ ALWAYS WANTED(his mother)(P(he)) → P(j)]
  [31] a. John is [{the, #every, #a, #only one} gifted mathematician that his father was __].
      b. [σ[λP[P = GIFTED MATHEMATICIAN ∧ P(i)(FATHER(JOHN))(i)]]] (j)
      c. ∀P[P = GIFTED MATHEMATICIAN ∧ P(i)(FATHER(JOHN))(i)] → P(j)]
      d. ∃P[P = GIFTED MATHEMATICIAN ∧ P(i)(FATHER(JOHN))(i) ∧ P(j)]

  The crucial difference between [30b] and [31c] is that the latter, but not the former, includes equation. While there is nothing semantically ill-formed about [31b,c], the fact that any property, and thus GM, is identical to only one thing, i.e., itself, *explicitly* quantifying over the properties identical with it implicates that there may be more or fewer than exactly one property identical with GM, and the outcome is pragmatically strange, much like *{the, #every, #a} father of the king is a millionaire* (under the standard interpretation of *father*).
  The explanation just provided extends to plural cases like [32a], whose translation is given in [32b], using plural properties. Since every atom in the plurality is identical to exactly one property, i.e., itself, universal quantification over P implicates that the equated pluralities may have had different cardinalities, and thus that some atomic property may have been identical to more or fewer than exactly one property
  [32] a. #These guys are all the gifted mathematicians that their fathers were.
      b. ∀P*[P* = GIFTED MATHEMATICIAN* ∧ P*(i)(FATHERS(THEM))(i)] → P*(THESE GUYS)]

  Turning now to EIRs, consider [33].
  [33] {The, #a, #every} lucky grand prize winner that John became at 11 pm sharp
     was the happiest of humans.
The crucial property of the semantics of EIRRs which enables an extension of the account of [31]-[32] to [33] is the equational construal of the copula. Since at any index, the extension of an individual concept is identical to exactly on entity, i.e, itself, explicitly

quantifying over one of the equated terms implicates that things may have been otherwise, with resulting infelicity.

We have thus elegantly captured the shared definiteness effects in predicative DPs and EIRRs, while keeping their derivations apart, and in addition providing independent support for the equational analysis of EIRRs.

We are not yet completely done with the analysis of EIRRs. When the copular subject is existential (and/or the intensional operator is), Min will cut too deep, providing a non-singleton of atoms, i.e., conceptual atoms defined for a single index or extensionally equated with a single atomic entity). This necessitates applying Union to the output of Min, thereby enabling the application of the iota (alternatively, by using sigma instead of iota, which includes the union operation). The additional Union operation might seem to argue against Surface Interpretation, since LF Interpretation doesn't need it, but the union operation is in fact independently motivated by the need to 'coerce' application of the definite article (for reasons already seen).

As far as EIRRs in isolation are concerned, there is no immediate reason for preferring one of the two analytical approaches. However, if they are considered in combination with data like [2] and [8], things are a bit different.

Jacobson (1994, 2002, 2004) proposes to analyze DPs like the one in [2] by means of machinery very similar to ours, except that the gap is a function of type <e,e>. Similar type-shifting operations and the operator Min are needed, except that the determiner need not be definite, there being no comparable use of equation (see [34]). The semantics of [2] is shown in [35].

[34] A relative of his that every boy invited __ to his birthday party was his mother, another one was his father.

[35] $\iota(\min(\lambda f_{<e,e>} [\forall x \in DOM(f) [RELATIVE(x)(f(x))]] \wedge [\forall x[BOY(x) \rightarrow$
$INVITED(f(x))(x)]])) = MOTHER$

Now, dependency of NP on an intensional operator may be combined with dependency on a universal distributive quantifier, as in [20e]. If we take (8) to imply that Surface Interpretation is preferable for this construction in general, then such a conclusion extends to [20e]. The semantics of the EIRR in [20e] with Surface Interpretation is:

[36] $\sigma(\min(\lambda f_{<e,<s,e>>}[\forall x \in DOM(f) \forall i' \in DOM(f(x)) [HEROIC FIGHTER(i')(f(x)(i'))] \wedge$
$\forall x \in SOLDIER(i) \forall i'' \in INCONTROVERTIBLE (i) [x = f(x)(i'')]]]))$

Issues for subsequent research:

Check whether EIRRs and data like [8] exist in languages like Lakhota, where NP is CP-internal, and if yes, devise a semantics for handling them.

References

Bhatt, R. 2002. The raising analysis of relative clauses: Evidence from adjectival modification. *NALS* 10.

Heycock, Caroline (2005), "On the interaction of adjectival modifiers and relative clauses", *Natural Language Semantics* 13, 359-382.

Jacobson, P. 1994. Binding connectivity in copular sentences. *Proceedings of semantics and linguistic theory IV*.

Jacobson, P. 2002. Direct compositionality and variable free semantics: The case of binding into heads. *SALT* 7.

Jacobson, P. 2004. Direct compositionality: Is there any reason why not? U. of Michigan Workshop on Linguistics and Philosophy.