Equational Intensional 'Reconstruction' Relatives

Manfred Krifka
Humboldt Universität zu Berlin
Zentrum für Allgemeine Sprachwissenschaft (ZAS), Berlin
krifka@rz.hu-berlin.de
(with Alex Grosu, Tel Aviv University)

Grosu, Alexander & Manfred Krifka (2008), "*The gifted mathematician that you claim to be*: Eqational intensional 'reconstruction' relatives." *Linguistics and Philosophy* 30, 445-485.

1. What are EIRRs?

(1) [The gifted mathematician [that Bill claims to be _]]
should be able to solve this simple problem easily.

Naturally occurring examples:

(2) If you are the "patriotic American" that you claim to be then you should have no problem in helping me to protect myself. (cryptome.info/0001/il-spies-tx.htm)

(3) in fact if it's the ground breaking device that nokia claim it to be, it should have a digital radio (discussions.europe.nokia.com/discussions/board/message?board.id=smartphones&message.id=21886)

<u>Compositionality Problem</u>

The head nominal, *gifted mathematician,* appears to be in the scope of modal within the relative clause, *supposedly*. Paraphrase:

(4) 'If Bill were a gifted mathematician, as he is supposed to be, he should be able …'

<u>Compatibility Problem</u>

The main clause must contain a modal operator that is "compatible" with the modal operator of the relative clause. (To be qualified later.)

(5) [The famous mathematician [that Bill$_i$ claims to be _]]
is standing in front of him$_i$ and casting furious glances at him$_i$.

(5) lacks a modal operator in the main clause, but then it has a different reading (Bill claims to be another person), where the head noun is not in the scope of *claim*.

(6) [The gifted mathematician [that Bill claims to be _]] has perhaps solved the problem.

(6) has a modal operator in the main clause, but it is of the wrong sort – an epistemic operator. The following clause again only a reading in which Bill claoms to be another person.

<u>Restriction to predicational interpretations</u>

The relative clause is predicational, including kinds of hidden predications.

(7) [The gifted mathematician that Bill is widely viewed as _]
should be able to solve this problem.

(8) [The gifted mathematician that you claim to have hired _]
should be able to solve this problem.
'You have hired someone, and you claim that this person is a gifted mathematician, and this person (according to the claim) should be able to solve this problem.'

Notice that one is tempted to put scare quotes around "gifted mathematican" here, cf. also (2), and use the corresponding intonation, to get the intended reading.

2. A reconstruction analysis of EIRRs?

Vergnaud (1974), Kayne (1994): Head-raising analysis of relative clause. For semantic interpretation, the head is reconstructed in a position within the relative clause. In our case:

(9) the [___ [that [Bill [supposedly [is <u>gifted mathematician</u>]]]]]

Cf. for recent approaches Bhatt (2002), Hulsey & Sauerland (2006), within a copy theory of movement (Chomsky 1993). The head is spelled out externally, but interpreted internally.

(10) SS: the [gifted mathematician [that [Bill [supposedly [is ~~gifted mathematician~~]]]]]
should have solved this problem.
LF: the [~~gifted mathematician~~ [that [Bill [supposedly [is gifted mathematician]]]]]
should have solved this problem.

The initial discusson centered around c-command restrictions (cf. Engdahl 1984):

(11) [The relative of his$_1$ [that every boy$_1$ likes most _]] is his$_1$ mother.
X
[The ___ [that every boy$_1$ likes most [relative of his$_1$]]] is his$_1$ mother.

There are hidden complexities in this solution, e.g. a rule of trace conversion that restricts the trace to variables that satisfy the head noun (Fox 2002). Cf. critical discussion in Jacobson (2002a), and methodological points raised in Jacobson (2002b).

For EIRRs: Note the wrong form of the relative-internal head (a nominal, *gifted mathematician*, not an NP/DP, *a gifted mathematician*). As this is in a predicative position, things might be o.k., but consider cases like (8), which require a DP.

Our goal: Develop analysis that does not require head raising, or reconstruction (hence the scare quotes in naming them "reconstruction" relatives).

Methodological point: Such an analysis is possible, explanatory, and perhaps even elegant. Cases like (1) do not constitute good arguments for a reconstruction analysis.

3. A non-reconstruction analysis for EIRRs

3.1 Skolem function analysis for anaphoric binding case

(12) [The relative of his_1 [that every boy_1 likes most _]] is his_1 mother.

Analysis (von Stechow 1990, Jacobson 1994, 2002a, Sharvit 1996, 1999):

(13) $\iota f[\forall u \in DOM(f)[\text{RELATIVE}(u)(f(u)) \wedge \forall v[\text{BOY}(v) \rightarrow \text{LIKE\_MOST}(f(v))(v)]]$
$= \text{MOTHER}$

‘The function f such that for every u, f(u) is a relative of u, and for which it holds that every boy v likes f(v) most (among the relatives – not represented here), is the mother-function (the function that maps person to their mother)

Notice: No reconstruction required.

3.2 An individual-concept analysis of EIRRs

Basic idea

Proposed treatment for EIRRs as ranging over individual concepts;
x: a variable over individual concepts, functions from indices i (words, times) to entities.

(14) ⟦*the gifted mathematician Bill supposedly is*⟧(i)
$= \text{THE } x\, [\forall i' \in DOM(x)[\text{GIFTED MATH}(i')(x(i'))] \wedge \forall i'' \in \text{SUPPOSED}(i)[\text{BILL}(i'') = x(i'')]]$

The individual concept x such that for every index i′ for which x is defined, the individual is a gifted mathematician, and in addition for every index i″ that is compatible with what is supposed to be the case at the index of evaluation i, Bill is identical to x.

Uniqueness of the individual concept

What does THE mean? It should be applied to the following set of individual concepts:

(15) ⟦[[*gifted mathematician*] [*that Bill supposedly is* _]]⟧(i)
= λx[⟦*gifted mathematician*⟧(i)(x) ∧ ⟦*that Bill supposedly is* _ ⟧(i)(x)]
$= \lambda x[\forall i' \in DOM(x)[\text{GIFTED MATH}(i')(x(i'))] \wedge \forall i'' \in \text{SUPPOSED}(i)[\text{BILL}(i'') = x(i'')]]$

The regular interpretation of *the* as iota (ι) requires a singleton set. However, (15) need not be a singleton set:

- On the one hand, x is unique for all the indices i″ **inside** SUPPOSED(i), by virtue of the equation BILL(i″) = x(i″). That is, it is guaranteed that for all indices i″ that are compatible with what is supposed to be the case, x is identical to Bill, a unique individual.
- But x is not necessarily unique for indices i″ that are **outside** of SUPPOSED(i), as (15) restricts x only with respect to indices within SUPPOSED(i).

For example, if SUPPOSED(i) = $\{i_1, i_2, i_3\}$, if BILL(i) = b for all indices, if b is a gifted mathematician in i_1, i_2 and i_3, and if j is a gifted mathematician in i_4 and m is a gifted mathematician in i_5, then (15) applies to at least the following individual concepts:

(16) a. $\{\langle i_1, b\rangle, \langle i_2, b\rangle, \langle i_3, b\rangle\}$
b. $\{\langle i_1, b\rangle, \langle i_2, b\rangle, \langle i_3, b\rangle, \langle i_4, j\rangle\}$
c. $\{\langle i_1, b\rangle, \langle i_2, b\rangle, \langle i_3, b\rangle, \langle i_5, m\rangle\}$
d. $\{\langle i_1, b\rangle, \langle i_2, b\rangle, \langle i_3, b\rangle, \langle i_4, j\rangle, \langle i_5, m\rangle\}$
e. $\{\langle i_1, b\rangle, \langle i_2, b\rangle, \langle i_3, b\rangle, \ldots\}$

Proposal: *the* picks out a **minimal** individual concept of this set, here: (16.a).

(17) Let S be a set of functions, then $\min(S) = \{f \mid f \in S \wedge \forall g \in S[g \subseteq f \rightarrow g = f]\}$

We assume that minimization is an operator that can be freely applied to meet the uniqueness condition of ι when applied to a set of functions.

(18) ⟦[*the* [[*gifted mathematician*] [*that Bill supposedly is* _]]]⟧(i)
$= \iota\, (\min (\lambda x[\forall i' \in DOM(x)[\text{GIFTED MATH}(i')(x(i'))]$
$\wedge \forall i'' \in \text{SUPPOSED}(i)[\text{BILL}(i'') = x(i'')]]))$

What licenses minimization?

Suggestion: Gricean maxim of quantity, according to which information is to be maximized: Everything that has to be said is indeed said.

EIRRs are **definitions** of individual concepts. We can assume that all the necessary information to identify the definiendum is given.

In non-technical definitions, this is often left implicit; in technical definitions, such as in the typical scheme of recursive definitions, this is often made explicit by saying that elements that can be generated by such-and-such rules are in a set, and **nothing else** is in the set.

(19) Recursive definition of set S_7 of multiples of 7:
$7 \in S_7$, and if $x \in S_7$ then $(x+7) \in S_7$,
(and nothing else is in S_7, i.e. S_7 is the minimal such set).

Weak modal operators

(15) has a **strong** modal operator(universal quantification over indices). With **weak** operators (cf. (20)), there is more than one minimal individual concept, as the set of individual concepts is not restricted to one individual within the range of the modal, and ι cannot be applied.

Suggestion: By set union we form the sum of these minimal concepts; this corresponds to the familiar maximizing function of the definite article.

(20) ⟦[*the* [[*gifted mathematician*] [*that Bill might (turn out to) be* _]]]⟧(i)
$= \cup \min(\lambda x[\forall i' \in DOM(x)[\text{GIFTED MATH}(i')(x(i'))]$
$\wedge \exists i'' \in \text{EPISTEMIC}(i)[\text{BILL}(i'') = x(i'')]])$

Assume that Bill is a gifted mathematician in i_1 and i_2, and that EPISTEMIC(i) = $\{i_1, i_2, i_3\}$. With an existential modal operator, minimization would yield a set of two minimal functions $\{\{\langle i_1, b\rangle\}, \{\langle i_2, b\rangle\}\}$, and union would give us the function $\{\langle i_1, b\rangle, \langle i_2, b\rangle\}$ – the individual concept that picks out Bill for the indices that are expected and where he is, in fact, a gifted mathematician.

3.3 EIRRs within their sentententential context

(21) $[\![[[$*the* $[[$*gifted mathematician*$]$ $[$*that Bill supposedly is* _ $]]]$
$[$*should have solved the problem*$]]]\!](i)$

$= [\![$*should have solved the problem*$]\!](i)$
$([\![$*the* $[[$*gifted mathematician*$]$ $[$*that Bill supposedly is* _ $]]]]\!](i))$

$= \forall i'' \in \text{EXPECT}(i)[\text{SOLVE THIS PROBLEM}(i'')$
$(\cup \min(\lambda x[\forall i' \in \text{DOM}(x)[\text{GIFTED MATH}(i')(x(i'))]$
$\wedge \forall i'' \in \text{SUPPOSED}(i)[\text{BILL}(i'') = x(i'')]]))(i'')]$

This states that

- for all indices i″ that are expectable with respect to the index of evaluation i,
- it holds that the value of the individual concept 'the gifted mathematician that Bill supposedly is' defined above solved the problem.

Notice that this requires that the indices of the modal operator of the main clause (EXPECT) must be in the domain of the individual concept. This predicts the compatibility restriction between the two modal operators; here: $\text{EXPECT}(i) \subseteq \text{SUPPOSED}(i)$. This will be accomodated: We count only those expectations with respect to the background of what supposedly is the case.

3.4 Compositional derivation of EIRRs

Assumptions:

- Common nouns and verbal predicates don't apply to individuals, but to individual concepts, perhaps by type-lifting:

(22) $[\![$*gifted mathematician*$]\!](i)$
a. $\lambda u[\text{GIFTED MATH}(i)(u)]$, basic interpretation
b. $\lambda x \forall i' \in \text{DOM}(x)[\text{GIFTED MATH}(i')(x(i'))]$, type-lifted interpretation,
the set of individual concepts x such that they are gifted mathematicians
for all indices for which they are defined.

In the type-lifted interpretation, the meaning of the predicate is "put into" the objects the predicate applies to (cf. Leibniz' conception of individual concepts).

- The predicational construction in the relative clause is equational in nature.

(23) $[\![$*that*$_1$ $[$*Bill* $[$*supposedly* $[$*is* $t_{se,1}]]]]\!](i) = \lambda x_1\ \forall i' \in \text{SUPPOSED}(i)[\text{BILL}(i') = x_1(i')]$

- Standard intersective combination of head noun and relative clause; no raising or lowering required.

(24) $[\![[$*the* $[[$*gifted mathematician*$]$ $[$*that*$_1$ $[$*Bill* $[$*supposedly is* $t_{se,1}\ ]]]]]\!](i)$
$= \cup (\min (\lambda x[\forall i' \in \text{DOM}(x)[\text{GIFTED MATH}(i')(x(i'))]$
$\wedge \forall i'' \in \text{SUPPOSED}(i)[\text{BILL}(i'') = x(i'')]]))$

4. Discussion of the analysis of EIRRs

4.1 Equational nature of the predication within the relative clause, and related constructions

A predicational interpretation of the gap seems more appropriate:

(25) [The gifted mathematician [that Bill claims to be _]]
should be able to solve this simple problem in no time.

Under a predicational analysis, the gap would be of type set:

(26) $[\![[_{CP}$ *that*$_1$ $[$*Bill is* $t_{set,1}\ ]]]\!](i)$, under predicational analysis: $\lambda P_1[P_1(i)(\text{BILL}(i))]$

We can combine this with the head noun as well, resulting in a **property relative clause*:***

(27) $[\![[[_{NP}$ *gifted mathematician*$]$ $[_{CP}$ *that*$_1$ $[$*Bill is* $t_{set,1}\ ]]]]\!](i)$
$= [\![[[_{CP}$ *that*$_1$ $[$*Bill is* $t_{set,1}\ ]]]\!](i)([\![[_{NP}$ *gifted mathematician*$]]\!](i))$
$= \lambda P_1[P_1(i)(\text{BILL}(i))](\lambda u[\text{GIFTED MATH}(i)(u)])$
$= \text{GIFTED MATH}(i)(\text{BILL}(i)$

But this is a proposition, not a meaning a determiner could apply to. It appears in constructions like:

(28) *Gifted mathematician that Bill is*, he solved the problem in no time.
presupposed: (27), asserted: 'Bill solved the problem in no time'

We achieve a relative clause meaning for this by type-lifting the nominal head to a singleton set, here $\lambda P[P = \text{GIFTED MATH}]$.

(29) $[\![[[_{NP}$ $[_{NP}$ *gifted mathematician*$]$ $[_{CP}$ *that*$_1$ $[$*Bill is* $t_{set,1}\ ]]]]\!](i)$
$= \lambda P[P = \text{GIFTED MATH} \wedge P(i)(\text{BILL}(i))]$

This meaning seems to occur as well. **equational property relative clause** construction:

(30) Abdul is finally
[the naturalized American that his mother always wanted him to be _].

(31) Bill is [the gifted mathematician that his mother was _].

(32) a. $[\![[_{CP}$ *that*$_1$ $[$*his mother was* $t_{set,1}\ ]]]\!](i) = \lambda P_1[P_1(i)(\text{BILL'S MOTHER}(i))]$
b. $[\![[_{NP}$ *gifted mathematician*$]]\!](i)$, after lifting: $\lambda P[P = \text{GIFTED MATH}]$
c. $[\![[_{NP}$ $[_{NP}$ *gifted mathematician*$]$ $[_{CP}$ *that*$_1$ $[$*his mother was* $t_{set,1}\ ]]]]\!](i)$
$= \lambda P[\![[_{NP}$ *gifted mathematician*$]]\!](i)(P) \wedge [\![[_{CP}$ *that*$_1$ $[$*his mother was* $t_{set,1}\ ]]]\!](i)(P))$
$= \lambda P[P = \text{GIFTED MATH} \wedge P(i)(\text{BILL'S MOTHER}(i))]$
d. $[\![[_{DP}$ *the* $[_{NP}$ $[_{NP}$ *gifted mathematician*$]$ $[_{CP}$ *that*$_1$ *his mother was* $t_{set,1}]]]]\!](i)$
$= \iota(\lambda P[P = \text{GIFTED MATH} \wedge P(i)(\text{BILL'S MOTHER}(i))])$
$= \text{GIFTED MATH}$,
under the presupposition that $\text{GIFTED MATH}(i)(\text{BILL'S MOTHER}(i))$

This reading also deals with the non-incestuous reading of:

(33) Bill wants to marry the blonde, blue-eyed woman that his father married.
'Bill wants to marry a blonde, blue-eyed woman,
with the presupposition that his father married a blonde, blue-eyed woman.'

Further types, see paper: **Subkind relative clauses** and **degree relative clauses**.

(34) Bill is the same mathematician his mother was (namely a number theorist)

(35) Bill is twice the mathematician his mother was.

4.2 Generalization to other types of subject NPs

Definite descriptions: possibly non-constant individual concepts

Definite descriptions can be handled: Non-constant individual concepts.

(36) The gifted mathematician that the head of the math department (whoever it is) certainly is should have been able to find a solution to this accounting problem.

Plural subjects: Sum individual concepts

Proposal in paper:

(37) [The gifted mathematicians that {Bill and Mary, the Johnsons} supposedly are _]
have undoubtedly won many distinctions in the course of their careers.

$\lambda x[\forall i' \in \mathrm{DOM}(x)[\textsc{gifted maths}(i')(x(i'))]$
$\wedge \forall i'' \in \textsc{supposed}(i)[\textsc{bill}(i'') \oplus \textsc{mary}(i'') = x(i'')]])]$

Sum operation lifted to individual concepts: $x \oplus y = \lambda i[x(i) \oplus y(i)]$.

Problem: Sum individuals whose parts to not coexist at the same index.

(38) [The pious popes that John XXI and Clemens VI supposedly were _]

Alternative proposal: Assume a genuine, irreducible sum operation for individual concepts (see Harvard talk).

Quantified subjects

(39) [The heroic fighter that every (single) soldier in this unit certainly is _]
will hopefully do his utmost to defend the fatherland.

Analyzed as a combination of functional relative (Sharvit, Jacobson) and an EIRR relative.

(40) $[\![[[\textit{heroic fighter}]\ [\textit{that}_1\ \textit{every soldier (in this unit) certainly is}\ t_{ese,1}\ ]]]\!](i)$
$= \lambda f[\forall u \in \mathrm{DOM}(f)\ \forall i' \in \mathrm{DOM}(f(u))[\textsc{heroic fighter}(i')(f(u)(i'))] \wedge$
$\forall u \in \textsc{soldier}(i)\ \forall i'' \in \textsc{certain}(i)[u = f(u)(i'')]])$

Here f is a function that maps individuals to individual concepts (in our case: soldiers u to individual concepts defined for CERTAIN(i) that are identical to u and are heroic fighters; notice that there is a unique such function f (modulo the considerations above). To say that this function has a certain property (to be hopefully ready to defend the fatherland) is to say that all the values of the function have this property.

4.3 A pragmatic condition

(41) #The gifted mathematician Bill claims to be will hopefully be able to lift 200 kgs.

We understand EIRRs such that the property indicated in the relative clause gives a reason why the predication can be applied. Explanation: The modal operator of the main clause (*hopefully*) accomodates the domain of the individual concepts of the relative clause as background; this type of accomodation must be relevant.

4.4 Admissible intensional operators

Examples with **epistemic** operators we have seen already; the following cases exemplify deontic, buletic, temporal and "judgemental" operators, including personal taste predicates, in the relative clause.

(42) [The reliable friend Mary should have been _ in this difficult situation]
would have stopped John from making a fool of himself.

(43) [The brave and selfless fighter for justice that Rose wished to be _]
would certainly have improved the lives of the villagers.

(44) [The idealist you once were _] would have jumped into action on hearing about this violation of basic human rights.

(45) [The abominable atrocity that the killing of the hostages was _]
must not go unpunished.

(46) [The delicacy that this Schwarzwald cherry cake was _]
could not have been topped by anything else.

Compatibility requirement between the two modals illustrated:

(47) [The Maoist that Bill once was _]
sincerely {believed, #believes} in the principles of perpetual revolution.

(48) #[The gifted mathematician that Bill claims to be _] is certainly able to lift 250 kilos.
Problem here: Restriction to indices at which Bill is a gifted mathematician do not form a plausible background for the modal of the main clause.

Other intensional constructions, e.g. intensional predicates:

(49) I admire very much [the idealist you once were _], not [the cynic you have become _]

admire, like *worship*, is an intensional predicate, taking an individual concept as argument. One can admire things that do not exist at the index of evaluation.

Intensional constructions that entail the existence of other potential indices:

(50) [The happy couple that Bill and Sue seemed to be _] is in fact a reality.

in fact indicates that other indices are considered at which the expression would have a different extension.