Intensional independence without world variables in LFG+Glue

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Background A well-known puzzle for the SCOPE THEORY OF INTENSIONALITY (STI) is that a quantificational noun phrase (QNP) may take scope under an intensional operator, while its restrictor is interpreted as independent of that operator. Some relevant examples are given in (1)–(2), along with the intended interpretations (other interpretations are of course possible). Example (2) in particular goes to show that these intensionally independent restrictors are not always evaluated relative to the actual world (w*).

(1) George thinks every Red Sox player is staying in some five-star hotel downtown. ([5], after [1])

⇒ For every world w corresponding to George's beliefs in w*, there is a five-star hotel downtown in w where every Red Sox player in w* is staying.

i.e. *every Red Sox player* is in the scope of *some five-star hotel downtown*, which is intensionally dependent on *thinks*, but *every Red Sox player* is intensionally independent of *thinks*

(2) If you had written some novels and people had rumoured that you hadn't written any of the novels you actually had written, you would be upset. ([2])

⇒ For every closest world w to w* such that you write novels in w, if in every world w' corresponding to the rumours in w there is no novel that you write in w and in w', you are upset in w.

i.e. *any…novels* is in the scope of *rumoured* but intensionally independent of it, yet intensionally dependent on *if*

Intensional independence is often taken to motivate the alternative BINDING THEORY OF INTENSIONALITY (BTI), according to which syntactically-represented world (or situation) pronouns determine intensional status. STI vs. BTI is an ongoing debate in the semantics literature: one can say that the STI has a tencency to undergenerate ([4, 11]), while the BTI has a tendency to overgenerate ([6]).

In this paper I will argue that LFG+Glue is ideally constructed so as to be able to formulate a version of the STI that sidesteps these problems of undergeneration. In addition to making no use of world *pronouns*, the account makes no use of world *variables* in its meaning representation language either, nor any actuality operators or their hybrid logic equivalents. It thus contributes some pushback against the oft-repeated claim that 'natural languages have the full expressive power of object language quantification over worlds' (e.g. [7]), which [12] has in any case shown rests on a misunderstanding.

The account We propose to generalize to the worst case and give a quantificational determiner two layers of scope-taking:

1. an inner layer determining quantificational scope, fixed by the local name $\%A$ in (3) below, and
2. an outer layer determining intensional status, fixed by $\%B$ in (3) below.

The account is somewhat reminiscent of one considered in [3, §8.3.2] according to which (elaborating slightly) the relevant QNP moves to its intensional scope position, leaving behind a trace of type $\langle\langle e,t\rangle\,,t\rangle$ in its quantificational scope position. As [3] notes, though, to adopt this account for examples like (1) or (2) would be to commit to a movement that should be barred given that finite clauses are 'scope islands'. In contrast, our account, stated within an LFG syntax and Glue semantics, is compatible with a principled and straightforward treatment of scope islands.

(3) *determiner* D

$$(\uparrow \textsc{pred}) = \text{`det'}$$
$$\%A = ((\textsc{quant\_scope\_path}\uparrow)\,\{\textsc{spec} \mid \epsilon\})$$
$$\%B = ((\textsc{int\_scope\_path}\uparrow)\,\{\textsc{spec} \mid \epsilon\})$$
$$\lambda P.\lambda V.\,{}^\wedge(\exists Q.Q = (\lambda x.\,{}^\vee(Px)) \wedge {}^\vee(V(\lambda F.\,{}^\wedge(\mathsf{det}'Q(\lambda y.\,{}^\vee(Fy))))))$$
$$: [(\textsc{spec}\uparrow) \multimap \uparrow] \multimap [((((\textsc{spec}\uparrow) \multimap \%A) \multimap \%A) \multimap \%B) \multimap \%B]$$

Here are some points to note about the meaning constructor in (3): (i) We are using an intensional logic in the style of [8]. However, we follow [9] *inter alia* in assuming that if c is a constant then $[\![c]\!]^{g,w}_M = \mathcal{I}(c)$, **not** $[\![c]\!]^{g,w}_M = \mathcal{I}(w)(c)$ as in [8]. In other words, int-/extensionalization is always explicitly marked by means of $^\wedge$ or $^\vee$ respectively. (ii) In the type map, clausal f-structures and the SPEC values of nominal f-structures map to $s \to t$; nominal f-structures map to e. It follows that the variables in (3) have the following types: $P :: e \to s \to t$, $V :: ((e \to s \to t) \to s \to t) \to s \to t$, $Q :: e \to t$, $x :: e$, $y :: e$ and $F :: e \to s \to t$. (iii) det' is the standard extensional determiner meaning of type $(e \to t) \to (e \to t) \to t$. (iv) In the case that $\%A = \%B$, the meaning constructor in (3) reduces to a more standard-looking one, as shown in Figure 1.

The constraint that a QNP may not take quantificational scope outside of a finite clause can be captured by appropriately constraining QUANT_SCOPE_PATH. Let us suppose that QUANT_SCOPE_PATH is an abbreviation for (4).

(4)
$$\left(\begin{array}{ccc} \textsc{ggf}^* & \textsc{gf} & \textsc{spec} \\ \neg(\to \textsc{tense}) & & \end{array}\right)$$

Given the simplified f-structure and instantiated meaning constructors for (1) shown in Figure 2, then, $\%A$ cannot resolve to f because the path (f COMP SUBJ SPEC) fails to satisfy the off-path constraint since (f COMP) ($=h$) has a tense value. We therefore do not allow $\forall$ to take scope over think′. However, we can derive the interpretation paraphrased above by setting $\%A := h$ and $\%B := f$, as shown in Figure 3. The other interpretations that (1) has are also derivable. (In Figures 2 and 3, [*in a hotel*] is shown on the assumption that a reduction of the kind shown in Figure 1 has already happened.)

In the same vein, the proof structure for the intended interpretation of (2) is:

$[\textit{if}]\big([\textit{and}]\big([a][\textit{novel}](\lambda G.G(\lambda x.[\textit{write}][\textit{you}]x))\big)\big([a][\textit{novel you wrote}](\lambda H.[\textit{rumoured}]([\textit{not}](H(\lambda y.[\textit{write}][\textit{you}]y))))\big)\big)\big([\textit{upset}][you]\big)$

Avoiding the overgeneration of BTI approaches [6] points out that BTI approaches have a hard time accounting for the fact that (5) and (6) respectively lack the readings shown below.

(5) John wants to meet the wife of the president. ([10])

$\not\Rightarrow$ For every world w corresponding to John's desires in w^*, John meets the wife in w^* of the president in w.

i.e. *president* cannot be interpreted *de dicto* while *wife* is interpreted *de re*

(6) Mary thinks that if three professors were professors, the classes would be better taught.

$\not\Rightarrow$ For every world w corresponding to Mary's beliefs in w^*, and in every closest world w' to w such that three professors in w^* are professors in w', the classes are better taught in w' than in w.

i.e. the *professors* in *three professors* cannot be interpreted *de re*

Example (5) is straightforwardly accounted for given the form of STI applied here, since *the president* is embedded within *the wife of the president*. The proof forms of the available interpretations of (5) are shown below, along with the form of an improper derivation which is an attempt to derive the unavailable reading.

Both *de dicto* $[\textit{want}][\textit{John}](\lambda u.[\textit{the}](\lambda x.[\textit{the}][\textit{president}](\lambda G.G(\lambda y.[\textit{wife}]xy)))(\lambda H.H(\lambda v.[\textit{meet}]uv)))$

Both *de re* $[\textit{the}](\lambda x.[\textit{the}][\textit{president}](\lambda G.G(\lambda y.[\textit{wife}]xy)))(\lambda H.[\textit{want}][\textit{John}](\lambda u.H(\lambda v.[\textit{meet}]uv)))$

'wife' *de dicto*, 'president' *de re* $[\textit{the}][\textit{president}](\lambda G.[\textit{want}][\textit{John}](\lambda u.[\textit{the}](\lambda x.G(\lambda u.[\textit{wife}]xy))(\lambda H.H(\lambda v.[\textit{meet}]uv))))$

'wife' *de re*, 'president' *de dicto $[\textit{the}](\lambda x.[\textit{wife}]xy)(\lambda H.H(\lambda v.[\textit{want}][\textit{John}](\lambda u.[\textit{the}][\textit{president}](\lambda G.G(\lambda y.[\textit{meet}]uv)))))$

Example (6) points to the need for INT_SCOPE_PATH in (3) to be constrained; we will now discuss how.

Overcoming the undergeneration of STI approaches [4] notes that the explanation offered in [6] for (6) rests on a 'putative generalization that nominals embedded under *two* scope islands cannot be interpreted *de re*. But the data supporting the generalization come from configurations in which the higher island is a finite clause and the lower island is of another sort [...] When a nominal is embedded under two finite clauses, it is not clear that the generalization holds'. In other words, the nature of the scope island seems to matter. For example, (7) *can* have the interpretation shown.

(7) Jo hopes that Mary believes that three professors are professors.

$\Rightarrow$ For every world w such that Jo's hopes in w^* are met, for every world w' such that Mary's beliefs in w are true, three professors in w^* are professors in w'

i.e. the *professors* in *three professors* can be interpreted *de re*

Looking at the two f-structures in Figure 4, we can express this differentiation by defining INT_SCOPE_PATH as shown in (8).

(8) $$\left(\begin{array}{ccccc} \text{GGF}^* & \{\text{ADJ} \in |\epsilon\} & \text{GGF}^* & \text{GF} & \text{SPEC} \\ \neg(\rightarrow \text{TENSE}) & & & & \end{array}\right)$$

For (6) to have the meaning paraphased above, $\%B$ for the embedded determiner *three* would have to resolve to f; but this is impossible, as the path (f COMP ADJ $\in$ SUBJ SPEC) does not satisfy (8), since ADJ $\in$ is ungovernable and (f COMP) has a tense value. In contrast, in the case of (7) $\%B$ for *three* **can** resolve to f, as the path (f COMP COMP SUBJ SPEC) does satisfy (8), since all the grammatical functions mentioned are governable. The LFG architecture shows itself to be perfect for expressing a combination of constraints on interpretation that other frameworks struggle with.

References

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$$
\dfrac{
  \dfrac{
    \dfrac{\begin{array}{c}[\textit{determiner}]: \\ (e \multimap q) \multimap ((((e \multimap p) \multimap p) \multimap p) \multimap p)\end{array} \quad [P : e \multimap q]^1}{[\textit{determiner}]P : (((e \multimap p) \multimap p) \multimap p) \multimap p}
    \quad
    \dfrac{\dfrac{[V : (e \multimap p) \multimap p]^2 \quad [F : e \multimap p]^3}{VF : p}}{\lambda V.VF : ((e \multimap p) \multimap p) \multimap p}\,2
  }{
    \dfrac{[\textit{determiner}]P(\lambda V.VF) : p}{\lambda F.[\textit{determiner}]P(\lambda V.VF) : (e \multimap p) \multimap p}\,3
  }
}{\lambda P.\lambda F.[\textit{determiner}]P(\lambda V.VF) : (e \multimap q) \multimap ((e \multimap p) \multimap p)}\,1
$$

$$\equiv \lambda P.\lambda F.{}^\wedge(\exists Q.Q = (\lambda x.{}^\vee(Px)) \wedge \mathsf{det}'Q(\lambda x.{}^\vee(Fx))) : (e \multimap q) \multimap ((e \multimap p) \multimap p)$$

$$\equiv \lambda P.\lambda F.{}^\wedge(\mathsf{det}'(\lambda x.{}^\vee(Px))(\lambda x.{}^\vee(Fx))) : (e \multimap q) \multimap ((e \multimap p) \multimap p)$$

Figure 1: Reduction of (3), with $e := (\textsc{spec}\uparrow), q := \uparrow$ and $p := \%A := \%B$

$$
f : \left[\begin{array}{ll}
\textsc{pred} & \text{‘think’} \\
\textsc{subj} & g : [\,\text{“George”}\,] \\
\textsc{comp} & h : \left[\begin{array}{ll}
\textsc{pred} & \text{‘stay’} \\
\textsc{tense} & \text{pres} \\
\textsc{subj} & i : \left[\begin{array}{ll}
\textsc{pred} & \text{‘player’} \\
\textsc{spec} & j : \left[\textsc{pred} \quad \text{‘every’}\right]
\end{array}\right] \\
\textsc{obl}_{\textsc{loc}} & k : [\,\text{“in some five-star hotel downtown”}\,]
\end{array}\right]
\end{array}\right]
$$

$[\textit{think}] := \mathsf{think}' : g \multimap h \multimap f$

$[\textit{George}] := \mathsf{george}' : g$

$[\textit{player}] := \mathsf{player}' : i \multimap j$

$[\textit{stay}] := \mathsf{stay}' : i \multimap k \multimap h$

$[\textit{in a hotel}] :=$
$\lambda U.{}^\wedge(\exists z.{}^\vee(\mathsf{hotel}'z) \wedge {}^\vee(U\,{}^\vee(\mathsf{in}'z)))$
$: (k \multimap h) \multimap h$

$[\textit{every}] :=$
$\lambda P.\lambda V.{}^\wedge(\exists Q.Q = (\lambda x.{}^\vee(Px)) \wedge {}^\vee(V(\lambda F.{}^\wedge(\forall y.Qy \rightarrow {}^\vee(Fy))))) : [i \multimap j] \multimap [(((i \multimap \%A) \multimap \%A) \multimap \%B) \multimap \%B]$

Figure 2: Simplified f-structure and instantiated meaning constructors for (1)

$$
\dfrac{
  \begin{array}{c}\vdots \\ [\textit{every}][\textit{player}] : \\ (((i \multimap h) \multimap h) \multimap f) \multimap f\end{array}
  \quad
  \dfrac{
    \dfrac{
      \begin{array}{c}\vdots \\ [\textit{think}][\textit{George}] : \\ h \multimap f\end{array}
      \quad
      \dfrac{
        \begin{array}{c}[\textit{in a hotel}] : \\ (k \multimap h) \multimap h\end{array}
        \quad
        \begin{array}{c}\left[\begin{array}{c}G : \\ (i \multimap h) \multimap h\end{array}\right]^1 \quad \begin{array}{c}[\textit{stay}] : \\ i \multimap k \multimap h\end{array} \\ \vdots \\ \lambda v.G(\lambda u.[\textit{stay}]uv) : k \multimap h\end{array}
      }{[\textit{in a hotel}](\lambda v.G(\lambda u.[\textit{stay}]uv)) : h}
    }{[\textit{think}][\textit{George}]([\textit{in a hotel}](\lambda v.G(\lambda u.[\textit{stay}]uv))) : f}
  }{\begin{array}{c}\lambda G.[\textit{think}][\textit{George}]([\textit{in a hotel}](\lambda v.G(\lambda u.[\textit{stay}]uv))) : \\ ((i \multimap h) \multimap h) \multimap f\end{array}}\,1
}{[\textit{every}][\textit{player}](\lambda G.[\textit{think}][\textit{George}]([\textit{in a hotel}](\lambda v.G(\lambda u.[\textit{stay}]uv)))) : f}
$$

$$\equiv {}^\wedge(\exists Q.Q = (\lambda x.{}^\vee(\mathsf{player}'x)) \wedge {}^\vee(\mathsf{think}'\mathsf{george}'\,{}^\wedge(\exists z.{}^\vee(\mathsf{hotel}'z) \wedge \forall y.Qy \rightarrow {}^\vee(\mathsf{stay}'y\,{}^\vee(\mathsf{in}'z)))))) : f$$

Figure 3: Derivation of the intended interpretation of (1) from the meaning constructors in Figure 2

$$
f : \left[\begin{array}{ll}
\textsc{pred} & \text{‘think’} \\
\textsc{subj} & [\,\text{“Mary”}\,] \\
\textsc{comp} & \left[\begin{array}{ll}
\textsc{pred} & \text{‘better\_taught’} \\
\textsc{tense} & \text{pres} \\
\textsc{subj} & [\,\text{“the class”}\,] \\
\textsc{adj} & \left\{\left[\begin{array}{ll}
\textsc{compform} & \text{if} \\
\ldots & \\
\textsc{subj}|\textsc{spec}|\textsc{pred} & \text{‘three’}
\end{array}\right]\right\}
\end{array}\right]
\end{array}\right]
\qquad
f : \left[\begin{array}{ll}
\textsc{pred} & \text{‘hope’} \\
\textsc{subj} & [\,\text{“Jo”}\,] \\
\textsc{comp} & \left[\begin{array}{ll}
\textsc{pred} & \text{‘believe’} \\
\textsc{subj} & [\,\text{“Mary”}\,] \\
\textsc{comp} & \left[\begin{array}{ll}
\ldots & \\
\textsc{subj}|\textsc{spec}|\textsc{pred} & \text{‘three’}
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

Figure 4: Simplified f-structures of (6) and (7)