Reasoning with an (Experiential) Attitude

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Abstract. This talk gives a compositional semantics for nominal, gerundive, and finite attitude reports (see A–F, below) that captures the intuitive entailment relations between these reports. These relations are identified through the familiar diagnostic tests. We observe that the entailments that are licensed by counterfactual attitude verbs (esp. imagine; cf. A.i–F.i) are largely different from the entailments between veridical vision reports (e.g. A.ii–F.ii) that are described in [**2**] (see [**1**, **3**]). To capture this difference, we give a non-clausal syntax for gerundive attitude reports (see [**9**]) and assign factive finite complements a different semantics from non-factive and non-finite complements (see [**4**]). The resulting account captures the entailment patterns of imagination and vision reports without assuming special axioms in the lexical semantics of see or imagine.

1. Diagnostics. To identify the above entailment relations, we distinguish three forms of attitude reports (cf. [**1**, p. 203], [**2**]). These are reports with a nominal complement (A), reports with a gerundive complement (C), and reports with a finite complement (F):

A. Ida i. imagined / ii. saw [a penguin].
B. Ida i. imagined / ii. saw [a real-world penguin] (diving into the sea).
C. Ida i. imagined / ii. saw [a penguin] diving into the sea.
D. Ida i. imagined / ii. saw [an aquatic flightless bird] diving into the sea.
E. There is [a penguin] which Ida i. imagined / ii. saw diving into the sea.
F. Ida i. imagined / ii. saw [that [a penguin] was diving into the sea].

To test for the intensionality of the embedded DP in these reports, we further consider variants of C that replace the embedded DP with a co-referential expression (D), that force a specific reading of the embedded DP (E; see [**2**]; cf. [**1**, p. 203]), and that modify the restrictor of the embedded DP by the adjective actual or real-world (B; see [**3**, pp. 248–249]).

	A	B	C	D	E	F
A	$\equiv$	$\not\Rightarrow / \Rightarrow$	$\not\Rightarrow$	$\not\Rightarrow$	$\not\Rightarrow$	$\not\Rightarrow$
B	$\Rightarrow$	$\equiv$	$\Rightarrow$	$\not\Rightarrow / \Rightarrow$	$\not\Rightarrow / \Rightarrow$	$\Rightarrow / \not\Rightarrow$
C	$\Rightarrow$	$\not\Rightarrow / \Rightarrow$	$\equiv$	$\not\Rightarrow / \Rightarrow$	$\not\Rightarrow / \Rightarrow$	$\Rightarrow / \not\Rightarrow$
D	$\not\Rightarrow / \Rightarrow$	$\not\Rightarrow / \Rightarrow$	$\not\Rightarrow / \Rightarrow$	$\equiv$	$\not\Rightarrow / \Rightarrow$	$\not\Rightarrow$
E	$\Rightarrow$	$\not\Rightarrow / \Rightarrow$	$\Rightarrow$	$\not\Rightarrow / \Rightarrow$	$\equiv$	$\Rightarrow / \not\Rightarrow$
F	$\not\Rightarrow$	$\not\Rightarrow$	$\not\Rightarrow$	$\not\Rightarrow$	$\not\Rightarrow$	$\equiv$

For A–F, we identify 30 interesting pairs of reports (excl. identity-pairs). We test them for entailments via the usual tests: Class 1 Class 2 Class 3 Class 4 Class 5

TABLE 1. Entailments.

Test 1 (non-cancellability): *If $X \Rightarrow Y$ is an entailment, then 'X, but (it is) not (the case that) Y' is a contradiction in any context.* (see [**2**])

Test 2 (non-reinforceability): *If $X \Rightarrow Y$ is an entailment, then 'X and, specifically, Y' is redundant/semantically deviant.* (see [**5**, pp. 672–673])

2. Entailments. The above tests identify 5 general entailments (**Class 1**: B–C/E $\Rightarrow$ A, B/E $\Rightarrow$ C), 12 entailments that only hold for vision reports (i.e. '$\not\Rightarrow / \Rightarrow$'; see **Classes 2–4**), and 3 entailments that only hold for imagination reports (i.e. '$\Rightarrow / \not\Rightarrow$'; see **Class 5**):

(1) a. C: Ida imagined/saw [a penguin] diving into the sea. (**Class 1**)
$\Rightarrow$ b. A: Ida imagined/saw [a penguin].

(2) a. A/C: Ida i. imagined / ii. saw [a penguin] (diving into the sea). (**Class 2**)
b. B: Ida $\not\Rightarrow$ i. imagined / $\Rightarrow$ ii. saw [a real-world penguin] (diving . . .).

(3) a. C: Ida i. imagined / ii. saw [a penguin] diving into the sea. (**Class 3**)
b. D: Ida $\not\Rightarrow$ i. imagined / $\Rightarrow$ ii. saw [an aquatic flightless bird] diving . . .

(4) a. C: Ida i. imagined / ii. saw [a penguin] diving into the sea. (**Class 4**)
b. E: There is [a penguin] which Ida $\not\Rightarrow$ i. imagined / $\Rightarrow$ ii. saw diving . . . .

(5) a. C: Ida i. imagined / ii. saw [a penguin] diving into the sea. (**Class 5**)
b. F: Ida $\Rightarrow$ i. imagined / $\not\Rightarrow$ ii. saw [that [a penguin] was diving into the sea].

3. Proposal. We propose to capture the different entailments of imagination and vision reports by a three-part strategy. This strategy involves (i) the same-type interpretation of nominal, gerundive, and finite complements, (ii) the adoption of a non-clausal syntax for gerundive reports, & (iii) the different interpretation of factive and non-factive that. Parts (i) & (iii) capture the entailments between gerundive and nominal resp. between gerundive and finite reports. Part (ii) gives us a better handle on the scope of the embedded DP.

On (ii): To account for the extensional behavior of the embedded DP in vision reports, we adopt Williams' Predication theory (see [**9**]). The latter is a non-clausal syntax that analyzes the complement in B–E as a non-constituent element of a ternary branching VP of the form [V DP XP] (s. (6)). The occurrences of see/imagine in B–E thus take two complements: a gerundive predicate (XP) and a DP that serves as the XP's syntactic subject.

(6) Ida $[_{\text{VP}}$saw $[_{\text{DP}}$a penguin$]$ $[_{\text{XP}}$diving into the sea$]]$.

To capture entailments (2.ii)–(4.ii), the predication relation b/w the DP & XP, and the observation that gerundive/nominal see selects a situation-argument (s. [**2**, **8**]), we assign 'DP XP'-taking see the semantics in (7), where $f_e(\lambda j.\, P_j(y))$ is the perceived visual scene:[1]

(7) $[\![\text{see-DP XP}]\!]^i \;=\; \lambda\mathcal{Q}\,\lambda P \lambda z\,[\mathcal{Q}_i(\lambda k \lambda y\,(\exists e)[see_k(e, z, f_e(\lambda j.\, P_j(y)))])]$

In (7), f is a choice function that selects a subset from a given set of situations $\lambda j\,[\ldots]$ in dependence on a parameter, e, for the described event (here, z's seeing in k). This subset represents the experienced situation. Our use of *sets of* situations is motivated by the fact that imagined situations are often not anchored in a particular world/time, and by the possibility of representing non-anchored situations by sets of situations. We give nominal and finite see the semantics in (8)–(9), where E is a situation-relative existence predicate:

(8) $[\![\text{see-DP}]\!]^i \;=\; \lambda\mathcal{Q}\,\lambda z\,[\mathcal{Q}_i(\lambda k \lambda y\,(\exists e)[see_k(e, z, f_e(\lambda j.\, E_j(y)))])]$ (cf. [**6**]'s sem. for find)

(9) $[\![\text{see-CP}]\!]^i \;=\; \lambda p \lambda z\,(\exists e)[see_i(e, z, p)]$

To capture the intensional behavior of the embedded DP in imagination reports (see the non-entailments (2.i)–(4.i)), we interpret this DP inside the scope of imagine (see (10)). Gerundive and finite occurrences of imagine receive the interpretation in (11) and (12):

(10) $[\![\text{imagine-DP}]\!]^i = \lambda\mathcal{Q}\,\lambda z\,(\exists e)[imagine_i(e, z, f_e(\lambda j.\, \mathcal{Q}_j(E)))]$ (cf. [**6**]'s sem. for seek)

(11) $[\![\text{imagine-DP XP}]\!]^i = \lambda\mathcal{Q}\,\lambda P \lambda z\,(\exists e)[imagine_i(e, z, f_e(\lambda j.\, \mathcal{Q}_j(P)))]$

(12) $[\![\text{imagine-CP}]\!]^i = \lambda p \lambda z\,(\exists e)[imagine_i(e, z, p)]$

4. Capturing the Entailments. Classes 2–4: (7) ensures that the interpretation of the embedded DP in B.ii–E.ii is relational in the sense of [**7**] (i.e. the DP's restrictor is interpreted at i) and specific (i.e. the DP's quantifier lies outside the scope of see). As a result of the former, the restrictor of the embedded DP in C.ii admits substitution by an extensional equivalent (in (13); **Class 3.ii**) and allows modification by real-world (**Class 2.ii**):

(13) a. $[\![\text{C.ii}]\!]^i \;=\; (\exists x)[penguin_i(x) \wedge (\exists e)[see_i(e, ida, f_e(\lambda j.\, dive_j(x)))]]$

b. (Ext) $(\forall x)[penguin_i(x) \leftrightarrow \textit{aquatic-flightless-bird}_i(x)]$

$\Leftrightarrow$ c. $[\![\text{D.ii}]\!]^i \;=\; (\exists x)[\textit{aquatic-flightless-bird}_i(x) \wedge (\exists e)[see_i(e, ida, f_e(\lambda j.\, dive_j(x)))]]$

As a result of the DP's specific interpretation, C.ii is equivalent to E.ii (see **Class 4.ii**).

In contrast to (7), (11) allows for the possibility that the embedded DP receives a notional (= non-relational) and non-specific interpretation. The *de re*-reading of C.i (see (14b)) thus has a different semantics from this report's *de dicto*-reading (in (14a)). The identification of E.i with the *de re*-reading of C.i then captures C.i $\not\Rightarrow$ E.i (see **Class 4.i**).

(14) a. $[\![\text{C.i}]\!]^i_{de\ dicto} = \;(\exists e)[imagine_i(e, ida, f_e(\lambda j \exists x.\, penguin_j(x) \wedge dive_j(x)))]$

$\not\equiv$ b. $[\![\text{C.i}]\!]^i_{de\ re} = \;(\exists x)[penguin_i(x) \wedge (\exists e)[imagine_i(e, ida, f_e(\lambda j.\, dive_j(x)))]] \;=\; [\![\text{E.i}]\!]^i$

The notional interpretation of the embedded DP in the *de dicto*-reading of C.i blocks the entailment to D.i (see (15); cf. **Class 3.i**) and to B.i (see (16); cf. **Class 2.i**):

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[1] Below, x, y, z are individual variables (type e); i, j, k are situation variables (type s); e is an event variable (type v). P, Q are variables over type-$s(et)$ properties. $\mathcal{Q}$ is a variable over type-$s((s(et))t)$ quantifiers.

(15) $[\![\text{D.i}]\!]^{i}_{de\ dicto} = (\exists e)[imagine_i(e, ida, f_e(\lambda j\,\exists x.\,aquatic\text{-}flightless\text{-}bird_{\boldsymbol{j}}(x) \wedge dive_j(x)))]$

(16) $[\![\text{B.i}]\!]^{i}_{de\ dicto} = (\exists e)[imagine_i(e, ida, f_e(\lambda j\,\exists x.\,penguin_j(x) \wedge E_{\boldsymbol{i}}(x)))]$

N.B.: A more standard 'clausal' version of (7) (in (17); cf. [**2**, **3**, **8**]) may try to capture (2.ii)–(4.ii) by interpreting the gerundive complement in C.ii as a syntactic constituent (see the S[mall] C[lause] in (17)) and by adopting the quantifier exportation rule in (18):

(17) $[\![\text{see}\ [_{\text{SC}}[_{\text{DP}}\ ]\,[_{\text{XP}}\ ]]]\!]^{i} = \lambda p \lambda z (\exists e)[see_i(e, z, f_e(p))]$

(18) $(\forall z)(\forall P)(\forall Q)(\forall e)[see_i(e, z, f_e(\lambda j\,\exists x.\,P_j(x) \wedge Q_j(x))) \rightarrow (\exists y)[P_i(y) \wedge see_i(e, z, f_e(\lambda j.\,Q_j(x)))]]$

However, because of the order-insensitivity of $\wedge$, this rule wrongly predicts that the embedded XP in C.ii (i.e. diving into the sea) also has an extensional interpretation (s. [**1**, **3**]).

Class 1: (8) and (10) suggest that A.i/ii are equivalent to (19).

(19) Ida [$_{\text{VP}}$imagines/sees [$_{\text{DP}}$a penguin] [$_{\text{XP}}$being there] (in her mental/visual scene)].

The entailment in (1) is then supported w.r.t. the fact that existing is a more general property than diving into the sea (see (20b)). The entailment further relies on (20c) and (20d):

(20) a. $[\![\text{C.ii}]\!]^{i} = (\exists x)[penguin_i(x) \wedge (\exists e)[see_i(e, ida, f_e(\lambda j.\,dive_j(x)))]]$
b. $(\forall j)(\forall x)[dive_j(x) \rightarrow E_j(x)]$ c. $(\forall p)(\forall q)[p \subseteq q \rightarrow (\forall e.\,f_e(p) \subseteq f_e(q))]$
d. $(\forall p)(\forall z)(\forall e)[see_i(e, z, p) \rightarrow (\forall q.\,p \subseteq q \rightarrow see_i(e, z, q))]$ (monotonicity)
$\Rightarrow$ e. $[\![\text{A.ii}]\!]^{i} = (\exists x)[penguin_i(x) \wedge (\exists e)[see_i(e, ida, f_e(\lambda j.\,E_j(x)))]]$

Class 5: To explain the (non-)entailment in (5), we follow Kratzer's [**4**] assumption that that is ambiguous b/w the propositional complementizer, i.e. that$_{\text{P}}$, and the factive complementizer, i.e. that$_{\text{F}}$, and that clause-taking occurrences of factive verbs (incl. see) select for clauses with the factive complementizer. Kratzer proposes that that$_{\text{F}}$ is interpreted as (21). This interpretation can be formalized as (22), where $\leq$ is a partial ordering on situations:

(21) $\lambda p \lambda j\,[exemplify(p, j)]$ (24) $[\![\text{that}_{\text{P}}]\!] = \lambda p \lambda j\,[p_j]$

(22) $[\![\text{that}_{\text{F}}]\!] = \lambda p.\,\Pi(p)$, where $\Pi := \lambda q \lambda j\,[q_j \wedge (\forall k.(q_k \wedge k \leq j) \rightarrow k = j)]$

The *de re*-reading of F.ii is then interpreted as (23c). This interpretation asserts the obtaining of the seeing relation between Ida and the set of minimal situations in which a particular penguin from i is diving into the sea. Since visual images typically do not represent isolated items of information, the scene that serves as the semantic argument of C.ii will likely not be a member of this set. The non-inclusion of the set, $f_e(\lambda j.\,dive_j(x))$, that codes this scene in the set $\Pi(\lambda j.\,dive_j(x))$ (s. (23b)) then captures C.ii $\not\Rightarrow$ F.ii (**Class 5.ii**):

(23) a. $[\![\text{C.ii}]\!]^{i} = (\exists x)[penguin_i(x) \wedge (\exists e)[see_i(e, ida, f_e(\lambda j.\,dive_j(x)))]]$
b. $(\exists k)(\exists x)(\exists e)[f_e(\lambda j.\,dive_j(x))(k) \wedge \neg\Pi(\lambda j.\,dive_j(x))(k)]$
$\not\Rightarrow$ c. $[\![\text{F.ii}]\!]^{i}_{de\ re} = (\exists x)[penguin_i(x) \wedge (\exists e)[see_i(e, ida, \Pi(\lambda j.\,dive_j(x)))]]$

Since it is non-factive, imagine selects for the propositional complementizer that$_{\text{P}}$. The semantics of that$_{\text{P}}$ (in (24) [above, nxt to (21)]) captures (4.i) (s. (25) for the *de dicto*-case). This entailment uses the upward-monotonicity of the complement of imagine (in (25b)):

(25) a. $[\![\text{C.i}]\!]^{i}_{de\ dicto} = (\exists e)[imagine_i(e, ida, f_e(\lambda j\,\exists x.\,penguin_j(x) \wedge dive_j(x)))]$
b. $(\forall p)(\forall z)(\forall e)[imagine_i(e, z, p) \rightarrow (\forall q.\,p \subseteq q \rightarrow imagine_i(z, q))]$ (monotonicity)
$\Rightarrow$ c. $[\![\text{F.i}]\!]^{i}_{de\ dicto} = (\exists e)[imagine_i(e, ida, \lambda j\,\exists x.\,penguin_j(x) \wedge dive_j(x))]$

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