

**Better Modelisation through Modalisation**  
Michael Hegarty / Louisiana State University

One way to explicate the meaning of an attitude ascription such as that in (1) is to invoke an abstract object of the attitude, such as an Interpreted Logical Form (ILF) (Higginbotham 1991; Larson and Ludlow 1993), a structured meaning (Cresswell 1985; and others), or a Discourse Representation Structure or Segmented DRS (Asher 1993; Asher and Lascarides 2003).

(1) Alex believes that Bill stole the artifact.

This can be given a Neo-Davidsonian representation (Parsons 1990) as in (2) below, interpreted at a world of evaluation  $w$ , where  $a_I = F(\text{Alex})$ , and  $\Psi$  is an ILF or DRS theme object (for  $F$  the mapping from natural language to the logical language  $\mathbf{L}$ ).

(2)  $\lambda w \exists e$  [ believe  $(e)(w)$  & Experiencer  $(a_I)(e)(w)$  & Theme  $(\Psi)(e)(w)$  ]

More exactly,  $e$  can be asserted to exist as in (3), as a state of belief experienced by Alex in the world of evaluation, and individuated by a condition which picks it out in worlds accessible to  $v$  ( $R_v w$ ) in which it is a belief state experienced by Alex, and individuates it by the condition Theme  $(\Psi)(e)(v)$  occurring in the nuclear scope [ . . . ] of  $\forall v$  in (3).

(3)  $\lambda w \exists e$  [ believe  $(e)(w)$  & Experiencer  $(a_I)(e)(w)$  &  
( $\forall v: R_v w$  & believe  $(e)(v)$  & Experiencer  $(a_I)(e)(v)$ ) [ . . . ] ]

The talk will take up (3), but dispense with the theme object of belief  $\Psi$ , and instead fill the nuclear scope [ . . . ] in (3) with dynamic semantic conditions on information state update.

The belief ascription in (1), like any indicative utterance, is intended to effect update of the information state shared by the speaker and addressee(s) at the point in the discourse when the utterance is made. But as an attitude ascription, what it reports on is of the same nature: it reports on the information state attributed by speaker and addressee(s) to Alex. (This is essentially Moltmann's (2003) secondary context.) Let  $\varphi = F(\text{Bill stole the artifact}) = \exists e_I$  [steal  $(e_I)(w)$  & Agent  $(a_5)(e_I)(w)$  & Theme  $(a_{17})(e_I)(w)$ ], the translation of the complement clause into  $\mathbf{L}$ , and let  $K_I$  and  $f_I$  be the DRS and assignment function attributed to Alex as the initial conditions of the attitude ascription. Then the nuclear scope of the individuating condition on  $e$  in (3) can be expressed as dynamic update of the world-assignment pair  $(v, f_I)$  by the context change potential  $[K_I \hat{\cap} \varphi]$  of  $K_I$  augmented by  $\varphi$ . The theme argument condition in the nuclear scope of  $\forall v$  in (3) can then be replaced by the update condition in (4a). Alternatively, defining an information state as a set of world-assignment pairs, essentially following Groenendijk, Stokhof and Veltman (1996), we can define the information state  $s_I(v)$  attributed to Alex in  $v$ , and replace the nuclear scope in (3) with an attribute-value assignment updating  $s_I(v)$  by the result of applying  $[K_I \hat{\cap} \varphi]$  to it, as in (4b). The choice between (4a) and (4b) will be discussed. Both will be pursued below.

(4) a.  $[\exists g : (v, f_I) [K_I \hat{\cap} \varphi] (v, g)$   
b.  $s_I(v) := s_I(v) [K_I \hat{\cap} \varphi]$

But there is lexical variation in the strength of this update condition, depending on the propositional attitude verb, as in (5).

- (5) a. Alex is sure / certain / convinced that Bill stole the artifact.  
 b. Alex thinks / expects that Bill stole the artifact.  
 c. Alex considers possible / conjectures that Bill stole the artifact.

Part of the difference among these can be explicated in dynamic semantics: the ascriptions in (5a) assert that the attributed information state **must** be updated by  $[K_I \wedge \varphi]$  to reflect Bill's theft of the artifact, according to information state update criteria attributed to Alex, while those in (5b) assert that the attributed state **should** be updated by  $[K_I \wedge \varphi]$ , and (5c) that it **could** be updated by  $[K_I \wedge \varphi]$ . Adapting Kratzer's (1991) theory of modality, this motivates replacing (4a,b) by (6a,b), for  $D(a_I, w) =$  (deontic or epistemic, or for predicates such as *want*, bouletic) conditions on information state update (for  $\mathbf{a}_I$  in  $w$ ), and  $\mathbf{Q}$  a quantifier over worlds with universal strength in (5a), a lesser strength (roughly that of **most**) in (5b), and still lesser strength (roughly that of **some**) in (5c).

- (6) a.  $(\mathbf{Q} w' : R_v w' \ \& \ w' \in D(a_I, v)) \ [\exists g : (w', f_I) [K_I \wedge \varphi] (w', g) ]$   
 b.  $(\mathbf{Q} w' : R_v w' \ \& \ w' \in D(a_I, v)) \ [s_I(w') := s_I(w')[\varphi]]$

Alongside the full Neo-Davidsonian interpretation of (1), obtained by plugging (6a) or (6b) into the nuclear scope of  $\forall v$  in (3), the talk will show that there is a “bare update” interpretation of (1) as asserting simply (7a) or (7b), and not asserting the existence of a belief state  $e$  at all.

- (7) a.  $\lambda w (\mathbf{Q} w' : R_w w' \ \& \ w' \in D(a_I, w)) \ [\exists g : (w', f_I) [K_I \wedge \varphi] (w', g) ]$   
 b.  $\lambda w (\mathbf{Q} w' : R_w w' \ \& \ w' \in D(a_I, w)) \ [s_I(w') := s_I(w')[\varphi]]$

This is the interpretation noted by Urmson (1952) and others, in which the matrix clause is “parenthetical” or less prominent. Entailment relations straightforwardly define a markedness scale for attitude predicates within a language (e.g. *long for* is more marked than *want*; *conjecture* is more marked than *believe*); a language-specific threshold determines which predicates can have the bare update interpretation in (7) (e.g. *believe*, *want*) alongside the full interpretation, and which can only have the full interpretation (e.g. *conjecture*, *long for*).

When the main clause is negated, predicates low on the markedness scale permit an interpretation with a Lower Interpretation of Negation (LIN). The interpretation without LIN is the result of negating a formula such as (3), and this is the only option for predicates above the threshold. LIN is obtained in ascriptions with predicates with the more minimal, bare update interpretations of the sort given in (7), by importing Neg under dualization, using the dual quantifier [e.g. **most**<sup>+</sup> = **most**<sup>-</sup> = **half or more**, a slightly weaker version of **most**, since  $\sim(\mathbf{most} \ A \ \text{are} \ B)$  iff **half-or-more** of  $A$  are not  $B$ .] And the dual to the update conditions in the nuclear scope of  $\mathbf{Q}$  in (7a,b) are shown, based on the definition of information state update, to be just update by  $[K_I \wedge (\sim \varphi)]$ . This accounts for “lower Neg” interpretations with matrix predicates such as *sure* and *imagine*, converting them to their respective duals, “suspect” and “rather expect”, as well as classical “Neg-Raising” predicates; the latter have a

lower bound just above the mid-point of the scale of modal strength (Horn 1978, 1989), and thus have duals which are just slightly weaker than themselves. But LIN has wider applicability, with the very same mechanisms, outside the classical mid-scalar Neg-Raising predicates, as in (8), in a non-standard dialect where *know* (with complementizer *as*) falls within the threshold for the bare update interpretation.

- (8) a. I don't know as we oughta do that. b. I don't know as I'd say he's a crook.  
(9) I don't really believe that he betrayed us. OK as: "I'm inclined to think he didn't."  
(10) I don't passionately believe that he betrayed us. # as "I'm inclined to think he didn't."

In (9), *really* serves to strengthen the quantifier **Q** for *believe*, to one whose dual is correspondingly weaker, paraphrased as "inclined to think" in (9). The adverbial *passionately* in (10) modifies the eventuality *e*, and thus invokes the full Neo-Davidsonian interpretation with (6a) or (6b) plugged into (3), which doesn't permit LIN.

Gajewski (2007) develops an Excluded Middle (EM) account of LIN in which the higher clause in *John thinks Mary left*, for example, has the EM presupposition that the set of worlds characterizing John's beliefs are either all a subset of the set of worlds in which Mary left, or all a subset of the set of worlds in which Mary didn't leave. This presupposition is inherited by *John doesn't think Mary left*, and combines with the truth conditions of the negated clause to yield LIN. LIN will not be obtained with a verb such as *say* in place of *think* since *say* does not have an EM condition associated with it as a conventional property of the verb. Gajewski shows that the EM property correlates with anti-additivity of the negated predicate. The lacuna in this account is that Neg-Raising, the EM property and anti-additivity are intra-implicational, but there is no explanation for why some predicates have these properties and some don't. In contrast, the account above was able to offer markedness effects and the disrupting effects of manner adverbs in the matrix clause, but no such effects with degree adverbs, as evidence for the distinction between the full Neo-Davidsonian interpretation in (3) versus the bare update condition (7).

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