# Stalnaker 1978

## I. Introduction.

4 'truisms' about (an act of) assertion:

a. it *expresses a proposition* (proposition ~ something that represents the world as being in a certain way) – the proposition is (part of) the assertion *content*
b. it is *made in a context* (context ~ it includes the speaker and the addressees with their respective beliefs and intentions)
c. its *content* is dependent on its *context* (e.g. who the speaker is, her spatial and temporal location)
d. it modifies the *context* (particularly: the attitudes of the participants) in a way that is dependent on its content.

The last 2 'truisms' give the core intuition of what dynamic semantics for natural language is intended to model – Groenendijk & Stokhof 1996: 104

> Within the logical-semantical tradition, the meaning of a sentence is (often) equated with its truth conditions: to know what a sentence means is to know in which circumstances it is true or false. In more up-to-date approaches, however, the meaning of a sentence is identified with its context change potential: to know the meaning of a sentence is to know how it changes a context.
>
> The difference is not that the context dependent nature of interpretation is taken into account. The importance of contextual factors is generally acknowledged within traditional logical semantics, too. Usually, truth conditions are stated relative to both a model of the world, and certain other parameters which provide contextual information, such as the time and place of the utterance, its source and addressee, and possibly other features of the utterance situation.
>
> What *is* new, is the focus on context *change*: interpretation not only *depends* on the context, but also *creates* context. This is why the more fashionable approaches are often advertised as 'dynamic'.

The *general* goals of Stalnaker 1978:

- sketch some theoretical concepts to develop the above truisms
- use these concepts to explain certain linguistics phenomena

The *specific* goal:

- give an explicit representation of *content* and *context* and their interaction as described by the above truisms

## II. Central notions: *possible world, proposition, speaker presupposition.*

*Possible world.*

'… participants do seek to distinguish among alternative ways that things might be or might have been. […] to bring out the formal structure of such activities is to focus on what is done with a given relevant set of alternative states of the world' (Stalnaker 1978: 316?)

[For an 'extreme realism' about possible worlds (the term is due to Stalnaker 1976), see Lewis 1973; for more discussion, see Stalnaker 1976 a.o. The quote from Lewis below is meant to elaborate on what a possible world intuitively means/does:

I believe that there are possible worlds other than the one we happen to inhabit. If an argument is wanted, it is this. It is uncontroversially true that things might be otherwise than they are. I believe, and so do you, that things could have been in countless ways. But what does this mean? Ordinary language permits the paraphrase: there are many ways things could have been besides the way they actually are. On the face of it, this sentence is an existential quantification. It says that there exist many entities of a certain description, to wit 'ways things could have been'; I believe permissible paraphrases of what I believe; taking the paraphrase at its face value, I therefore believe in the existence of entities that might be called 'ways things could have been'. I prefer to call them 'possible worlds'.

I do not make it an inviolable principle to take seeming existential quantifications in ordinary language at their face value. But I do recognize a presumption in favor of taking sentences at their face value, unless (1) taking them at face value is know to lead to trouble, and (2) taking them some other way is known not to. (Lewis 1973: 84)]

Nota bene: 'The decision to treat possible worlds, or possible situations, as PRIMITIVE elements in a theory of propositions and propositional attitudes does not require an ontological commitment to possible worlds as basic entities of the universe. Rather, it is a decision to theorize at a certain level of abstraction'. (Stalnaker 1978: 316?)

*Proposition.*

- 'a proposition is a way – any way – of picking out a set of possible states of affairs – all those for which the proposition takes the value true' (Stalnaker 1978: ??)
- a proposition is a function from possible worlds into truth values (true or false), i.e. a characteristic function of a set of possible worlds; hence, a proposition is a set of possible worlds.
- 'any proposition determines a set of possible worlds' and 'every set of possible worlds determines a proposition' (Stalnaker 1978: ??)

Intuitive motivation for this analysis of propositions: 'a proposition – the content of an assertion or belief- is a representation of the world as being a certain way. But for any given representation of the world as being a certain way, there will be a set of all possible states of the world which accord to the representation – which *are* that way.' (Stalnaker 1978: ??)

*Speaker presupposition.*

- the central concept needed to characterize contexts
- 'the presuppositions of a speaker are the propositions whose truth he takes for granted as part of the background of the conversation'
- 'presuppositions are what is taken by the speaker to be the COMMON GROUND of the participants in the conversation, what is treated as their COMMON KNOWLEDGE or MUTUAL KNOWLEDGE' (for the purposes of the conversation at hand; the participants do not need to really believe them)

- The presuppositions can also be characterized as a single proposition/set of worlds, namely 'the possible worlds compatible with what is presupposed'; this CONTEXT SET is 'the set of possible worlds recognized by the speaker to be the "live options" relevant to the conversation' and it is obtained by taking the conjunction/intersection of the set of propositions that are presupposed: 'a proposition is presupposed if and only if it is true in all these possible worlds'

[A proposition is presupposed if:

'the speaker is disposed to act as if he assumes or believes that the proposition is true' (in the actual world)

'he [the speaker] assumes or believes that his audience assumes or believes that it is true as well']

*"Live options" as possible worlds and the purposes of the conversational process:*

'To engage in conversation is, essentially, to distinguish among alternative possible ways that things may be. The purpose of expressing propositions is to make such distinctions. The presuppositions define the limits of the set of alternative possibilities among which speakers intend their expressions of propositions to distinguish'.

More on the context set:

- each participant has its own context set
- it is part of the concept of presupposition that a speaker assumes that the members of his audience presuppose everything that s/he presupposes
- *nondefective context*: the presuppositions of the various participants in the conversation are all the same
- a *defective context* will be unstable and 'will tend to adjust to the equilibrium position of a nondefective context'
- 'a context is *close enough* to being nondefective if the divergences do not affect the issues that actually arise in the course of conversation'

## **III.** Assertion and context change.

An assertion changes the context in 2 ways:

- 'the fact that a speaker is speaking, saying the words he is saying in the way he is saying them' changes the common ground (CG) of the speaker and his audience (see Bittner 2004 for a semantics analysis of certain natural language constructions that incorporates this observation – in particular, the prominence of the speaker utterance event – in a dynamic framework)

['I mention this common place way assertions change the context in order to make clear that the context on which the an assertion has its ESSENTIAL effect is not defined by what is presupposed before the speaker begins to speak, but it will include any information which the speaker assumes his audience can infer from the performance of the speech act']

- the ESSENTIAL effect of an assertion on the context: 'to change the presuppositions of the participants in the conversation by adding the context of what is asserted to what is presupposed. This effect is voided only if the assertion is rejected.'

[Connection with Lewis 1979: 'One may think of a nondefective conversation as a game where the common set is the playing field and the moves are either attempts to reduce the size of the set in certain ways or rejections of such moves by others. […] The game could be expanded by introducing other kinds of moves like making stipulations, temporary assumptions or promises, asking questions and giving commands and permissions.']

## **IV.** Constraints on context update (the 1st principle).

The 1st constraint on context (CG) update:
'a proposition asserted is always true in some but not all of the possible worlds in the context set' (Stalnaker 1978: ??).

The constraint has the following intuitive motivation: 'to assert something incompatible with what is presupposed is self-defeating; one wants to reduce the context set, but not to eliminate it altogether. And to assert something which is already presupposed is to attempt to do something that is already done' (Stalnaker 1978: ??).

## **V.** Formalizing CG update in type logic.

Carpenter 1997: 37 et seqq
'The λ-calculus provides an elegant solution not only to the vexing problems of providing denotations for the basic expressions of a language, but also for productively composing these basic meanings into larger units. […]
The λ-calculus was invented by Church (1940), with the goal of providing a uniform language with which to describe functions. […]
A significant application of the λ-calculus is in both the operational and denotational description of higher-order programming languages such as Lisp and ML. […]
Λ-calculus […] forms the basis of the compositional method of defining the meanings of expressions in terms of the meanings of their parts. […]
… in first-order logic there are two types of expressions: terms and formulas. In the simply typed λ-calculus there are infinitely many types for expressions.'

Stalnaker 1978

- three basic types: $e$ (entities), $\mathbf{w}$ (worlds), $t$ (truth values);
- CG: a set of worlds (type $\mathbf{w}t$);
- CG update: set intersection.

(1) CG: the set of worlds $K_{\mathbf{w}t}:=A_0\cap \dots \cap A_n\cap \dots = \lambda w.\ A_0(w)\ \&\ \dots\ \&\ A_n(w)\ \&\ \dots$
where the set of propositions $\{A_n\text{: n}\in N\}$ is the common background knowledge of the conversation.

(2) CG update – set intersection: $K' := K \cap B = \lambda w.\ K(w)\ \&\ B(w)$

where $K$ is the input / initial CG, $B$ is the proposition expressed by the assertion and $K'$ is the output CG.

(3) The 1st constraint on CG update:

An assertion of a proposition $B$ is felicitous with respect to a CG $K$ only if:

(i) it is non-contradictory: $K \cap B \neq \emptyset$, i.e. $\exists w\ (\ K(w)\ \&\ B(w)\ )$;

(ii) it is non-redundant: $K \setminus B \neq \emptyset$, i.e. $\exists w\ (\ K(w)\ \&\ \sim B(w)\ )$.

**Example:**

| | | |
|---|---|---|
| (4) John came in. | (5) He sat down. | *felicitous* |
| | (5') #He stayed outside. | *contradictory* |
| | (5") #He entered. | *redundant* |

(4) is interpreted as the set of worlds $B_0$ in (6) below. The term of type $\mathbf{w}t$ in (6) is interpreted with respect to a $Ty_2$ model $M = \langle D^M, \|\cdot\|^M \rangle$ and an $M$-variable assignment $\theta$; every entity in the domain $D_e^M$ is assumed to exist at every world in $D_{\mathbf{w}}^M$; *come_in* and *john* are non-logical constants of type $\mathbf{w}et$ and $e$ respectively.

(4) John came in. (6) $B_0 := \lambda w.\ come\_in_w(john)$

(7) CG update: $K_1 = K_0 \cap B_0 = \lambda w.\ K_0(w)\ \&\ come\_in_w(john)$

Assuming that the input CG is the set of worlds $K_0$ and that $B_0$ is not contradictory or redundant with respect to the input CG (i.e. it satisfies (3i, ii) above), the CG is successfully updated and its output value is the set $K_1$.

Sentence (5) is interpreted as in (8) below: the pronoun 'He' is translated as a free variable $x_e$ and the intuitively correct interpretation of the pronoun, i.e. its referential dependency on the proper name 'John', is captured if (5) is interpreted with respect to a variable assignment $\theta$ which assigns to the variable $x$ the entity denoted by the constant *john*.

(5) He sat down.

(8) $B_1 := \lambda w.\ sit\_down_w(x)$, interpreted wrt an assignment $\theta$ s.t. $\theta(x) = john\|^M$

Again, it can be assumed that $B_1$ is not contradictory or redundant with respect to the input CG $K_1$ and the CG update in (9) below is successful. Hence, the discourse (4-5) is correctly predicted to be felicitous and the output CG $K_2$ is correctly predicted to entail that John came in and sat down.

(9) CG update: $K_2 = K_1 \cap B_1 = \lambda w.\ K_0(w)\ \&\ come\_in_w(john)\ \&\ sit\_down_w(x)$,

interpreted wrt an assignment $\theta$ s.t. $\theta(x) = \|john\|^M$

The sentences in (5') and (5") are interpreted as in (10) and (11) below – again, with respect to a variable assignment $\theta$ such that $\theta(x) = \|john\|^M$.

(5') He stayed outside. (10) $B_1{}' := \lambda w.\ stay\_out_w(x)$
(5'') He entered. (11) $B_1{}'' := \lambda w.\ enter_w(x)$

Given that coming in contradicts staying outside and means (basically) the same thing as entering – as stated in (12) below, the discourses (4-5') and (4-5'') are correctly predicted to be infelicitous since they do not satisfy the non-contradiction and non-redundancy constraints in (3) above.

(12) (i) $\forall w \forall x\ (come\_in_w(x) \leftrightarrow \sim stay\_out_w(x))$; (ii) $\forall w \forall x\ (come\_in_w(x) \leftrightarrow enter_w(x))$
(13) (i) $K_1 \cap B_1{}' = \varnothing$ (contradiction); (ii) $K_1 \setminus B_1{}'' = \varnothing$ (redundancy)

**VI.** A challenge for this kind of CG theory.

Intuitively, the following two sets of data instantiate the same kind of phenomenon as (4-5/5'/5'') above:

(nominal anaphora)

| | | |
|---|---|---|
| (14) A man came in. | (15) He sat down. | *felicitous* |
| | (15') #He stayed outside. | *contradictory* |
| | (15'') #He entered. | *redundant* |

(nominal and modal anaphora)

| | | |
|---|---|---|
| (16) A wolf might come in. | (17) It would eat John. | *felicitous* |
| | (17') #It would stay outside. | *contradictory* |
| | (17'') #It would enter. | *redundant* |
| | (17') #It will eat John. | *infelicitous…* |

These examples pose problems for a Stalnaker-type theory of CG update. Examples like (14-15/15'/15'') are discussed in Kamp 1981, Heim 1982, Groenendijk & Stokhof 1991 a.o. Examples like (16-17/17'/17'') are discussed in Roberts 1989, Stone 1999 a.o. A particularly elegant system that (can be extended to) account for these examples can be found in Muskens 1995, 1996.

*The problem posed by the mini-discourses in (14-15/…)*

The indefinite noun phrase in (14) will be interpreted in a Stalnaker-type system as existential quantification over entities; hence, (14) is interpreted as in (18) below and the CG is successfully updated as in (19).

(14) A man came in. (18) $B_0 := \lambda w.\ \exists x\ (man_w(x)\ \&\ come\_in_w(x))$
(19) CG update: $K_1 = K_0 \cap B_0 = \lambda w.\ K_0(w)\ \&\ \exists x\ (man_w(x)\ \&\ come\_in_w(x))$

The sentence in (15) is interpreted as above, i.e. the pronoun is translated as the free variable $x$ whose value is given by a variable assignment $\theta$.

(15) He sat down. (20) $B_1$:=$\lambda w$. $sit\_down_w(x)$, interpreted wrt an assignment θ.

The CG $K_1$ is updated with $B_1$ as in (21) below.

(21) $K_2$=$K_1$∩$B_1$=$\lambda w$. $K_1(w)$ & $B_1(w)$
=$\lambda w$. $K_0(w)$ & $\exists x$ ($man_w(x)$ & $come\_in_w(x)$) & $sit\_down_w(x)$

The CG update fails to capture the anaphoric dependency between the pronoun 'He' and the indefinite 'A man': the pronoun is interpreted as a free variable outside the scope of existential quantification and receiving its interpretation from the variable assignment θ.

The CG update in (21) makes the counterintuitive prediction that discourse (14-15) does not entail sentence (22), i.e. it makes the incorrect prediction that $K_2$ is not included in $B$ (see (23) and (24) below).

(22) A man came in and sat down.
(23) $B$:= $\lambda w$. $\exists x$ ($man_w(x)$ & $come\_in_w(x)$ & $sit\_down_w(x)$); (24) ~($K_2 \subseteq B$)

Stalnaker 1978 does not necessarily predict that discourse (14-15) is infelicitous – but it does not capture the dynamics of knowledge 'growth' that the CG update was meant to model. The failure is clearer in the infelicitous assertion cases. Discourse (14-15') is incorrectly predicted to be felicitous: sentence (15') is again interpreted as $B_1'$ in (10) above and the CG update does not necessarily fail even if the meaning postulate in (12i) holds.

(25) $K_2$=$K_1$∩$B_1'$=$\lambda w$. $K_0(w)$ & $\exists x$ ($man_w(x)$ & $come\_in_w(x)$) & $stay\_out_w(x)$

The variable $x$ in (25) is not bound by the existential quantifier (it is interpreted wrt the assignment θ). The update in (25) is different from the intuitively correct update given in (26) below, where by the meaning postulate (12i) the intersection $K_1$∩$B_1'$ is predicted to be empty and the discourse (14-15') to be contradictory:

(26) $K_2$=$K_1$∩$B_1'$=$\lambda w$. $K_0(w)$ & $\exists x$ ($man_w(x)$ & $come\_in_w(x)$ & $stay\_out_w(x)$)=∅

A similar incorrect prediction is made with respect to the redundant discourse (14-15'').

In addition, the nominal+modal anaphora cases (16-17/17'/17'') cannot be captured by the above static account, as they involve both individual level and modal anaphora.

**VII.** Towards a solution: dynamic semantics.

Muskens 1995

- four basic types: $s$ (information states), $e$, $\mathbf{w}$, $t$;
- discourse referents (drefs) for entities (type $se$) and worlds (type $s\mathbf{w}$);
- CG: a set of info states (type $st$);

- CG update: based on binary relations between input and output info states (type *sst*).

Muskens 1995 recasts in type logic an extensional version of Discourse Representation Theory (DRT – see Kamp 1981, Heim 1982) and then extends it to a dynamic intensional system. I will use a simplified version of his intensional system, with only four basic types: information states (type *s*), entities (type *e*), worlds (type **w**) and truth-values (type *t*). All terms are interpreted with respect to a $Ty_3$ model $M=<D^M, \|\cdot\|^M>$ and an *M*-variable assignment θ.

*Information states.*

Information states can be thought of as a different (and more general) way of thinking about the context of an utterance. They should be able to derive (directly or indirectly) the notion of CG/context set and its update and, at the same time, make possible an account of the anaphoric examples above.

Groenendijk & Stokhof 1996:

'… information states should contain two kinds of information: information about the world, and discourse information. In the end, it is information about the world that counts, but in acquiring such information through discourse, one also has to store information pertaining to the discourse as such. For example, in order to be able to resolve anaphoric links across utterances, one has to keep track of the discourse items, viz., the "things" which were talked about.'

An information state will keep track of items which are introduced in discourse. These items can be individuals/entities or possible worlds/possibilities. A discourse referent (dref) is a 'name' for an item – and it will name a particular item depending on the information state (context) in which it is used. This is why drefs are functions from info states to entities (type *se*) or worlds (type *s***w**). Info states do the job that the variable assignment θ was doing in the account of discourses (4-5/5'/5"): when 'he' was conveniently interpreted as referring to John by the variable assignment θ, it was the variable assignment that 'recorded' that the item 'John' was previously introduced/mentioned in discourse.

(27) drefs for entities: functions of type *se*, e.g. $u_1, u_2$ etc.
drefs for possible worlds: functions of type *s***w**, e.g. $W_1, W_2$ etc.

An assertion would be dynamically interpreted as a binary relation between an input info state and an output info state, i.e. a term of type *sst* – implementing the last two 'truisms' of Stalnaker: the input info state will determine the exact content of the assertion, while the output info state is the way the assertion modifies the input context.

The contents, i.e. the binary relations over info states, will be represented by pairs:

(28) [ | ]:

- the first member of the pair contains the new drefs introduced in discourse
- the second member of the pair contains the actual 'infromational content' of the assertion

For example:

(14) A man came in. (29) $D_0$:=[$u_1$ | $man_{W_0}\{u_1\}$, $come\_in_{W_0}\{u_1\}$]

In type logic, the representation in (29) is actually the 'unpacked' term in (30):

(30) $\lambda i_s j_s.\ i[u_1]j\ \&\ man_{W_0j}(u_1j)\ \&\ come\_in_{\ W_0j}(u_1j))$

It is implicit in (30) that lexical relations like 'come in', 'sit down' are analyzed as functions of type *st* and are relativized to a possible world dref *W*:

(31) $come\_in_W\{u\} := \lambda i_s.\ come\_in_{Wi}(ui)$

Muskens 1995 does not offer an explicit theory of the CG update, but a Stalnaker-type account can be provided by replacing possible worlds with info states:

(32) *the CG* is the set *I* of info states currently under consideration (type *st*)

(33) CG update: $I'$=$\lambda j.\ I(j)\ \&\ \exists i\ (I(i)\ \&\ Dij)= I\cap \text{Ran}\ D{\upharpoonright}I$
where *I* is the input CG, *D* is the asserted DRS and *I'* is the output CG.

Stalnaker's felicity constraint on assertions could be formulated in terms of info states; however, to make the relationship between the new CG update and Stalnaker's account more transparent, I will state it in terms of sets of possible worlds.

Note first that all assertions should be interpreted with respect to the same world dref, i.e. with respect to the world that the participants in the conversation take to be the actual / speech world. For this purpose, I will designate the dref $W_0$ of type $s\mathbf{w}$ to stand for 'reality' (the speech world) and all the lexical relations in DRSs will be relativized to the 'reality' dref $W_0$ (this proposal is similar to an idea in Stone 1999).

The set of candidates for the actual / speech world in a CG *I* is the set *K* of all the worlds that are possible values of the dref $W_0$ at the info states in *I*:

(34) For any CG $I_{st}$: $K_{\mathbf{w}t}$:=$\lambda w.\ \exists i\ (I(i)\ \&\ w=W_0i)$

Stalnaker's constraint on the felicity of assertions can now be stated directly in terms of the candidates for the actual world – very much like in (3) above.

(35) Given an assertion of a DRS *D* wrt a CG *I* and assuming that the set of info states *I'* is the result of updating the CG I with the DRS D, the assertion is felicitous only if:

(i) it is non-contradictory: $K\cap K'\neq\varnothing$, i.e. $\exists w\ (\ K(w)\ \&\ K'(w)\ )$;
(ii) it is non-redundant: $K\setminus K'\neq\varnothing$, i.e. $\exists w\ (\ K(w)\ \&\ {\sim}K'(w)\ )$.
where $K{:=}\lambda w.\ \exists i\ (I(i)\ \&\ w{=}W_0 i)$ and $K'{:=}\lambda w.\ \exists i\ (I'(i)\ \&\ w{=}W_0 i)$

***Example – analyzing the discourses (4-5/5'/5'')***

Sentence (4) is interpreted as in (38).

(4) John came in. (38) $D_0{:=}[\ \mid come\_in_{W_0}\{John\}]$

Assuming for simplicity that the input CG $I_0$ is the set of all info states, i.e. $D_s^M$, we infer that the initial set $K_0$ of candidates for the actual world is the set of all possible worlds $D_{\mathbf{w}}^M$.

(the equivalence between existential quantification over info states and existential quantification over possible worlds in (40) below is established using the 'enough states axiom' AX1 in Muskens 1995: 152)

(39) $I_0{:=}\lambda i.\ i{=}i$ (40) $K_0 \quad {:=}\lambda w.\ \exists i\ (I_0 i\ \&\ w{=}W_0 i){=}\lambda w.\ \exists i\ (w{=}W_0 i)$
(by AX1)$=\lambda w.\ \exists w'\ (w{=}w'){=}\lambda w.\ w{=}w$

The value $I_1$ of the updated CG is given in (41) below.

(41) CG update: $I_1{:=}\lambda j.\ I_0(j)\ \&\ \exists i\ (I_0(i)\ \&\ D_0 ij){=}\lambda j.\ come\_in_{W_0 j}(john)$

To determine the felicity of the assertion, we have to compute the set $K_1$ of candidates for the actual worlds at the new CG $I_1$ – as shown in (42). The values of $K_0$ and $K_1$ satisfy both conditions in (37i, ii), so asserting (1) is felicitous.

(42) $K_1 \quad {:=}\lambda w.\ \exists i\ (I_1(i)\ \&\ w{=}W_0 i){=}\lambda w.\ \exists i\ (come\_in_{W_0 i}(john)\ \&\ w{=}W_0 i)$
(by AX1)$=\lambda w.\ \exists w'\ (come\_in_{w'}(john)\ \&\ w{=}w'){=}\lambda w.\ come\_in_w(john)$

Sentence (2) is interpreted as in (43) below: the pronoun 'He' is anaphoric to the dref $John_{se}$, symbolized by subscripting the pronoun with this dref. The result of the CG update is computed in (44).

(2) $\text{He}_{John}$ sat down. (43) $D_1{:=}[\ \mid sit\_down_{W_0}\{John\}]$
(44) CG update: $I_2{:=}\lambda j.\ come\_in_{W_0 j}(john)\ \&\ sit\_down_{W_0 j}(john)$

The candidates for the actual world at CG $I_2$ form the set $K_2$ in (45) below. The sets $K_1$ and $K_2$ satisfy the non-contradiction and non-redundancy requirements, so discourse (4-5) is correctly predicted to be felicitous. Moreover, we correctly derive the fact that, by the end of discourse (4-5), it is true that John came in and sat down in all the candidates for the actual / speech world.

(45) $K_2{:=}\lambda w.\ \exists i\ (I_2(i)\ \&\ w{=}W_0 i){=}\lambda w.\ come\_in_w(john)\ \&\ sit\_down_w(john)$

The sentences in (5') and (5'') are interpreted as in (46) and (47) below.

(5') He stayed outside. (46) $D_1'$:=[ | $stay\_out_{W_0}\{John\}$]
(5'') He entered. (47) $D_1''$:=[ | $enter_{W_0}\{John\}$]

The CG updates $I_2'$ and $I_2''$ are given in (48) and (50) and the corresponding sets of candidates for the speech world are computed in (49) and (51).

(48) $I_2' := \lambda j.\ come\_in_{W_0j}(john)\ \&\ stay\_out_{W_0j}(john))$
(49) $K_2' := \lambda w.\ come\_in_{w}(john)\ \&\ stay\_out_{w}(john)$
(50) $I_2'' := \lambda j.\ come\_in_{W_0j}(john)\ \&\ enter_{W_0j}(john))$
(51) $K_2'' := \lambda w.\ come\_in_{w}(john)\ \&\ enter_{w}(john)$

By the meaning postulates in (12i) above, the two assertions are predicted to be contradictory and redundant respectively and the discourses (4-5') and (4-5'') are correctly predicted to be infelicitous, as (52) shows.

(15) (i) $\forall w \forall x\ (come\_in_w(x) \leftrightarrow \sim stay\_out_w(x))$; (ii) $\forall w \forall x\ (come\_in_w(x) \leftrightarrow enter_w(x))$
(52) (i) $K_2' = \varnothing$ (contradiction); (ii) $K_2'' = \lambda w.\ come\_in_w(john) = K_1$ (redundancy)

***The account of nominal anaphora cases.***

The indefinite noun phrase in (14) will introduce a new dref $u_1$, symbolized by superscript on the indefinite determiner. Hence, (14) is interpreted as in (53).

(14) A man came in. (53) $D_0$:=[$u_1$ | $man_{W_0}\{u_1\}$, $come\_in_{W_0}\{u_1\}$]

Just as before, the initial CG $I_0$ is assumed to be the set of all info states, i.e. $\lambda i.\ i=i$, and the corresponding $K_0$ is the set of all possible worlds $\lambda w.\ w=w$. The result of the CG update is given in (54) below.

(54) $I_1 \quad := \lambda j.\ I_0(j)\ \&\ \exists i\ (I_0(i)\ \&\ D_0ij) = \lambda j.\ \exists i\ (i[u_1]j\ \&\ man_{W_0j}(u_1j)\ \&\ come\_in_{W_0j}(u_1j))$
(by $i[u_1]j$)$= \lambda j.\ man_{W_0j}(u_1j)\ \&\ come\_in_{W_0j}(u_1j)$

The corresponding set $K_1$ is computed in (55). The update correctly predicts that all the candidates for the speech world have to 'contain' a man that came in (just as before, I assume for simplicity that every entity in $D_e^M$ exists at every world in $D_{\mathbf{w}}^M$). Since the set $K_1$ is a proper subset of $K_0$, the assertion is felicitous.

(55) $K_1 \quad := \lambda w.\ \exists j\ (I_1(j)\ \&\ w=W_0j) = \lambda w.\ \exists j\ (man_{W_0j}(u_1j)\ \&\ come\_in_{W_0j}(u_1j)\ \&\ w=W_0j)$
(by AX1)$= \lambda w.\ \exists w'\ \exists x\ (man_{w'}(x)\ \&\ come\_in_{w'}(x)\ \&\ w=w')$
$= \lambda w.\ \exists x\ (man_w(x)\ \&\ come\_in_w(x))$

Sentence (15) is interpreted as in (56), with the pronoun 'He' anaphoric to the dref $u_1$. The result of the CG update is given in (57). Note that the representation successfully captures the anaphoric connection between sentence (3) and sentence (2).

(15) He$_{u1}$ sat down. (56) $D_1$:=[ | $sit\_down_{W_0}\{u_1\}$]

(57) CG update: $I_2$:=$\lambda j.\ I_1(j)\ \&\ \exists k\ (I_1(k)\ \&\ D_1kj)$

$=\lambda j.\ man_{W_0j}(u_1j)\ \&\ come\_in_{\ W_0j}(u_1j)\ \&\ sit\_down_{W_0j}(u_1j)$

Moreover, the corresponding set $K_2$ (computed in (58) below) correctly constrains all the candidates for the speech world to 'contain' a man that came in and sat down. The set $K_2$ is a proper subset of $K_1$, so discourse (3-2) is predicted to be felicitous.

(58) $K_2$:=$\lambda w.\ \exists j\ (I_2(j)\ \&\ w=W_0j)=\lambda w.\ \exists x\ (\ man_w(x)\ \&\ come\_in_w(x)\ \&\ sit\_down_w(x)\ )$

Sentences (15') and (15'') are interpreted as in (59) and (60) below.

(15') He$_{u1}$ stayed outside. (59) $D_1'$:=[ | $stay\_out_{W_0}\{u_1\}$]

(15'') He$_{u1}$ entered. (60) $D_1''$:=[ | $enter_{W_0}\{u_1\}$]

The CG updates $I_2'$ and $I_2''$ and the sets $K_2'$ and $K_2''$ are given below.

(61) $I_2'$:=$\lambda j.\ man_{W_0j}(u_1j)\ \&\ come\_in_{\ W_0j}(u_1j)\ \&\ stay\_out_{W_0j}(u_1j)$

(62) $K_2'$:=$\lambda w.\ \exists x\ (\ man_w(x)\ \&\ come\_in_w(x)\ \&\ stay\_out_w(x)\ )$

(63) $I_2''$:=$\lambda j.\ man_{W_0j}(u_1j)\ \&\ come\_in_{\ W_0j}(u_1j)\ \&\ enter_{W_0j}(u_1j)\ )$

(64) $K_2''$:= $\lambda w.\ \exists x\ (\ man_w(x)\ \&\ come\_in_w(x)\ \&\ enter_w(x)\ )$

By the meaning postulates in (15), the two discourses (3-2') and (3-2'') are correctly predicted to be infelicitous, as (65) shows.

(65) (i) $K_2'=\varnothing$ (contradiction); (ii) $K_2''=K_1$ (redundancy)

For modal+nominal anaphora see Stone 1999 and …

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