# Update Semantics for the Scopal Relation of Japanese Evidentials

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## 1. Introduction

The aim of this paper is to propose an account of scopal phenomena involving Japanese evidentials in terms of Update Semantics. Evidentials are linguistic devices that mark the source of information on which an utterance is based (Aikhenvald (2004)). Although Japanese has a variety of evidential items, we will focus on two of them: the indirect *yoo* and the reportative *soo*. This is because the literature about these two items is relatively rich compared to other Japanese evidentials.[1] Their typical use is as follows:

(1) Ame-ga futteiru-yoo/soo-da.
rain-Nom falling-yoo/soo-Cop.
'[It seems/I hear] that it is raining.'

$\phi$+*yoo* indicates that the speaker acquires or infers $\phi$ through indirect evidence, and $\phi$+*soo* signals that $\phi$ has been told to the speaker by someone else.

This paper concerns the scopal behavior of Japanese evidentials. First, Japanese evidentials obligatorily take wider scope over negation.

(2) a. Ame-ga futtei-nai-yoo/soo-da.
rain-Nom falling-Neg-yoo/soo-Cop.
'[It seems/I hear] that it is not raining.'
b. # Ame-ga futteiru-yoo/soo-de-nai.
rain-Nom falling-yoo/soo-Cop-Neg.

'(Intended) [It doesn't seem/I don't hear] that it is raining.'

The negative marker *-nai* in (2 b) is intended to negate the contribution of the evidentials, but the sentence sounds terribly awkward, while (2 a), where *-nai* stays within the scope of evidentials, is totally acceptable. A similar pattern is observed for epistemic modals:

(3) a. Ame-ga futteiru-kamoshirenai/nichigainai-yoo/soo-da.
rain-Nom falling-might/must-yoo/soo-Cop.
'[It seems/I hear] that it might/must be raining.'
b. # Ame-ga futteiru-yoo/soo-dearu-kamoshirenai/nichigainai.
rain-Nom falling-yoo/soo-Cop-might/must
'(Intended) [It might/must seem / I might/must hear] that it is raining.'

As with negation, the epistemic modals *kamoshirenai* 'might' and *nichigainai* 'must' cannot scope over evidentials. This paper deals with why such contrasts arise. To the best of my knowledge, there are no studies that attempt to elucidate the answer to this question.

The rest of this paper is structured as follows. Section 2 introduces the ingredients of my framework, which is based on Veltman (1996) and McCready (2015). Section 3 shows how my proposal works in explaining the preceding data. Section 4 is the conclusion.

## 2. The Framework of Update Semantics

In this section, I construct my own framework. In the course of discussion, first I introduce the basic framework of Update Semantics and the more complicated one proposed by McCready (2015). After that I integrate the two systems and build my own system that can explain the data at issue.

## 2.1. The Basic Notions

In Update Semantics, it is assumed that what an agent (in other words, a participant in the conversation) knows (or believes) is represented as the *information state* of the agent, which is defined to be a set of possible worlds where all propositions that she knows (or believes) are true. I further assume that the information state of an agent represents her knowledge in the discourse, that is, what she is known to know. Thus, the context of conversation contains each participant's information state. When the speaker utters *it is raining*, other participants learn that she knows (or at least believes) the truth of that proposition, and her information state $\sigma$ is updated by it in the following way ( $\sigma\,[\phi]$ stands for '$\sigma$ updated by $\phi$', and now $\phi$ is *it is raining*):

(4) $\sigma\,[\phi] = \sigma \cap [\![\phi]\!]$

That is, due to the update, only worlds where $\phi$ is true (henceforth, $\phi$-worlds) are left in $\sigma$, and $\neg\phi$-worlds are eliminated from it. If the updated state is the empty set, it is regarded as a contradiction and the discourse crashes.

Following Veltman (1996), I adopt particular forms of update for negation and a possibility modal (*might* in English, *kamoshirenai* in Japanese)[2].

(5) a. Negation

$\sigma\,[\neg\phi] = \sigma - \sigma\,[\phi]$

b. Possibility modal

$$\sigma\,[\Diamond\phi] = \begin{cases} \sigma \text{ if } \sigma\,[\phi] \neq \emptyset \\ \emptyset \text{ if } \sigma\,[\phi] = \emptyset \end{cases}$$

As in (5 a), a negated proposition $\neg\phi$ updates $\sigma$ in two steps; first, $\phi$ updates $\sigma$ according to (4), leaving only $\phi$-worlds in the resulting state, and second, the resulting state is subtracted from the original state $\sigma$.

This process is equivalent to eliminating $\phi$-worlds from $\sigma$. (5 b) is the updating process posed by $\Diamond\phi$. Veltman says that $\Diamond\phi$ tells us to perform a test on $\sigma$ as to whether there is a possibility in $\sigma$ that $\phi$ is true, rather than to incorporate some new information into $\sigma$. If $\sigma\,[\phi] \neq \varnothing$, that is, $\sigma$ contains at least one $\phi$-world, $\sigma$ passes the test, and otherwise ($\sigma\,[\phi] = \varnothing$, which means that it is not possible that $\phi$), contradiction occurs. This form of update is designed to account for the deviance of the following example, which is of the form $\sigma\,[\phi \wedge \Diamond \neg \phi]$:[3]

(6) #Ame-ga futteiru. Daga futtei-nai-kamoshirenai.
rain-Nom falling. but falling-Neg-might.
'It is raining. But it might not be raining.'

The first sentence updates the speaker's information state $\sigma$, resulting in $\sigma$ containing only $\phi$-worlds. Thus the resulting state cannot pass the test posed by the second sentence, since $\sigma$ [*it is not raining*] $= \varnothing$.

A necessity modal is treated as in traditional modal logic: it is the dual of a possibility modal, i.e., $\Box\phi \leftrightarrow \neg\Diamond\neg\phi$ (von Fintel and Gillies (2007) point out the validity of this treatment). Let us see how the computation proceeds:

(7)
$$\begin{aligned}\sigma\,[\Box\phi] &= \sigma\,[\neg\Diamond\neg\phi] \\ &= \sigma - \sigma\,[\Diamond\neg\phi] \\ &= \begin{cases} \sigma - \sigma \text{ if } \sigma\,[\neg\phi] \neq \varnothing \\ \sigma - \varnothing \text{ if } \sigma\,[\neg\phi] = \varnothing \end{cases} \\ &= \begin{cases} \varnothing \text{ if } \sigma - \sigma\,[\phi] \neq \varnothing \\ \sigma \text{ if } \sigma - \sigma\,[\phi] = \varnothing \end{cases}\end{aligned}$$

Like $\Diamond\phi$, $\Box\phi$ poses a test on $\sigma$ in order to check whether all the worlds contained in $\sigma$ are $\phi$-worlds; contradiction occurs if $\sigma\,[\neg\phi] \neq \varnothing$, that is, there is at least one $\neg\phi$-world in $\sigma$, and otherwise $\sigma$ is retained.

### 2.2. McCready's (2015) Multiple Information States

Addressing the proper treatment of evidentials, McCready (2015) adopts a dynamic framework that involves multiple information states. The reason he introduces such a complication rests on the nature of evidentials. Evidentials are linguistic expressions that indicate that the speaker's utterance is based on a certain type of evidence or information source. Indirect evidentials refer to certain indirect evidence, and reportative evidentials signal that the utterance is based on a report from someone else. What matters is that the difference in types of evidence allows utterance of the form *Indirect* ($\phi$) $\wedge$ *Reportative* ($\neg\phi$), as in (8):

(8) Jimen-no-jootai-o-miru-ni Ame-ga futta-yoo-da ga
ground-Gen-state-Acc-see-from rain-Nom fall-yoo-Cop but
Taro-ga-iu-niwa fur-anak-atta-soo-da.
Taro-Nom-say-from fall-Neg-Past-soo-Cop.
'Judging from the state of the ground, it seems that it rained, but I hear from Taro that it didn't.'

In a case like (8), if the two conjuncts share the same form of update and target the same information state, the result state will be contradictory. To avoid this, the two conjuncts have to target distinct states. McCready therefore assumes that one's information state $\sigma$ can be divided into several substates, as in the following:

(9) $\sigma = \{\sigma_{Ind}, \sigma_{Rep}, \ldots\}$ or
$\sigma = \{\sigma_i : i \in \text{Source}\}$, where Source is the set of evidence types.[4]

Thus, *Indirect* ($\phi$) targets $\sigma_{Inf}$ and *Reportative* ($\phi$) targets $\sigma_{Rep}$. The general formulation of targeting substates is represented in (10).

(10) a. $E_i\phi$ represents the proposition with $i$-type evidence.

b. $\sigma\,[E_i\phi] = \sigma'$ where, for all $\sigma_j \in \sigma$, $\begin{cases} \sigma'_j = \sigma_j\,[\phi] & \text{if } i = j. \\ \sigma'_j = \sigma_j & \text{if } i \neq j. \end{cases}$

(10) says that what is affected by the update with a proposition with $i$-type evidence is only a substate indexed with $i$. Note that each substates contains the same worlds: if $\sigma_i = \{w_1, w_2\}$ and $\sigma_j = \{w_1, w_2\}$, the worlds sharing the same numeral index are identical, although they are housed in distinct substates.

McCready further assumes that an evidentially marked proposition manipulates the plausibility of possible worlds, rather than eliminates some of them. Concretely, $E_i\phi$ targets $\sigma_i$ and makes $\phi$-worlds in it more plausible than $\neg\phi$-worlds. The precise formulation is as follows.

(11) a. A substate $\sigma$ consists of a set of possible worlds $S$ and the ordering $\leq_a$ over $S$.

b. For two worlds $s$ and $t$, $s \leq_a t$ iff agent $a$ considers $t$ to be as plausible as $t$.

As is clear from (11 a), a substate is a partially ordered set of possible worlds. A proposition with $i$-type evidence updates $\sigma_i$ in the following fashion (henceforth, an element with a prime like $S'$ stands for the updated version of that element):

(12) a. $\sigma\,[\phi]_{\Uparrow} = \sigma'$ where $S' = S$ and $s \leq'_a t$ iff either (i) $s \in [\![\phi]\!]$ and $t \in s\,(a) \cap [\![\phi]\!]$ or (ii) $s \leq_a t$.

b. $s\,(a)$ is the set of worlds comparable to $s$ in terms of $\leq_a$.

Putting (10) and (12) together, informally, once a substate is updated by $\phi$, no worlds are eliminated, but instead $\phi$-worlds are made more plausible than $\neg\phi$-worlds.

Let us see one simple example. Suppose that the speaker says with an indirect evidential that it is raining. Then, in $\sigma_{Ind}$, raining worlds are ranked higher than non-raining worlds. After that, if the speaker utters with a reportative evidential that it is not raining, it targets $\sigma_{Rep}$ and orders non-raining worlds higher than raining-worlds. In this fashion, pieces of information about the plausibility of worlds are stored in distinct substates, without contradicting each other.

These pieces of information stored in distinct substates and not interacting with one another cannot be employed in order to compute the speaker's whole knowledge (or belief) without further operations. In the example of the last paragraph, we do not know which worlds the speaker considers to be more plausible, raining or non-raining worlds; we have to know the global plausibility ordering that is generated by taking into account orderings in each substate. To do this, McCready introduces a merge operation called lexicographic merge. Although its precise definition is too complicated to introduce here, let us see informally what it does. Given that there are two substates $a$ and $b$, and the information source associated with $a$ is more reliable than that associated with $b$, represented as $a > b$, then the lexicographic merge gives rise to a new ordering where the ordering in $a$ is retained and privileged over the ordering in $b$. If the worlds are ranked equally in $a$ while $b$ orders one of them higher, the latter ordering is reflected.[5]

Consider an example. Suppose there are two substates $\sigma_{Ind}$ and $\sigma_{Rep}$, both containing three worlds, and the plausibility orderings in them are as in (13 a). If indirect information source is more reliable for the speaker than the reportative one, the ordering in $\sigma_{Ind}$ has a privileged status and is retained, ignoring the parts of the ordering in $\sigma_{Rep}$ that contradict their counterparts in $\sigma_{OInd}$. Thus, the ordering between $w_1$ and $w_2$ in $\sigma$ takes over that of $\sigma_{Ind}$. However, since $\sigma_{Ind}$ is indifferent to the ordering between $w_2$ and $w_3$, the ordering in $\sigma_{Rep}$ plays a role. The result of merging the two substates will be (13 b). By applying this merging operation to each pair of substates, we can compute the global plausibility ordering of an agent.

(13) a. $$\boxed{\sigma_{Ind}:\ w_1 \leq_a w_2 =_a w_3} \qquad \boxed{\sigma_{Rep}:\ w_1 \geq_a w_2 \leq_a w_3}$$

b. $$\boxed{\sigma:\ w_1 \leq_a w_2 \leq_a w_3}$$

To summarize, in McCready's (2015) system, the contribution of an evidential-marked proposition is directed to a certain substate, but affects the global state $\sigma$ by applying the lexicographic merge to substates. That is, what a proposition with an evidential does to the global state is to affect its plausibility ordering, without eliminating any worlds in it. In this sense, evidential-marked propositions are 'weaker' than ordinary assertions, which eliminates worlds incompatible with them. This weakness is necessary because at least Japanese allows $Evid(\phi) \wedge \Diamond \neg \phi$:

(14) Ame-ga futteiru-[yoo/soo]-da. Ga futtei-nai-kamoshirenai.
rain-Nom falling-[yoo/soo]-Cop. But falling-Neg-might
'[It seems/I hear] that it is raining. But it might not be raining.'

If $Evid(\phi)$ eliminates $\neg\phi$-worlds from the global state, the following $\Diamond \neg\phi$ makes the discourse contradictory.

## 2.3. Integrating the Two Frameworks: Informal Discussion

McCready's (2015) dynamic system is dedicated to the treatment of evidentials and does not go well with the standard framework reviewed in Section 2.1., which accommodates negation and modals. The aim of this section is to modify McCready's system to fit with the standard model.

First, and most importantly, in the framework of McCready

(2015), one's information state is not a set of possible worlds. Rather, as is seen in (8), it is a set of sets of worlds. Since update operations employed in the standard model, such as (4) and (5), are designed for an information state as a set of worlds, they are inapplicable to McCready's system. To solve this dilemma, I assume that the global information state $\sigma$, as well as the substates, is a set of worlds and that $\sigma$ and substates are distinct elements, while McCready defines the former as containing the latter as its elements. Propositions without evidentials affect the global information state directly, while those with evidentials contribute to substates. Figures 1 and 2 are schematic images of

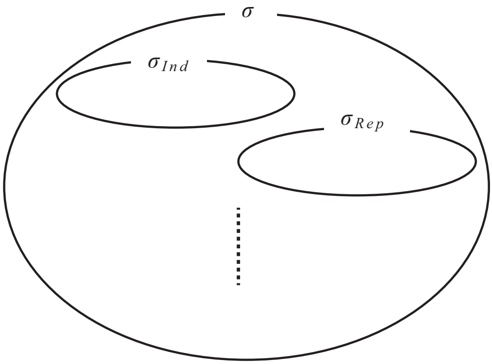


Figure 1: The model in McCready (2015)

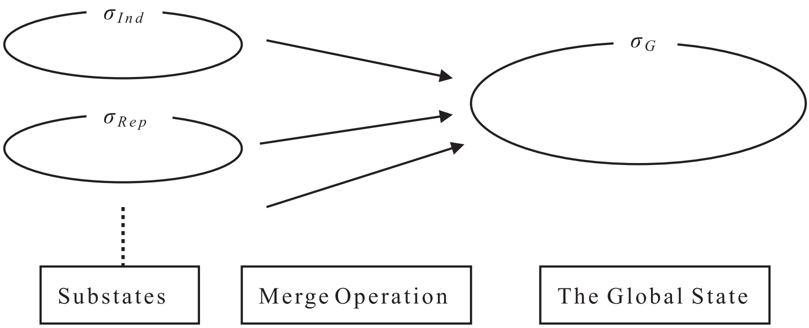


Figure 2: The current model

McCready's system and my own.

This modification allows update with an evidential and that of the standard style to coexist. This move accompanies the assumption that for a participant of the conversation, the discourse stores a global information state and substates separately. I further assume that substates are accessible from the global state $\sigma_G$; when an evidentially marked proposition tries to update $\sigma_G$, it does not update it but rather accesses the relevant substate.

The second point of departure from McCready (2015) is that I adopt the eliminative update for substates as well as for the global state. $E_i\phi$ updates $\sigma_i$ and eliminates $\neg\phi$-worlds in it in the same way as $\phi$ updates $\sigma_G$. There are technical and empirical motivations for this somewhat radical modification. As for the technical one, the definition of $\sigma\,[\phi]_{\Uparrow}$, which $E_i\phi$ triggers, is at work only when the updater $\phi$ is a proposition (a set of worlds), as is seen in the definition in (12), repeated as (15) here (in order to make my point clear, I add an underline):

(15) a. $\sigma_i\,[\phi]_{\Uparrow} = \sigma'$ where $S' = S$ and $s \leq'_a t$ iff either (i) $\underline{s \in [\![\phi]\!] \text{ and } t \in s\,(a) \cap [\![\phi]\!]}$ or (ii) $s \leq_a t$.

b. $s\,(a)$ is the set of worlds comparable to $s$ in terms of $\leq_a$.

Given that $\Diamond\phi$ is not a set of worlds in the standard model of Update Semantics, we cannot compute the update posed by $E_i\Diamond\phi$ with (14), although such a configuration is in fact observed in Japanese, as in (3 b).

The empirical advantage of allowing $E_i\phi$ to perform the eliminative update is that if it did not exclude any words from $\sigma_i$, $E_i\phi$ would be consistent with a following $E_i\Diamond\neg\phi$, which is contrary to fact:

(16) # Ame-ga futteiru-soo-da.
rain-Nom falling-soo-Cop.
Ga futtei-nai-kamoshirenai-soo-da.

But falling-Neg-might-soo-Cop.
'I hear that it is raining. But I hear that it might not be raining.'

What (16) teaches us is that $E_i\phi \wedge E_i\Diamond\neg\phi$ sounds contradictory as is the case with $\phi \wedge \Diamond\neg\phi$. We can capture the oddness of (15) straightforwardly by adopting the assumption that whether a proposition possesses an evidential or not, it updates its relevant state in the eliminative way.

Here a question arises: How can we compute the global plausibility ordering? In McCready's (2015) system, evidentially marked propositions update their own relevant state but eliminate no world in them, just manipulating the plausibility ordering between worlds. The plausibility ordering in the global state $\sigma_G$ is computed by applying the lexicographic merge to pairs of orderings in substates. The lexicographic merge is, by definition, operative only if a pair of orderings (i.e. substates) contains the same number of worlds; in the case where orderings in $\sigma_i$ and $\sigma_j$ are '$w_1 \leq_a w_2 =_a w_3$' and '$w_1 \geq_a w_2$', respectively, and $i$ is more reliable than $j$, the lexicographic merge cannot generate the ordering between $w_2$ and $w_3$ since one of the pair has lost $w_3$. My framework predicts this would happen because an evidentially marked proposition eliminates worlds in substates.

What is needed is a mechanism that deals with substates that have different numbers of worlds. First, let us consider how the plausibility of a world in a substate is recast in the current framework. When $E_i\phi$ updates $\sigma_i$, $\neg\phi$-worlds are excluded from $\sigma_i$, which means that in $\sigma_i$, there is no possibility that $\neg\phi$ is true. In terms of plausibility, $\phi$-worlds are more plausible than $\neg\phi$-worlds. Thus, the eliminative update made by $E_i\phi$ in my system has an effect similar to the non-eliminative one in McCready's (although the former is stronger than the latter in that the former excludes any possibility of $\neg\phi$). This allows the following reasoning: a world $w_n$ in $\sigma$ is more plausible than $w_m$ iff the number of substates containing $w_n$ is greater than that containing $w_m$, represented schematically as follows:

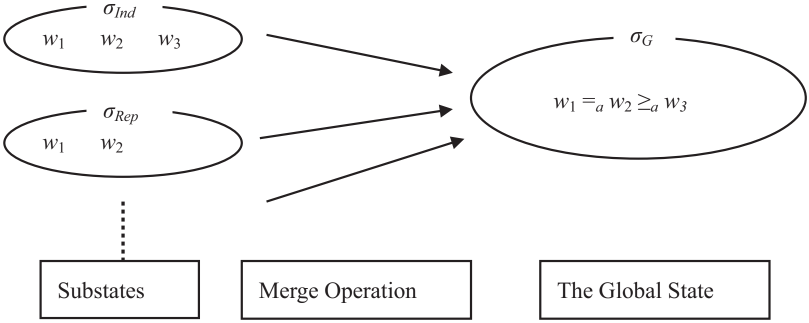


Figure 3: Calculation of the global plausibility ordering

The result of this operation reflects the plausibility relation in substates. Note that while the lexicographic merge in the system of McCready (2015) is applied to a pair of substates, the current merging operation targets each pair of worlds in the global information state.

This is not the whole story. The merging operation developed so far cannot deal with the case where the same number of substates contain two distinct worlds subject to it. For example, suppose $\sigma_i = \{w_1, w_2\}$, $\sigma_j = \{w_1, w_3\}$, and $\sigma_k = \{w_1, w_2\}$, $\sigma_l = \{w_3\}$. In this case, $w_1$ will be the highest-ranked world (since for both $w_1$, $w_2$ and $w_1$, $w_3$, the number of substates that contain $w_1$ is greater than the number containing any other world), but what about the ranking between $w_2$ and $w_3$? This situation is like the one we saw in McCready's system, where two orderings contradict each other, like $w_2 \geq_a w_3$ in $\sigma_i$ and $w_2 \leq_a w_3$ in $\sigma_j$. McCready proposes that in such cases the reliability of an evidence source is at work, that is, if $i$ is more reliable than $j$, $i$'s ordering is privileged. I instead adopt this idea: If we are confronted with cases like the example just above, check what the most reliable source is for the two sets of substates that contradict each other, and give priority to the set of substates that have the more reliable source. In the current case, as for the ordering between $w_2$ and $w_3$ $\sigma_i$ and $\sigma_k$, which contain $w_2$, are incompatible with $\sigma_j$ and $\sigma_l$. Suppose the reliability ranking between these sources is $k < l < j < i$. Then the most reliable source on the side of $w_2$ is $i$, while that on the side of $w_3$ is $j$, and therefore the former will have privileged status, resulting in $w_2 > w_3$.

Let us now take a stock. I modified McCready's (2015) system to allow the global information state to be a set of possible worlds and evidentially marked propositions to perform the eliminative update. This move makes it necessary to develop another merging operation different from that in McCready's system. The next subsection formulates the ideas discussed so far.

### 2.4. Formulation

The knowledge (or belief) of an agent contains her global information state $\sigma_G$ and substates $\sigma_{Ind}$, $\sigma_{Rep}$..., which are accessible from $\sigma_G$, and they are sets of possible worlds with indices. The worlds sharing the same index are identical, but they are contained in distinct states:

(17) For any $i \in \{G, Ind, Inf \ldots\}$, $\sigma_i = \{w_j : j \in \text{Index}\}$.

Regardless of whether an evidential is present, a simple proposition and those with negation or modals update information states in a certain manner:

(18) For any $i \in \{G, Ind, Rep, Dir \ldots\}$,

a. $\sigma_i [\phi] = \sigma_i \cap [\![\phi]\!]$.

b. $\sigma_i [\neg\phi] = \sigma_i - \sigma_i [\phi]$

c. $\sigma_i [\Diamond\phi] = \begin{cases} \sigma_i \text{ if } \sigma'_i [\phi] \neq \emptyset. \\ \emptyset \text{ if } \sigma'_i [\phi] = \emptyset. \end{cases}$

Evidentially marked propositions which try to update $\sigma_G$ access their relevant substates, and update them in the common fashion ($S_i$ is the set of worlds contained in $\sigma_i$):

(19) a. $\sigma_G [E_i\phi] = \sigma'_G$, where $S'_G = S_G \wedge \sigma'_i = \sigma_i [\phi]$, where $i \in$ Type.
b. Type = {*Ind*, *Rep*, *Dir*,...}

The merging operation, which is applied to a pair of worlds in $\sigma_G$, can be defined as follows.

(20) a. $w_m <_a w_n$ in $\sigma_G$ if
$|\{w_m: w_m \in \sigma_i \text{ for } i \in \text{Type}\}| < |\{w_n: w_n \in \sigma_i \text{ for } i \in \text{Type}\}|$,
or $\text{Best}(\{i: i \in \text{Type} \wedge w_m \in \sigma_i \wedge w_n \notin \sigma_i\})$
$< \text{Best}(\{i: i \in \text{Type} \wedge w_n \in \sigma_i \wedge w_m \notin \sigma_i\})$
b. Best(P) is the reliability of the most reliable element in P.

So far, it has been unclear when the merge operation is applied to each pair of worlds in $\sigma_G$. I assume that it operates as soon as an evidentially marked proposition updates $\sigma_G$. In other words, update by an evidentially marked proposition accompanies the merging operation. I redefine (19) as (21).

(21) $\sigma_G [E_i\phi] = \sigma'_G$, where $S'_G = S_G \wedge \sigma'_i = \sigma_i [\phi] \wedge$ for all $w_m, w_n \in \sigma'_G$,
if $\{ w_m: w_m \in \sigma'_i \text{ for } i \in \text{Type}\}| < |\{w_n: w_n \in \sigma'_i \text{ for } i \in \text{Type}\}|$
or $\text{Best}(\{i: i \in \text{Type} \wedge w_m \in \sigma'_i \wedge w_n \notin \sigma'_i\}) < \text{Best}(\{i: i \in \text{Type} \wedge w_n \in \sigma'_i \wedge w_m \notin \sigma'_i\}$,
then $w_m <_a w_n$.

Let me illustrate how $\sigma_G$ and substates will be when updated by an evidentially marked proposition. Suppose that $[\![\phi]\!] = \{w_1, w_3\}$, there are four substate $\sigma_i$, $\sigma_j$, $\sigma_k$, and $\sigma_l$, the reliability ranking is $l < k < j < i$, and $\sigma_G$ and substates are as in Figure 4 before the update. If $\sigma_G$ is updated by $E_i\phi$, Figure 5 results, where a $\neg\phi$-world $w_2$ is excluded from $\sigma_i$, and therefore the number of substates containing $w_2$ is the same as contain $w_3$. Since the most reliable source among substates containing $w_2$ but not $w_3$ is $j$, while on the side of $w_3$, it is $i$, $w_3$ wins the competition

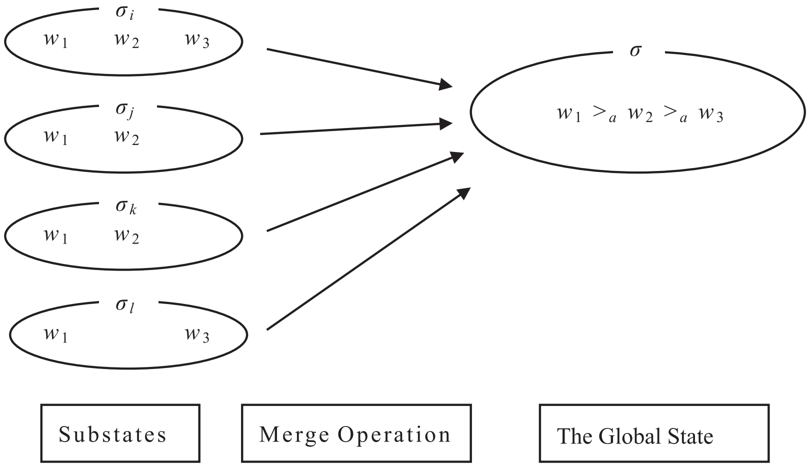


Figure 4: Before update

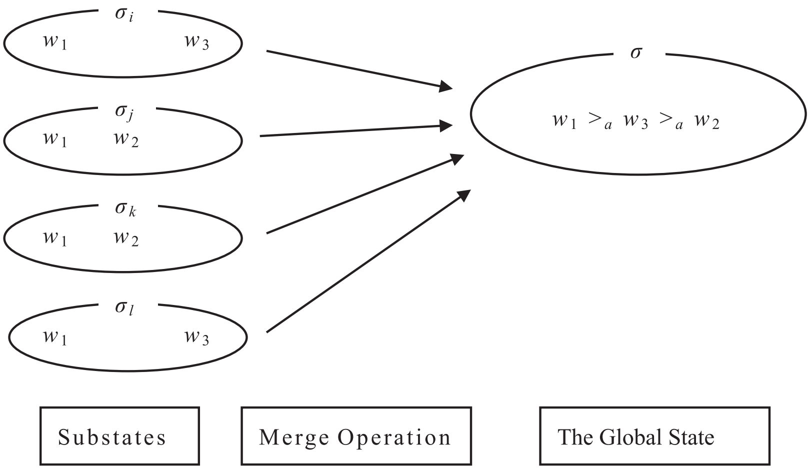


Figure 5: After update by $E_i\phi$

and is ranked higher than $w_2$.

## 3. Illustration

Let us return to the main concern of this paper: why Japanese evidentials asymmetrically take wide scope over negation and epistemic modals. For the sake of space, all the examples below are *yoo*-sentences, but the account I will give is valid no matter which evidential is employed. First, consider the case of negation:

(22) a. Ame-ga futtei-nai-yoo-da.
rain-Nom falling-Neg-yoo-Cop.
'It seems that it is raining.'
b.# Ame-ga futteiru-yoo-de-nai.
rain-Nom falling-yoo-Cop-Neg.
'(Intended) It does not seem that it is falling.'

We start with the acceptable case, (22 a). The utterance in (22 a) is represented as $E_{Ind}\neg\phi$, which updates $\sigma_G$ in the following way.

(23) $\sigma_G\,[E_{Ind}\neg\phi] = \sigma'_G$, where $S'_G = S_G \wedge \sigma'_{Ind} = \sigma_{Ind}\,[\neg\phi] \wedge$ for all $w_m, w_n \in \sigma'_G$,
if $|\{w_m: w_m \in \sigma'_i \text{ for } i \in \text{Type}\}| < |\{w_n: w_n \in \sigma'_i \text{ for } i \in \text{Type}\}|$
or Best $(\{i: i \in \text{Type} \wedge w_m \in \sigma'_i \wedge w_n \notin \sigma'_i\}) <$ Best $(\{i: i \in \text{Type} \wedge w_n \in \sigma'_i \wedge w_m \notin \sigma'_i\}$,
then $w_m <_a w_n$.
$(\sigma_{Ind}\,[\neg\phi] = \sigma_{Ind} - \sigma_{Ind}\,[\phi])$

This excludes $\phi$-worlds from $\sigma_{Ind}$, and alter the plausibility ordering in $\sigma_G$, as desired. Nothing is wrong with this updating process, predicting the acceptability of (22 a).

Let us not turn to (22 b). Its utterance is represented as $\neg E_i\phi$ (I will omit the description of the computation of the global plausibility ordering since below it has nothing to do with the contrast in (21)).

(24) a. $\sigma_G [\neg E_{Ind}\phi] = \sigma_G - \sigma_G [E_{Ind}\phi]$
$= \sigma_G - \sigma'_G$, where $S'_G = S_G \wedge \sigma'_{Ind} = \sigma_{Ind} [\phi] \wedge$ for all...
$= \varnothing$.

As a result of this update, the global information state will always be the empty set, which means contradiction and the failure of the discourse. What causes the contradiction is that the update by an evidentially marked proposition does not eliminate any worlds in $\sigma_G$; all it does is alter the plausibility ordering. Therefore, subtracting $\sigma_G [E_i\phi]$ from $\sigma_G$ necessarily results in the empty set, regardless of what kind of evidence is referred to and what $\phi$ denotes. This straightforwardly accounts for the deviance in (22 b).

Next, let us see how the contrast between (3 a) and (3 b) is captured. Those examples involve epistemic modals. The case of possibility modals is presented below:

(25) a. Ame-ga futteiru-kamoshirenai-yoo-da.
rain-Nom falling-might-yoo-Cop.
'It seems that it might be raining.'
b.# Ame-ga futteiru-yoo-dearu-kamoshirenai.
rain-Nom falling-yoo-Cop.-might
'(Intended) It might seem that it is raining.'

The update in (25 a) will be of the form $\sigma_G [E_i \Diamond\phi]$. The computation proceeds as follows:

(26) $\sigma_G [E_{Ind} \Diamond\phi] = \sigma'_G$, where $S'_G = S_G \wedge \sigma'_{Ind} = \sigma_{Ind} [\Diamond\phi] \wedge$ for all...
$= \begin{cases} \sigma'_G, \text{ where } S'_G = S_G \wedge \sigma'_{Ind} = \sigma_{Ind} \wedge \text{for all..., if } \sigma_{Ind} [\phi] \neq \varnothing. \\ \varnothing, \text{ where } S'_G = S_G \wedge \sigma'_{Ind} = \varnothing \wedge \text{for all..., if } \sigma_{Ind} [\phi] \neq \varnothing. \end{cases}$

The result of computation in (26) says that the indirect substate will be left untouched if it is compatible with $\phi$ and otherwise it will be empty, hence contradiction. In other words, $E_i\Diamond\phi$ performs the test on $\sigma_i$, checking whether $\sigma_i$ is compatible with $\phi$, as $\Diamond\phi$ does on $\sigma_G$. This is what we wanted, considering that it also explains why $E_i\phi \wedge E_i \neg\phi$ makes contradiction, as in (16).

Below is the update process by the utterance of (25 b), that is, $\Diamond E_i\phi$:

(27) $$\sigma_G [\Diamond E_{Ind}\phi] = \begin{cases} \sigma_G \text{ if } \sigma_G [E_{Ind}\phi] \neq \emptyset. \\ \emptyset \text{ if } \sigma_G [E_{Ind}\phi] = \emptyset. \end{cases}$$
$$= \begin{cases} \sigma_G \text{ if } \sigma'_G\text{, where } S'_G = S_G \wedge \sigma'_{Ind} = \sigma_{Ind} [\phi] \wedge \text{for all} \ldots \neq \emptyset. \\ \emptyset \text{ if } \sigma'_G\text{, where } S'_G = S_G \wedge \sigma'_{Ind} = \sigma_{Ind} [\phi] \wedge \text{for all} \ldots = \emptyset. \end{cases}$$
$$= \sigma_G.$$

As is clear from the result of the computation, the update does not influence $\sigma_G$ at all. This is because an evidentially marked proposition eliminates no worlds from $\sigma_G$, and therefore $\sigma_G [E_i\phi]$ will never be empty, regardless of the content of $\phi$. That is, although the contribution of a possibility modal is to examine whether the current state is compatible with the uttered proposition, $\Diamond E_i\phi$ cannot play that role; it will let any state pass through the test. Put differently, the utterance of the form $\Diamond E_i\phi$ makes no contribution to the discourse, and it is quite plausible that meaningless utterances are regarded as deviant, hence the unacceptability of (25 b).

The same account can be applied to the case of necessity modals:

(28) a. Ame-ga futteiru-nichigainai-yoo-da.
rain-Nom falling-must-yoo-Cop.
'It seems that it must be raining.'
b.# Ame-ga futteiru-yoo-dearu-nichigainai
rain-Nom falling-yoo-Cop.-must

'(Intended) It must seem that it is raining.'

Before turning to (28 b), let us make sure that (28 a) involves a coherent update process (the reader is referred to (7) for computation of the $\Box$-operator).

(29) $\sigma_G\,[\mathrm{E}_{Ind}\Box\phi] = \sigma'_G$, where $S'_G = S_G \wedge \sigma'_{Ind} = \sigma_{Ind}\,[\Box\phi] \wedge$ for all...

$$= \begin{cases} \sigma'_G, \text{ where } S'_G = S_G \wedge \sigma'_{Ind} = \varnothing \wedge \text{for all..., if } \sigma_{Ind} - \sigma_{Ind}\,[\phi] \neq \varnothing. \\ \sigma'_G, \text{ where } S'_G = S_G \wedge \sigma'_{Ind} = \sigma_{Ind} \wedge \text{for all..., if } \sigma_{Ind} - \sigma_{Ind}\,[\phi] = \varnothing. \end{cases}$$

The result will be contradictory if $\sigma_{Ind} - \sigma_{Ind}\,[\phi] \neq \varnothing$, i.e., $\sigma_{Ind}$ contains at least one $\neg\phi$-world, and otherwise $\sigma_{Ind}$ will pass the test. Let us move on to (28 b):

(30) $\sigma_G\,[\Box\mathrm{E}_{Ind}\phi] = \begin{cases} \varnothing \text{ if } \sigma_G - \sigma_G\,[\mathrm{E}_{Ind}\phi] \neq \varnothing. \\ \sigma_G \text{ if } \sigma_G - \sigma_G\,[\mathrm{E}_{Ind}\phi] = \varnothing. \end{cases}$

$$= \begin{cases} \varnothing \text{ if } \sigma_G - \sigma'_G, \text{ where } S'_G = S_G \wedge \sigma'_{Ind} = \sigma_{Ind}\,[\phi] \wedge \text{for all...} \neq \varnothing. \\ \sigma_G \text{ if } \sigma_G - \sigma'_G, \text{ where } S'_G = S_G \wedge \sigma'_{Ind} = \sigma_{Ind}\,[\phi] \wedge \text{for all...} = \varnothing. \end{cases}$$

$$= \sigma_G.$$

Since $\sigma_G\,[\mathrm{E}_{Ind}\phi]$ does not lead to eliminating worlds in $\sigma_G$, $\sigma_G - \sigma_G\,[\mathrm{E}_{Ind}\phi]$ will always be empty independent of the denotation of $\phi$; the test posed by $\Box\mathrm{E}_i\phi$ does not play its role as a test as in the case of possibility modals.

## 4. Conclusion

In this paper, I integrated McCready's (2015) innovative dynamic system into the basic one. What I did is two-fold. First, I posited the global information state as a set of possible worlds in which the worlds are ranked according to their plausibility, which is computed with the help of a merging operation different from McCready's. Second, I allowed evidentially marked propositions to perform the eliminative update, in order for the system to deal with evidentially marked propositions accompanying epistemic modals. This modification is supported by empirical data. Thanks to these two modifications, we were able to account for the asymmetric scopal relation between evidentials and negation/epistemic modals, while maintaining the advantage of McCready's system. What enables this account is that evidentially marked propositions do not eliminate worlds in the global state.

According to Aikhenvald (2004), the scopal behavior this paper is concerned with is observed in other languages that have grammatical evidentials. Given that McCready's (2015) system is applicable to any language, the framework proposed in this paper, which is a modified version of McCready's, can account for the scopal characteristics that evidentials generally show.

## Notes

1 Although I term *yoo* an indirect evidential, following Davis and Hara (2014), some researchers such as McCready and Ogata (2007), call it an *inferential* evidential. In this paper I do not commit to a position is the debate on how *yoo* is categorized, and nothing in the following discussion hinges on this terminology.

2 Other researchers, such as Groenendijk et al. (1996), adopt the same definition of these operators. For a more detailed introduction to these operators, see Portner (2009).

3 Here and henceforth, I assume the following definition of conjunction:

(i) $\sigma[\phi \wedge \psi] = \sigma[\phi][\psi]$

4 Since Japanese does not have direct evidentials, which encodes the presence of direct evidence for the uttered proposition, I do not present $\sigma_{Dir}$ as an example of substates. However for languages that possess direct evidentials, such as Cuzco Quechua (Faller (2002)) and Tibetan (Garrett (2001)), we have to posit a substate indexed with *Dir*.

5 The reader is referred to Chapter 3 of McCready (2015) for how to compute

the reliability of an information source.

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