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Darou ka↑: The interplay of deictic modality, sentence type and prosody

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Abstract This study examines the interaction of the Japanese modal particle *darou* with different sentence types and intonation. A detailed investigation of *darou* reveals an interesting paradigm with respect to parameters such as clause type, boundary tone and pragmatic context. Two naturalness rating studies are conducted to support the predictions regarding the interpretations and felicity of the target sentences. I propose that *darou* is a root-level modal operator which expresses the epistemic knowledge of the deictic center. A rising intonational contour is a Kaplanian monster which shifts the deictic center of *darou* from the speaker to the addressee. The proposal is formally implemented in the framework of inquisitive dynamic epistemic logic. I propose that *darou* is an entertain modality $E_{\odot}$, where the value of $\odot$ is determined by an assignment g, which can be modified by rising intonation.

1 Introduction

Many languages express question meanings morpho-syntactically and prosodically. In Japanese, the question particle *ka* marks a sentence as interrogative (1) with or without rising prosody ('↑' henceforth; L%H% in J_ToBi (Venditti 2005a)).

(1) John-ga kuru ka↑ / ↓
John-NOM come Q
'Is John coming?'

A question-like meaning can also be expressed by a declarative sentence with rising intonation:

(2) John-ga kuru↑
John-NOM come
'John is coming?'

Although all of these utterance types express some kind of question meaning, previous analyses (Gunlogson 2003; Nilsenova 2002, etc.) agree that they are

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not completely interchangeable. This study examines the interaction between the Japanese modal particle *darou*, sentence type and intonation, which sheds new light on the influence of sentence types and intonational contours on the interpretation of sentences. I propose that *darou* is a root-level modal which involves a deictic element pointing to the speaker's knowledge. A rising contour is a Kaplanian (1977) monster which shifts the deictic center (Lyons 1977; Levinson 1983) of *darou*. The semantics of *darou* is defined in the framework of inquisitive dynamic epistemic logic (Ciardelli & Roelofsen 2015), which provides a model in which modal operators can embed both declarative and interrogative sentences. A detailed investigation of *darou* reveals an interesting paradigm with respect to parameters such as clause type, boundary tone and pragmatic context.

The paper is structured as follows. Section 2 summarizes introspection-based data relating to the distribution of *darou*-sentences in different clause types and with different boundary tones. It will be observed that *darou* cannot occur in a rising interrogative and that other acceptable combinations give rise to different interpretations. Section 3 presents two rating experiments which empirically support the observations in Section 2. To account for the distributional patterns shown in Sections 2 and 3, I propose in Section 4 that *darou* is a root-level modal operator E, which expresses the epistemic knowledge of the deictic center $\odot$. The proposal is divided into three sub-proposals. First, syntactically, *darou* moves to [Spec CP] to check its uninterpretable feature, [uROOT]. Second, the rising prosody ↑/L%H% is semantically a Kaplanian monster which modifies the assignment function so that the deictic center maps to the addressee. Third, the semantics of *darou* as $E_{\odot}$ is given in the framework of inquisitive dynamic epistemic logic (Ciardelli & Roelofsen 2015). Section 5 shows how the proposals derive the various interpretations of *darou*. Section 6 concludes the paper.

2 Basic Paradigm

2.1 Falling Declaratives: *darou*↓

When *darou* is attached to the end of a plain declarative as in (3), the whole sentence indicates that the speaker has a bias toward the prejacent proposition *John-ga kuru* 'John is coming'.

(3) John-ga kuru darou↓
Jonn-NOM come DAROU
'John is coming, I bet./Probably, John is coming.'

The conclusion that falling *darou*-declaratives must express "the speaker's bias" is supported by the following observations: 1) their co-occurrence with probability adverbs is restricted, and 2) they have an obligatory wide-scope reading under *because*-clauses.

Sugimura (2004) observes that *darou* can co-occur with high-probability adverbs (4) but not with low-probability adverbs (5).

(4) Kare-wa tabun/kitto kuru darou.
he-TOP probably/certainly come DAROU
'Probably/Certainly, he will come.'

(5) *Kare-wa moshikasuruto kuru darou.
he-TOP maybe come DAROU

(Sugimura 2004)

This asymmetry suggests that *darou* requires some minimal degree of bias toward the prejacent proposition, which conflicts with the low degree of commitment expressed by the low probability adverb *moshikasuruto* 'maybe' in (5).[1]

The contrast between (6) and (7) shows that the agent of this bias needs to be the speaker.

(6) Boku-wa ame-ga furu darou kara kasa-o mot-te it-ta.
I-TOP rain-NOM fall DAROU because umbrella-ACC have-and go-PAST
'Because it will rain (I bet), I took an umbrella with me.'

(7) #John-wa ame-ga furu darou kara kasa-o mot-te it-ta.
John-TOP rain-NOM fall DAROU because umbrella-ACC have-and go-PAST
'Because it will rain (I bet), John took an umbrella with him.'

In (6), the speaker's assessment of the likelihood of rain is the cause of his bringing his umbrella. The infelicity of (7) results from the fact that the bias contributed by *darou* cannot be shifted to *John*. The sentence ends up meaning that the speaker's bias toward 'it will rain' has caused John to bring an umbrella, instead of the intended reading according to which *John*'s assessment of the likelihood of rain causes him to bring his umbrella.

Contrasts like those in (6) and (7) show that in falling declaratives, *darou* marks the *speaker's bias* toward the prejacent proposition. As we will see below, however, this speaker-orientedness of *darou* is not invariable: With rising intonation, the holder of the bias can be the addressee.[2]

2.2 Falling Interrogatives: *darou ka*↓

Polar interrogatives in Japanese are marked with the sentence final particle *ka*. If *darou* occurs within such a falling interrogative, it is interpreted as a self-addressing question, as in (8) produced with the pitch profile in Figure 1.

(8) Marie-wa wain-o nomu darou ka↓
Marie-TOP wine-ACC drink DAROU Q

[1] Furthermore, Hara (2006) shows that *darou* takes a higher scope than other "normal" modals. Compare (5) with (i), in which the phrase *kanousei-ga hikui* 'the possibility is low' is embedded inside *darou*:

(i) Kare-ga kuru kanousei-ga hikui darou.
he-TOP come possibility-NOM low DAROU
'Probably, the possibility that he would come is low.' (Hara 2006, 138)

Since (i) does not lead to inconsistency, unlike (5), Hara (2006) argues that there are two kinds of modalities in Japanese, root-level and proposition-level. The root-level modals include *darou*, *tabun/kitto* 'probably/certainly' and *moshikasuruto* 'maybe', while the proposition-level modals include *kanarazu* 'certainly', and *kanousei-ga aru/hikui* 'the possibility exists/is low'. See Section 4.1 and Hara (2006) for more arguments.

[2] When *darou* is embedded under an attitude predicate, the holder of the bias can be the subject of the attitude predicate as well. See Section 4.2.

'I wonder if Marie drinks wine.'

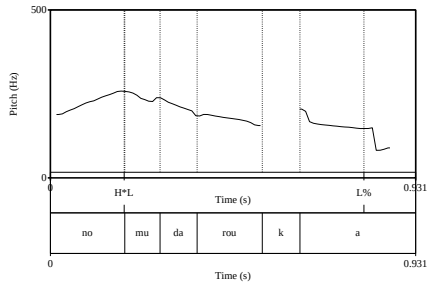


Fig. 1 Falling Interrogative

Put another way, by uttering a construction like (8), the speaker is inquiring into his or her own knowledge state, i.e., entertaining an issue, namely the question of whether or not Marie drinks wine.[3]

The question particle *ka* is optional for *wh*-interrogatives as in (9). In other words, the *wh*-word *nani* 'what' alone can mark the construction as an interrogative.

(9) Tsugi-wa nani-ga okoru (ka)?
next-TOP what-NOM happen Q
'What will happen next?'

This optionality of *ka* in *wh*-interrogatives predicts that falling *wh*-interrogatives with *darou* are always interpreted as self-addressing questions with or without *ka*. This prediction is indeed borne out, as shown in (10):[4]

(10) Tsugi-wa nani-ga okoru darou (ka)↓
next-TOP what-NOM happen DAROU Q
'I wonder what happens next.'

[3] An anonymous reviewer questioned this self-addressing nature of the construction since in (i), a falling *darou*-interrogative seems to be used to address the hearer:

(i) Nee, kono-hon Taroo-kun-wa yomu darou ka↓
Hey, this-book Taro-Mr.-TOP read DAROU Q
'Hey, I wonder if Taro will read this book.'

I argue that the utterance in (i) is interpreted as a question directed to the addressee at the pragmatic level. In other words, the construction semantically denotes a description of the speaker's epistemic state, i.e., it indicates that the speaker is entertaining an issue (see Section 5 for the formal implementation). Together with a discourse marker like *nee* 'hey', the utterance pragmatically functions as an indirect question act just as in the English translation 'I wonder ...', which can function as a question directed at the hearer.

[4] I owe this example to an anonymous reviewer.

To recapitulate, falling *darou*-interrogatives seem to express self-addressing questions in which the speaker is entertaining a certain issue, so they naturally translate as "I wonder if ..." in English.

2.3 Rising Declaratives: *darou*↑

Turning to the rising counterparts of the above two types, *darou* can be used in declaratives with final rising intonation (L%H% in the J_ToBI system (Venditti 2005b)). Such utterances appear to function as tag/confirmation questions, as seen in (11) produced with the pitch profile in Figure 2.

(11) Marie-wa wain-o nomu darou↑
Marie-TOP wine-ACC drink DAROU
'Marie drinks wine, right?'

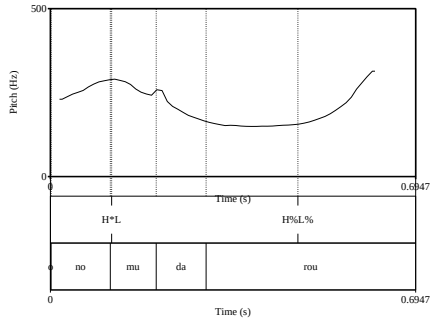


Fig. 2 Rising Declarative

In other words, in uttering a rising *darou*-declarative, the speaker is checking the addressee's knowledge state. Thus, the rising contour seems to shift the holder of the bias from the speaker to the addressee.

2.4 Rising Interrogatives: *darou ka*↑

Finally, *darou* seems to be incompatible with rising interrogative constructions. Native speakers judge examples like (12), with a pitch profile like that in Figure 3, as deviant or unacceptable in out of the blue contexts, although, as we will see later, such uses can be made felicitous in a very particular kind of context.

(12) #Marie-wa wain-o nomu darou ka↑
Marie-TOP wine-ACC drink DAROU Q
Intended: 'Does Marie drink wine, probably?'

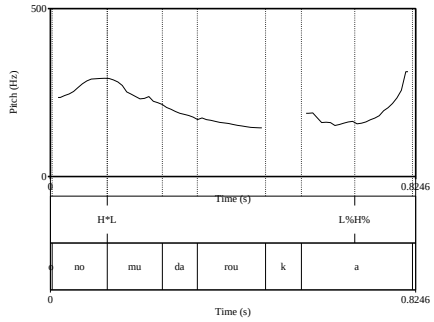


Fig. 3 Rising Interrogative

2.5 Summary

Darou indicates the speaker's bias in falling declaratives, but its interpretation varies as a function of both the clause type and the final prosody.

(13) Meaning of *darou* according to sentence type and intonation

	Falling	Rising
Declarative	*darou*↓ statement ('I bet')	*darou*↑ tag/confirmation Q ('... right?')
Interrogative	*darou ka*↓ self-addressing Q ('I wonder')	*darou ka*↑ #

To confirm this observation objectively (see Schütze 1996), two rating experiments were conducted.

3 Experiments

The previous section gave an informal characterization of the distribution of *darou* with respect to different clause types and sentence-final intonations. In the first experiment, native speakers of Japanese judged the naturalness of different combinations of clause types and with intonation indicated via auditory means. In the second experiment, they judged the naturalness of combinations of contexts and clause types with visually-indicated intonation.

3.1 Experiment I

Section 2 introspectively observed that an interrogative with *darou* is not compatible with rising intonation. Thus, it is predicted that native speakers will disprefer an interrogative with *darou* when it is pronounced with a rising contour.

3.1.1 Method

Stimuli The stimuli had two fully-crossed factors—sentence types (declarative/interrogative) and final prosodies (falling/rising), which resulted in the appearance of *darou* in four conditions. Each condition had 16 items, resulting in 64 target sentences (16 items * 4 conditions). 64 fillers were included.

Recording A native female speaker of Japanese, who was naive to the purpose of the experiment, pronounced the stimuli in a sound-attenuated room at the Research Laboratory for Phonetics and Cognitive Studies of City University of Hong Kong. She produced all the stimuli in isolation, and the stimuli were presented in Japanese orthography. For each sentence, the speaker was asked to pronounce it with a rising and falling contour.

Procedure The rating experiment was conducted in a sound-attenuated room in the Sound Lab at the University of Tokyo. The stimuli were presented by the assessment management software program, Perception.[5] The participants were asked to wear headphones. The first page of the test showed the instructions.

In the main section, the participants were asked to listen to each stimulus, and then judge its naturalness on a 5-point scale (provided in Japanese): very natural, somewhat natural, undecidable, somewhat unnatural, very unnatural. They were also reminded not to rate the naturalness in terms of the social appropriateness of the speech.

The test started with a practice session where the participants ran through five practice items, which were unique to the practice block. The main experiment was organized into four blocks separated by three break signs. Each block contained 16 items. None of the stimuli were repeated and the order of the stimuli within each block was randomized by the Perception software. No minimal pair sentences appeared next to each other.

Participants Fourteen native speakers of Tokyo Japanese participated in the rating experiment. They were undergraduate students recruited from the University of Tokyo and received 1000 Japanese yen as compensation.

Statistics The responses were converted to numerical values which corresponds to the degree of acceptability as follows: very natural=5; somewhat natural=4; undecidable=3; somewhat unnatural=2; very unnatural=1. To analyze the results, a general linear mixed model (Baayen 2008; Baayen et al. 2008; Bates 2005) was run using the `lmerTest` package (Kuznetsova et al. 2015) implemented in R (R Core Team 2015). The Likert scale is numerical so we can assume that it measures the degree of acceptability across conditions (see Schütze & Sprouse 2014).[6] Sentence types and final prosodies were the fixed factors. The random effects were modelled by intercepts for participants and items. The p-values were calculated by the Markov chain Monte Carlo method using the `LanguageR` package (Baayen 2013).

If the availability of the rising contour depends on the type of the sentence, then the dependency is expected to result in a significant interaction between sentence types and boundary tones.

[5] ©2015 Questionmark Computing Limited. `https://www.questionmark.com/`

[6] See also Kawahara (2011) who utilizes a general mixed model for a rating study.

3.1.2 Result

Figure 4 shows the average naturalness rating for each condition. Regardless of syntactic constructions, rising intonations were dispreferred in general ($t = -36.28, p < .001$). There was no significant interaction between falling declarative and interrogative constructions. On the other hand, with a rising intonation, the speakers judged interrogative constructions least natural. Because of this asymmetry, the interaction between syntax and intonation was significant in the linear mixed model analysis ($t = -13.12, p < .001$).

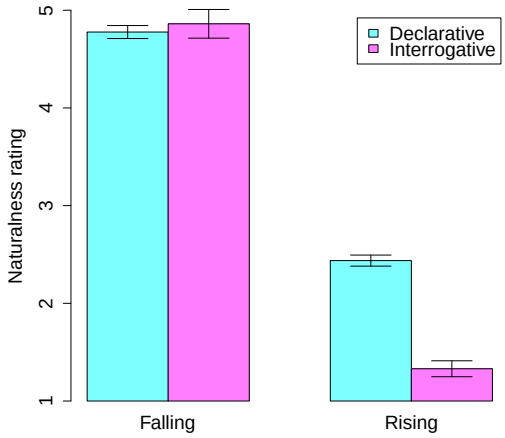


Fig. 4 Average Naturalness Ratings of Experiment I

3.1.3 Discussion

The results show that native speakers judge *darou ka*↑ unacceptable. Note also that native speakers disprefer rising *darou* in general. I speculate that this main effect is due to the fact that in Experiment I, stimuli were presented without context. As I argue below, rising intonation requires a presence of an addressee. Without explicit context, the participants were forced to accommodate an addressee, and this extra cost of accommodation caused the rising *darou*-sentences to degrade.

3.2 Experiment II

Experiment I shows that native speakers judge the combination of *darou ka*↑ unacceptable. Section 2 also discussed the fact that the other combinations, although acceptable, are used in different contexts. The purpose of Experiment II is to verify the intuition that the acceptability of each combination depends on the

context. Thus, in Experiment II, three kinds of contexts were prepared, ANSWER, AGREE-SEEK and SELF-ADDRESS as in (14). In the ANSWER context, A, the speaker of the target sentence was asked a question, so the following utterance of A should be regarded as a straightforward description of A's own knowledge. The SELF-ADDRESS(ING) context describes the situation in which A is wondering about a certain issue. Finally, the AGREE(MENT)-SEEK(ING) context describes the situation in which A wants to check his/her discourse partner's knowledge:

(14) Contexts:

a. ANSWER context
A wa yuujin ni dare ga paatii ni kuru to omouka kikarete kotaeta:
'A was asked by a friend who he thinks will come to the party and answered:'

b. SELF-ADDRESS context
A wa dare ga paatii ni kuru ka hitoride kangae te iru:
'A is wondering by himself who is going to come to the party:'

c. AGREE-SEEK context
A wa yuujin ga "dare mo paatii ni konai" to itteiru no o kiite itta:
'A's friend said "No one will come to the party" and A said:'

Given the observations made in Section 2, the predictions for the distribution of sentence type and context are as follows:

(15) a. Falling *darou*-declaratives should be rated more natural in ANSWER contexts than in other contexts, and other sentence types should be rated less natural than falling declaratives in this context.

b. Rising *darou*-declaratives should be rated more natural in AGREE-SEEK contexts than in other contexts, and other sentence types should be rated less natural than rising declaratives in this context.

c. Falling *darou*-interrogatives should be rated more natural in SELF-ADDRESS contexts than in other contexts, and other sentence types should be rated less natural than falling interrogatives in this context.

The purpose of Experiment II is thus to verify these predictions.

3.2.1 Method

Stimuli The stimuli had two fully-crossed factors—contexts (ANSWER/AGREE-SEEK/SELF-ADDRESS) and sentence-contour types (falling declarative/ rising declarative/falling interrogative), which resulted in the appearance of *darou* in nine conditions. The sentence final intonation of the target sentences were indicated visually with arrows ↓/↑ and verbally in parenthesis with *Kakoo/Jooshoo intonesshon* 'Falling/Rising intonation' as exemplified in (16). Each of the nine conditions had 16 items, resulting in 144 target sentences (16 items * 9 conditions). 36 sentences from another experiment were also included.

(16) Target Sentences:

a. Falling *darou*-declarative

Yamashita-san ga kuru darou↓ (Kakoo intoneeshon)
Yamashita.MR NOM come DAROU (Falling intonation)

'Mr. Yamashita will come.'

b. Rising *darou*-declarative

Yamashita-san ga kuru darou↑ (Jooshoo intoneeshon)
Yamashita.MR NOM come DAROU (Rising intonation)
'Mr. Yamashita will come, right?'

c. Falling *darou*-interrogative

Yamashita-san ga kuru darou ka↓ (Kakoo inonesshon)
Yamashita.MR NOM come DAROU Q (Falling intonation)
'I wonder if Mr. Yamashita will come.'

Procedure The rating experiment was conducted in a quiet meeting room at Waseda University. The stimuli were presented in Japanese orthography by Qualtrics.[7] The first page of the test showed the instructions.

In the main section, the participants were asked to listen to each stimulus, and then judge the naturalness of the stimuli on a 7-point scale (provided in Japanese): from "7: very natural" to "1: very unnatural". The scale was changed from 5-point to 7-point because Experiment II was conducted together with another experiment which employed a 7-point scale.

The main experiment was organized into four blocks separated by three break signs. Each block contained 36 items. None of the stimuli were repeated and the order of the stimuli within each block was randomized by the Qualtrics software. No minimal pair sentences appeared next to each other.

Participants Fourteen native speakers of Japanese participated in the rating experiment. They were undergraduate students recruited from Waseda University and received 1000 Japanese yen as compensation.

Statistics The responses were recorded as numerical values: from very natural=7 to very unnatural=1. Context types and sentence types were fixed factors. The other aspects were the same as Experiment I.

If the naturalness of sentence-contour combination depends on the type of context, then the dependency is expected to result in a significant interaction between contexts and sentence-contour combinations.

3.2.2 Result

Figure 5 shows the average naturalness ratings in each condition. The discussion above leads to the prediction that falling *darou*-declaratives are more natural in ANSWER contexts than in SELF-ADDRESS and AGREE-SEEK contexts. This prediction was confirmed; ANSWER contexts were rated most natural for falling *darou*-declaratives (compared with SELF-ADDRESS: $t = -5.353$, $p < 0.001$; with AGREE-SEEK: $t = -4.751$, $p < 0.001$).[8] SELF-ADDRESS contexts made falling *darou*-interrogatives most natural (compared with ANSWER: $t = -11.03$, $p < 0.001$; with

[7] Qualtrics is a web-based system that conducts online surveys. Version 45634 of the Qualtrics Research Suite. Copyright©2013 Qualtrics. Qualtrics and all other Qualtrics product or service names are registered trademarks or trademarks of Qualtrics, Provo, UT, USA. `http://www.qualtrics.com`.

[8] As stated in Section 3.1.1, the p-values were calculated by the Markov chain Monte Carlo method using the `LanguageR` package (Baayen 2013).

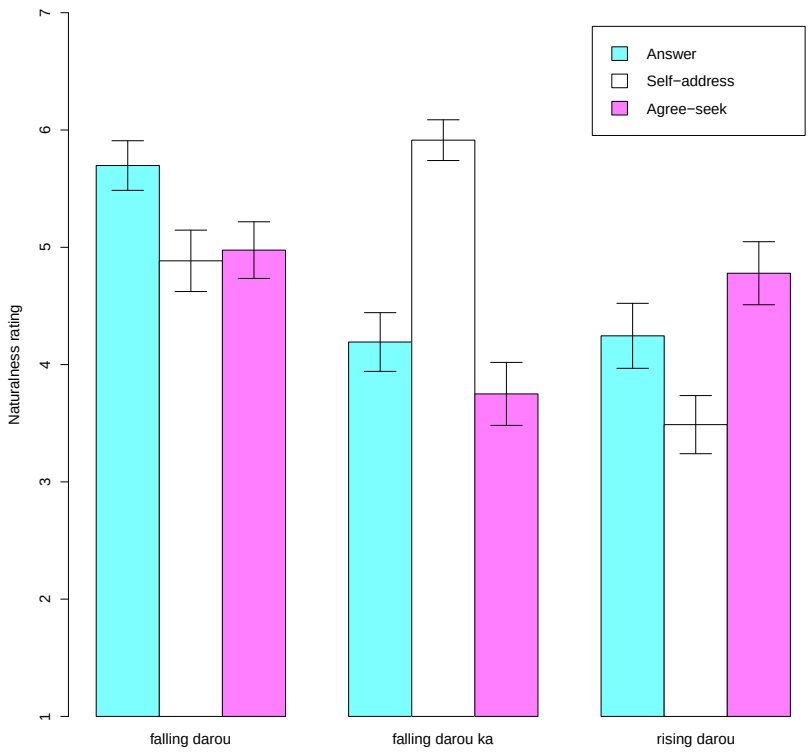


Fig. 5 Average Naturalness Ratings of Experiment II

AGREE-SEEK: $t = -13.87$, $p < 0.001$). AGREE-SEEK contexts made rising *darou*-declaratives most natural (compared with ANSWER: $t = -3.126$, $p < 0.01$; with SELF-ADDRESS: $t = -7.566$, $p < 0.001$).

Note also that in AGREE-SEEK contexts, there was no significant difference between falling *darou*-declaratives and *darou*-declaratives ($t = -1.095$, $p = 0.274$). That is, falling *darou*-declaratives (mean = 4.97) were judged as natural as rising *darou*-declaratives (mean = 4.77).[9]

3.2.3 Discussion

The results confirmed the predictions given in (15) repeated here as (17):

(17) a. Falling *darou*-declaratives should be rated more natural in ANSWER contexts than in other contexts, and other sentence types should be rated less natural than falling declaratives in this context.

[9] I would like to thank an anonymous reviewer for pointing this out.

b. Rising *darou*-declaratives should be rated more natural in AGREE-SEEK contexts than in other contexts, and other sentence types should be rated less natural than rising declaratives in this context.
c. Falling *darou*-interrogatives should be rated more natural in SELF-ADDRESS contexts than in other contexts, and other sentence types should be rated less natural than falling interrogatives in this context.

Note also that native speakers accept falling *darou*-declaratives in AGREE-SEEK contexts as much as rising *darou*-declaratives in the same AGREE-SEEK contexts. This is because the AGREE-SEEK contexts in Experiment II are also compatible with situations where the speaker expresses his or her own knowledge; by doing so, the speaker is proposing to update the common knowledge of speaker and interlocutor (Stalnaker 1978). What is more crucial to the current paper is that the AGREE-SEEK contexts make rising *darou*-declaratives most natural among the three kinds of contexts.

4 Proposal

The result of the two experiments confirm the introspection-based pattern given in Section 2, repeated here as (18).

(18) Meaning of *darou* according to sentence type and intonation

	Falling	Rising
Declarative	*darou*↓ statement ('I bet')	*darou*↑ tag/confirmation Q ('... right?')
Interrogative	*darou ka*↓ self-addressing Q ('I wonder')	*darou ka*↑ #

Notice that *darou* can express the speaker's or the addressee's bias and that it can embed either a declarative or an interrogative. In order to derive the distribution and interpretations summarized in (18), I make the following proposal.

(19) Proposal
Darou is a root-level modal operator $E_{\odot}$, which expresses epistemic issues associated to the deictic center, $\odot$.

This proposal breaks down into the following three sub-proposals:

(20) Sub-proposals:
Sub-proposal 1: Syntactically, *darou* is a root-level operator, which moves to [Spec CP] to check off its uninterpretable feature, [uROOT].
Sub-proposal 2: The rising intonation ↑ modifies the assignment function so that the deictic center maps to the addressee.
Sub-proposal 3: Semantically, *darou* is an Entertain Modality, $E_{\odot}$, in Inquisitive Dynamic Epistemic Logic, henceforth IDEL (Ciardelli & Roelofsen 2015).

In understanding the effects of *darou* sentences, the current paper assumes the framework of dynamic update semantics (Stalnaker 1968; Heim 1982), in which utterances are considered as context change potentials (CCPs), i.e., functions from contexts to contexts. More specifically, an utterance of φ updates an input context associated with an attitude holder with the propositional content of φ by taking the intersection of the content of the input context and the propositional content. In IDEL, as we will see below, both contexts to be updated and propositions are modelled as inquisitive states, so both declarative and interrogative updates can be uniformly defined as intersecting the input context with the propositional content.[10] Let M be an inquisitive epistemic model, g an assignment function from variables to agents, w a possible world and C a variable over contexts.[11] Then, the interpretation of an utterance of φ can be defined as in (21). $[\![\varphi]\!]^{M,g,w}$ is a CCP with a presupposition: It checks whether its input context is an inquisitive state of the deictic center (21-a). If the presupposition is satisfied, then it acts as a function which updates the input context with the propositional content of φ (21-b).

(21) (Context change potential)
   a. $[\![\varphi]\!]^{M,g,w}$ is defined only if the input context C is an inquisitive state of agent $g(\odot)$ at world w.
   b. If defined, $[\![\varphi]\!]^{M,g,w} = \lambda C.C \cap [\varphi]_{M,g}$, where $[\varphi]_{M,g}$ is the propositional content of φ.

In the following subsections, I motivate each sub-proposal in (20) with linguistic data and show how it is implemented.

4.1 Sub-Proposal 1: *darou* as a root-level modal

First, I propose that *darou* functions as a root-level modal operator (Zimmermann 2004; Davis 2009). Under this analysis, *darou* expresses epistemic knowledge associated with the deictic center, which is the speaker by default. The following contrast supports the treatment of *darou* as a root-level modal. While the "normal" propositional modals *nichigainai* 'must' and *kamoshirenai* 'may' can occur inside embedded questions (22), *darou* cannot (23).

(22) Emi-ga igirisu-ni itta nichigainai/kamoshirenai ka douka kiite
Emi-NOM England-DAT went must/may Q or.not to.ask
mita.
tried
'I asked whether Emi must/may have left for England or not.'

(23) *Emi-ga igirisu-ni itta darou ka douka kiite mita.
Emi-NOM England-DAT went DAROU Q or.not to.ask tried
Intended: 'I asked whether Emi probably left for England or not.'

[10] As we will see below, in IDEL, contexts, declarative propositions and interrogative propositions are all formulated as inquisitive states, i.e., sets of information states. Information states in the sense of standard epistemic logic can be retrieved by taking union, i.e., $\sigma_a(w) = \bigcup \Sigma_a(w)$. See Section 4.3.2.

[11] See (43) for the full definition of inquisitive epistemic model.

The ungrammaticality of (23) shows that the combination of *darou* with interrogatives should be considered a root phenomenon in the sense of Emonds (1969) and Hooper & Thompson (1973).[12] That is, the combination is only possible in the highest matrix clause (see Hara (2006) for more arguments).[13]

Furthermore, as discussed in Section 2, the contrast between (6) and (7), repeated here as (24) and (25), shows that *darou* in a falling declarative indicates *the speaker's* bias.

(24) Boku-wa ame-ga furu darou kara kasa-o mot-te it-ta.
I-TOP rain-NOM fall DAROU because umbrella-ACC have-and go-PAST
'Because it will rain (I bet), I took an umbrella with me.'

(25) #John-wa ame-ga furu darou kara kasa-o mot-te it-ta.
John-TOP rain-NOM fall DAROU because umbrella-ACC have-and go-PAST
'Because it will rain (I bet), John took an umbrella with him.'

Compare (25) with cases where "normal" modals are embedded under *because*. The felicity of (26) shows that the knowledge holder of the "normal" modals can be shifted. That is, the propositional modals in (26) expresses *John*'s assessment of the likelihood of rain, so it can felicitously cause John to bring an umbrella.

(26) John-wa ame-ga furu nichigainai/kamoshirenai kara kasa-o
John-TOP rain-NOM fall must/may because umbrella-ACC
mot-te it-ta.
have-and go-PAST
'Because it must/may rain, John took an umbrella with him.'

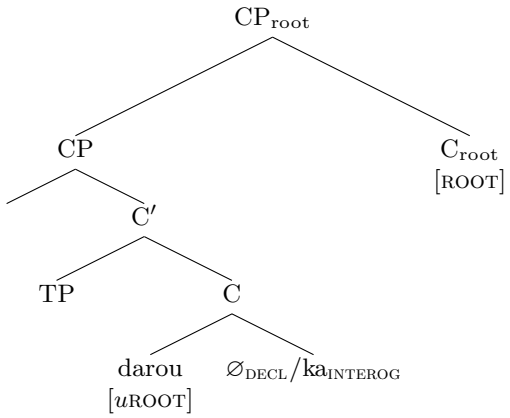
To recapitulate, the empirical data show that *darou* is a root-level modal which takes wider scope than the "normal" propositional modals. Furthermore, when the sentences are uttered with falling intonation, the agent of the knowledge must be the speaker. Formally, *darou* translates as an entertain modality $E_{\odot}$, where $\odot$ is a deictic center variable which points to the speaker by default.[14] The root-orientedness of *darou* is syntactically realized using the uninterpretable feature [*u*ROOT], which needs to be checked off by the matching feature [ROOT] at C_{root}.

[12] Emonds (1969) defines a root sentence as "either the highest S in a tree, an S immediately dominated by the highest S or the reported S in direct discourse" (p. 6).

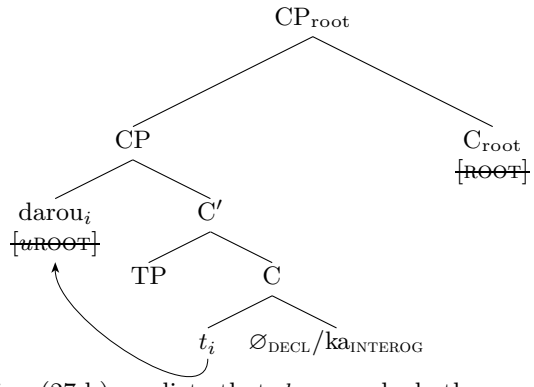
[13] Hara & Davis (2013) also argue that *darou* is an expressive item (Potts 2005), so its content always takes widest scope.

[14] For the purpose of exposition, I delay the semantic definition of $E_{\odot}$ to Section 4.3.

(27) a.



b.



This LF configuration (27-b) predicts that *darou* embeds the combination of the sentence-radical p and the sentence-type marker $\varnothing_{\text{DECL}}/ka_{\text{INTEROG}}$, i.e., *darou*($p$-$\varnothing_{\text{DECL}}$) and *darou*($p$-$ka_{\text{INTEROG}}$), which translate to $E_{\odot}p$ and $E_{\odot}?p$, respectively. As we will see below in Section 4.3, inquisitive epistemic dynamic logic indeed provides a system in which modal operators can embed both declarative and interrogative sentences. The following table summarizes how each combination translates to the logical form:

(28) LFs of *darou*-sentences

Declarative ($\varnothing_{\text{DECL}}$)	p-*darou*$\rightsquigarrow E_{\odot}p$
Interrogative (ka_{INTEROG})	p-*darou ka*$\rightsquigarrow E_{\odot}?p$

4.2 Sub-Proposal 2: ↑ as a deictic shifter

The previous section emphasized that the holder of the knowledge expressed by *darou* with falling intonation must be the speaker. Some operators, however, can change the holder of the knowledge. In (29-a), for instance, the bias expressed by *darou* is attributed to Mary, since the speaker can felicitously challenge the content of the bias as in (29-b).

(29) a. Mary-wa John-ga kuru darou to omot-teiru.
Mary-TOP John-NOM come DAROU COMP think-PROG
'Mary thinks that probably, John will come.'

b. Boku-wa sou-wa omow-anai-kedo.
I-TOP so-TOP think-NEG-though
'I don't think so (that he will come), though.' (Hara 2006, 128-129)

In Schlenker (2003), attitude predicates are analyzed as embedding speech acts. On this view, the embedded sentence is a root clause and the subject of the attitude predicate is the agent of the embedded speech act, i.e., the deictic center.

I argue that a similar shifting process happens with rising intonation ↑. That is, the seat of knowledge seems to be shifted from the speaker to the addressee as we have seen in (11), repeated here as (30).

(30) Marie-wa wain-o nomu darou↑
Marie-TOP wine-ACC drink DAROU
'Marie drinks wine, right?'

Thus, I propose that the boundary rising contour ↑ (L%H%) is an intonational morpheme which denotes an operator that modifies an assignment function so that the deictic center maps to the addressee.

A brief review of deictic expressions is in order. As Lyons (1977) says, deixis is interpreted "in an egocentric way" (Levinson 1983, p. 63) by default: the central individual is the speaker, the central time is the utterance time, the central location is the utterance location, etc. However, the deictic center can also be shifted ("deictic projection" in Lyons (1977, p. 579)). Consider the following:

(31) a. Can I go to your office tomorrow?
b. Can I come to your office tomorrow? (Huang 2007)

In (31-a), there is no deictic projection since the motion verb *go* indicates the movement away from the deictic center, i.e., the speaker's location. In contrast in (31-b), the deictic center is shifted to the addressee because *come* indicates the movement towards the shifted deictic center, i.e., the addressee's location. I implement this default specification of the deictic center and the shifting of the default setting using an assignment function g. First, g maps the deictic center variable $\odot$ to the speaker, SPKR by default:

(32) $g = [\odot \mapsto \textsc{spkr}]$

Take a falling *darou*-interrogative as an example. From the LF structure, we obtain $E_{\odot}?p$ and $g(\odot) = \textsc{spkr}$. Recall that we treat each utterance as a context change potential (CCP). Thus, the interpretation function $[\![\cdot]\!]^{M,g,w}$ maps $E_{\odot}?p$ to a CCP. Since falling intonation (↓) is semantically vacuous, the variable assignment g is unmodified. The CCP first checks whether its input is an inquisitive state of agent $g(\odot) = \textsc{spkr}$ at world w. Then, it updates the input context, i.e., the speaker's inquisitive state, with the proposition $[E_{\textsc{spkr}}?p]_{M,g}$.[15]

(33) Falling interrogative
a. LF: *p-darou ka*$\rightsquigarrow E_{\odot}?p$
b. Interpretation

[15] In inquisitive dynamic epistemic logic, the proposition $[\varphi]_{M,g}$ is defined as the set of all states that support φ. For the purpose of exposition, I delay the presentation of the formal definitions to Section 4.3.2.

(i) $[\![E_{\odot}?p]\!]^{M,g,w}$ is defined if C is an inquisitive state of agent $g(\odot) =$ SPKR at world w.
(ii) If defined,
$[\![E_{\odot}?p]\!]^{M,g,w} = \lambda C.C \cap [E_{\text{SPKR}}?p]_{M,g}$

In contrast, the boundary rising tone ↑ (L%H%) is semantically active. I propose that ↑ is an intonational morpheme which modifies the assignment function g. In particular, if the utterance contains a deictic expression, it shifts the value of the deictic center $\odot$ to the addressee ADDR (Kaplan 1977; Schlenker 2003; Anand 2006; McCready 2007; Shklovsky & Sudo 2014). In other words, ↑ is a Kaplanian monster which has the following semantics.

(34) $[\![\varphi \uparrow]\!]^{M,g} = [\![\varphi]\!]^{M,g[\odot \mapsto \text{ADDR}]}$

Consider a rising *darou*-declarative as an example. Rising intonation (↑) modifies g so that $g^{\text{ADDR}/\odot}(\odot) =$ ADDR (35-b-i). The interpretation of $E_{\odot}p$ presupposes that the agent of the input context is the addressee, ADDR (35-b-ii). The resulting logical expression is a CCP that updates the addressee's inquisitive state with $[E_{\text{ADDR}}p]_{M,g^{\text{ADDR}/\odot}}$ (35-b-iii).

(35) Rising declarative
a. LF: *p-darou*$\rightsquigarrow E_{\odot}p$
b. Interpretation
(i) $[\![E_{\odot}p \uparrow]\!]^{M,g,w} = [\![E_{\odot}p]\!]^{M,g[\odot \mapsto \text{ADDR}],w}$
(ii) $[\![E_{\odot}p]\!]^{M,g[\odot \mapsto \text{ADDR}],w}$ is defined if C is an inquisitive state of agent $g^{\text{ADDR}/\odot}(\odot) =$ ADDR at world w.
(iii) If defined,
$[\![E_{\odot}p]\!]^{M,g[\odot \mapsto \text{ADDR}],w} = \lambda C.C \cap [E_{\text{ADDR}}p]_{M,g^{\text{ADDR}/\odot}}$

A similar shifting process of the holder of knowledge is observed for the English rising contour. Gunlogson (2003) argues that an English rising declarative like (36-b) denotes the addressee's commitment of the propositional content, while a falling counterpart denotes the speaker's commitment.[16]

[16] Similarly, according to Bartels (1999), the H% tone in the sentence-final rising contour H-H% in English indicates that the utterance is directed at an addressee as in (i), and serves to emphasize the speaker's expectation that the addressee will resolve the posed question.

(i) S: (Interested friend) So you actually got yourself a job at the embassy — I'm impressed.
Do you speak Portuguese?
H* H-H%
(Bartels 1999, p. 152)

In contrast, a falling contour (H-L%) lacks this H% tone. Thus, an utterance with a falling contour (H-L%) is not construed as targeting the addressee in the same way; the question is merely posed as in (ii).

(ii) S: (Overworked official) This form here says you're applying for jobs LB18 and LB27. I suppose you know the requirements.
Do you speak Portuguese?
H* H-L%
(Bartels 1999, p. 152)

(36) a. It's raining↓
b. It's raining↑

To recapitulate, in sentences with a falling contour, the epistemic state of *darou* is associated with the speaker while in sentences with a rising contour, it is associated with the addressee. I account for this shifting process by proposing that *darou* is a deictic modality and the rising contour ↑ is a Kaplanian monster. *Darou* translates as a deictic modality $E_{\odot}$ where $\odot$ is a deictic center variable the value of which is assigned to the speaker by an assignment g. The rising contour ↑ modifies g so that it maps $\odot$ to the addressee.

The following table summarizes the propositions expressed by *darou*-sentences with the interpretations of the deictic center:

(37) Propositions expressed by *darou*-sentences

	Falling	Rising
Declarative	*p-darou*↓ $[E_{\text{SPKR}}p]_{M,g}$	*p-darou*↑ $[E_{\text{ADDR}}p]_{M,g^{\text{ADDR}/\odot}}$
Interrogative	*p-darou ka*↓ $[E_{\text{SPKR}}?p]_{M,g}$	*p-darou ka*↑ $[E_{\text{ADDR}}?p]_{M,g^{\text{ADDR}/\odot}}$

The next section provides the semantics of the modal operator E in the framework of inquisitive dynamic epistemic logic.

4.3 Sub-Proposal 3: *darou* as an Entertain Modal

Finally, we define the interpretation of the modal component of *darou*, namely $E_{\odot}$. An interesting feature of the syntax of *darou* is that it can take both a declarative and interrogative as its argument. Thus, the semantics of *darou* should be able to handle issues raised by interrogatives as well as information brought by declaratives.

Also, recall that although *darou* in a falling declarative indicates the speaker's bias toward the embedded proposition, the bias meaning disappears in falling interrogatives, as seen in (38).

(38) Ashita hareru darou ka. Zenzen wakar-anai.
tomorrow sunny DAROU Q at.all understand-not
'I wonder if it will be sunny tomorrow. I have no idea.'

This shows that the bias meaning should not be lexically encoded in the semantics of *darou* itself. How then does the bias effect of *darou* in falling declaratives come about?

Inquisitive dynamic epistemic logic (IDEL) (Ciardelli & Roelofsen 2015) offers a framework that can model the process of raising and resolving issues and defines an entertain modality that deals with the issues that the agents entertain.[17] The current paper claims that *darou* is a linguistic realization of the entertain modality the agent of which is a deictic center variable $\odot$. The following section briefly goes over the relevant technicalities of IDEL. Note also that as discussed above in Section 4.2, in order to understand the effect of intonation, it is crucial to make

[17] I would like to thank an anonymous reviewer for introducing this framework to me.

epistemic agents shiftable. Thus, the language of IDEL is slightly modified from the original version by Ciardelli & Roelofsen (2015) so that the language includes agent variables Var and the semantics contains an assignment function g which interprets the variables. A more detailed overview of IDEL is given in Appendix A.

4.3.1 Inquisitive dynamic epistemic logic

IDEL is an extension of dynamic epistemic logic (DEL) (Plaza 1989; van Ditmarsch et al. 2008) where the framework is enriched with an inquisitive component. DEL models how the information is associated with a set of agents and how an assertion updates the information state. Let $\mathcal{W}$ be the set of all possible worlds. As with standard epistemic logic, an information state is identified with a set of possible worlds. Inquisitive epistemic logic introduces another dimension which can characterise the issues that are entertained by the agents. An issue is defined as a set of information states:

(39) a. An information state s is a set of possible worlds, i.e., $s \subseteq \mathcal{W}$.
b. An *issue* $I \subseteq \wp(\mathcal{W})$ is a non-empty, downward closed set of information states. We say that an information state t *settles* an issue I in case $t \in I$. (adapted from Ciardelli & Roelofsen 2015, 1649)

In inquisitive epistemic logic, there are two modal operators, a knowledge modality K and an entertain modality E. K encodes an agent's information state just like standard epistemic logic, while E encodes an agent's inquisitive state, which encapsulates the issues that the agent entertain. As discussed above, I argue that the modal particle *darou* translates to the modality operator E with the agent $\odot$:

(40) *darou* $\rightsquigarrow E_{\odot}$

In what follows, I review the syntax and semantics of the entertain modality E as well as the knowledge operator K in IDEL and provide some motivations for adopting IDEL to analyze *darou*.

4.3.2 Syntax and Semantics of the entertain modality E

The syntax of E is defined in (41). $\mathcal{L}_!$ is the set of declaratives while $\mathcal{L}_?$ is the set of interrogatives. Let $\mathcal{A}$ be a finite set of agents and Var a countably infinite set of variables. As can be seen in (41), the entertain modality E_a and E_x can embed declaratives $\mathcal{L}_!$ and interrogatives $\mathcal{L}_?$ and the entire constructions are declaratives as a whole:

(41) (Syntax of E)
If $\varphi \in \mathcal{L}_\circ$ for $\circ \in \{!, ?\}$ and $a \in \mathcal{A}$, then $E_a\varphi \in \mathcal{L}_!$
If $\varphi \in \mathcal{L}_\circ$ for $\circ \in \{!, ?\}$ and $x \in$ Var, then $E_x\varphi \in \mathcal{L}_!$ (modified from Ciardelli & Roelofsen 2015, 1652)

Following Ciardelli et al. (2013), interrogatives are introduced by a disjunction $\vee$:[18]

[18] In Ciardelli & Roelofsen (2015), '?' introduces interrogative sentences and '$\vee$' is used as a classic non-inquisitive disjunction. '$\bot$' is used to define negation. See also Appendix A.1.1.

(42) If $\alpha \in \mathcal{L}_!$ and $\beta \in \mathcal{L}_!$, then $\alpha \vee \beta \in \mathcal{L}_?$

Before turning to the semantics of E, we need to understand how simple declaratives and interrogatives are interpreted in inquisitive epistemic logic. In standard epistemic logic, sentences are evaluated against a world in a model, since the meaning of a sentence is understood as a condition on worlds that make the sentence true. Now, the meaning of an interrogative sentence is understood as a condition on information states that resolve the issue expressed by the sentence. In the current framework, then, both declaratives and interrogatives are evaluated against information states. An inquisitive epistemic model M is defined as in (43). Π is the set of all issues. $\mathcal{A}$ is a finite set of agents, such as a, SPKR (the speaker), ADDR (the addressee), etc. Ciardelli & Roelofsen's original model (2015) only has $\mathcal{A}$. Since the current paper needs to make some of the epistemic agents shiftable in order to account for the shiftability of the epistemic agents of *darou*-sentences, the syntax includes Var, which is a countably infinite set of variables, such as x, $\odot$, etc., and the model includes an assignment function g.

(43) An inquisitive epistemic model for a set $\mathcal{P}$ of atomic sentences and a set Π of issues is a tuple $M = \langle \mathrm{Var}, \mathcal{W}, V, g, \Sigma_{\mathcal{A}} \rangle$ where:

a. $\mathcal{A}$ is a finite set of agents.
b. Var is a countably infinite set of variables. Var and $\mathcal{A}$ are disjoint.
c. $\mathcal{W}$ is a set, whose elements are called *possible worlds*.
d. $V : \mathcal{W} \to \wp(\mathcal{P})$ is a *valuation map* that specifies for every world w which atomic sentences are true at w.
e. $g : \mathrm{Var} \to \mathcal{A}$ is an assignment function.
f. $\Sigma_{\mathcal{A}}$ is a set of *state maps* $\Sigma_a : \mathcal{W} \to \Pi$, each of which assigns to any world w an issue $\Sigma_a(w)$[19]

(modified from Ciardelli & Roelofsen 2015, 1650-1651)

In standard epistemic logic, each agent is associated with an information state $\sigma_a(w)$ that encodes the information that is available to the agent a at w. In inquisitive epistemic logic, each agent is associated with an inquisitive state $\Sigma_a(w)$ that encodes the issues that are entertained by a at w, and the information state $\sigma_a(w)$ is obtained by taking a union of the inquisitive state:

(44) (*Information state* of agent a in w)
$\sigma_a(w) := \bigcup \Sigma_a(w)$.

In other words, $\Sigma_a(w)$ represents both the information and inquisitive states of the agent and we do not need $\sigma_a(w)$ as an independent notion in the logical model.

The following definition (45) defines the conditions when a state s supports (notation: $\models$) a sentence. A state s supports an atomic declarative p when p is true in all worlds in s, i.e., "*established* or *true everywhere* in s" (Ciardelli & Roelofsen 2015, 1653) as in (45-a). A state s supports a negative sentence $\neg\varphi$ when no non-empty subset of s supports φ (45-b). Finally, s supports an interrogative $\alpha \vee \beta$ when at least one of the answers is supported by s, i.e., the question is "*resolved* in s" (Ciardelli & Roelofsen 2015, 1653) as in (45-c).

[19] $\Sigma_a(w)$ observes factivity and introspection conditions. See Definition 2 in Appendix A.

(45) Let M be an inquisitive epistemic model, s an information state in M and g an assignment function from variables Var to agents $\mathcal{A}$.

a. $\langle M, g, s\rangle \models p \Longleftrightarrow p \in V(w)$ for all worlds $w \in s$
b. $\langle M, g, s\rangle \models \neg\varphi \Longleftrightarrow$ for all non-empty $t \subseteq s$, $\langle M, g, t\rangle \not\models \varphi$
c. $\langle M, g, s\rangle \models \alpha \vee \beta \Longleftrightarrow \langle M, g, s\rangle \models \alpha$ or $\langle M, g, s\rangle \models \beta$

Note that a sentence is evaluated against states in the current framework, while a sentence is evaluated against possible worlds in the classical possible world semantics. Therefore, in inquisitive epistemic logic, the proposition expressed by a sentence φ is defined as a set of all states that support φ:

(46) (Propositions)
$[\varphi]_{M,g} := \{s \subseteq \mathcal{W} | \langle g, s\rangle \models \varphi\}$

(Ciardelli & Roelofsen 2015, 1656)

Note also that we treat $?p$ as an abbreviation of $p \vee \neg p$. Thus, the support condition for polar interrogatives is the same as that for disjunction:

(47) (Support condition for polar interrogatives)
$\langle M, g, s\rangle \models ?\alpha \Longleftrightarrow \langle M, g, s\rangle \models \alpha$ or $\langle M, g, s\rangle \models \neg\alpha$

Let us now look at the modal operators, K and E, which are the most important to the current paper. First, just like E, the knowledge operator K can be syntactically applied to both declaratives and interrogatives. When K is applied to a declarative α, $K_a\alpha$ is supported by s iff α is true everywhere in $\sigma_\alpha(w)$ for any $w \in s$. That is, α is compatible with the information available to a at any $w \in s$, which is concurrent with the knowledge modality in standard epistemic logic.

(48) (Support condition for $K_a\varphi$)
$\langle M, g, s\rangle \models K_a\varphi \Longleftrightarrow$ for any $w \in s$, $\langle M, g, \sigma_a(w)\rangle \models \varphi$

Let us look at the state depicted in Figure 6 as an illustration. Following Ciardelli & Roelofsen (2015), only the maximal element of each issue is represented in the diagrams. Our language only has two atomic sentences, p and q and our model consists of four worlds, $\mathcal{W} = \{w_{11}, w_{10}, w_{01}, w_{00}\}$ such that $V(w_{11}) = \{p\}$, $V(w_{10}) = \{p\}$, $V(w_{01}) = \{q\}$, and $V(w_{00}) = \{q\}$. In Figure 6, $s = \{w_{11}, w_{10}\} = \sigma_a(w_{11}) = \sigma_a(w_{10})$. Thus, $\langle M, g, \sigma_a(w_{11})\rangle \models p$ and $\langle M, g, \sigma_a(w_{10})\rangle \models p$. Since for any $w \in s$, $\langle M, g, \sigma_a(w)\rangle \models p$, $\langle M, g, s\rangle \models K_a p$.[20]

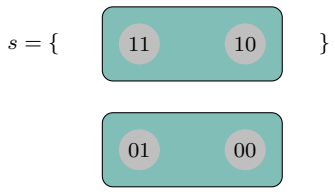


Fig. 6 $\langle M, g, s\rangle \models K_a p$, $\langle M, g, s\rangle \models K_a ?p$

[20] The same state depicted in Figure 6 supports $K_a ?p$. See Appendix A.1.3 for an illustration.

Consider another state, depicted in Figure 7, to see the difference between K_a and E_a. The state depicted in Figure 7 does not support $K_a?p$. In Figure 7 we have $s = \{w_{11}, w_{10}, w_{01}, w_{00}\}$, $\sigma_a(w_{11}) = \sigma_a(w_{10}) = \{w_{11}, w_{10}\}$ and $\sigma_a(w_{01}) = \sigma_a(w_{00}) = \{w_{01}, w_{00}\}$. Since $p \notin V(w_{01})$, $\langle M, g, \sigma_a(w_{01})\rangle \not\models p$. Since $\{w_{11}\} \subseteq \sigma_a(w_{11})$ and $\langle M, g, \{w_{11}\}\rangle \models p$, $\langle M, g, \sigma_a(w_{11})\rangle \not\models \neg p$. Therefore, $\langle M, g, s\rangle \not\models K_a?p$. As we will see below, the same state does support $E_a?p$ with an entertain modality E.

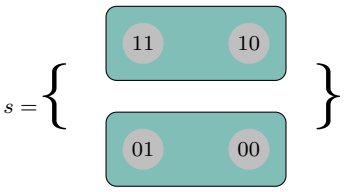


Fig. 7 $\langle M, g, s\rangle \not\models K_a?p$, $\langle M, g, s\rangle \models E_a?p$

Finally, we are ready to define the entertain modality E, to which the Japanese modal particle *darou* translates. When the entertain operator E applies to φ, a state s supports $E_a\varphi$ just in case φ is supported by any $t \in \Sigma_a(w)$ for any $w \in s$. Intuitively, $E_a\varphi$ states that once the issues entertained by a are resolved, φ will be supported:

(49) (Support condition for $E_a\varphi$)
$\langle M, g, s\rangle \models E_a\varphi \Longleftrightarrow$ for any $w \in s$ and for any $t \in \Sigma_a(w)$, $\langle M, g, t\rangle \models \varphi$
(modified from Ciardelli & Roelofsen 2015, 1653-1654)

Recall that an inquisitive state $\Sigma_a(w)$ is the set of issues entertained by a at w, i.e., the set of enhancements of $\sigma_a(w)$ where the issues of a are resolved. The state depicted in Figure 7 supports $E_a?p$ though it did not support $K_a?p$. The inquisitive states in Figure 7 are: $\Sigma_a(w_{11}) = \Sigma_a(w_{10}) = \{\{w_{11}, w_{10}\}, \{w_{11}\}, \{w_{10}\}\}$ and $\Sigma_a(w_{01}) = \Sigma_a(w_{00}) = \{\{w_{01}, w_{00}\}, \{w_{01}\}, \{w_{00}\}\}$. Now, all states support either p or $\neg p$: $\langle M, g, \{w_{11}, w_{10}\}\rangle \models p$, $\langle M, g, \{w_{01}, w_{00}\}\rangle \models \neg p$, $\langle M, g, \{w_{11}\}\rangle \models p$, $\langle M, g, \{w_{10}\}\rangle \models p$, $\langle M, g, \{w_{01}\}\rangle \models \neg p$, and $\langle M, g, \{w_{00}\}\rangle \models \neg p$. Thus, for any $w \in s$ and any $t \in \Sigma_a(w)$, $\langle M, g, t\rangle \models p \vee \neg p$. Therefore, $\langle M, g, s\rangle \models E_a?p$.

One fact about the relation between K and E is important to the current paper. If the embedded sentence is a declarative α, $E_a\alpha$ entails $K_a\alpha$.[21] Since $K_a\alpha$ entails $E_a\alpha$ (see Fact 14 in Appendix A.1), $E_a\alpha$ is equivalent to $K_a\alpha$.[22]

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[21] Entailment is defined as follows:

(i) (Definition of Entailment)
We say that a sentence φ entails another sentence ψ (notation $\varphi \models \psi$) just in case for all models M, states s and assignment functions g, if $\langle M, g, s\rangle \models \varphi$ then $\langle M, g, s\rangle \models \psi$.
(Ciardelli & Roelofsen 2015, 1657)

[22] Equivalence is defined as follows:

(i) (Definition of Equivalence)
We say that two sentences φ and ψ are equivalent (notation $\varphi \equiv \psi$) just in case for all

(50) (Fact)
For any declarative α, $a \in \mathcal{A}$ and $x \in \mathrm{Var}$, $K_a\alpha \equiv E_a\alpha$, $K_x\alpha \equiv E_x\alpha$
(modified from Ciardelli & Roelofsen 2015, 1659)

As we will see below, this equivalence is crucial to the semantics of *darou*. When *darou* embeds a declarative clause, it expresses the bias of the speaker or the addressee rather than an issue. Thus, the modal appears to function as the knowledge operator K_a rather than the entertain operator E_a. Thanks to this equivalence, we can assign a uniform semantics to *darou* as E while two modal meanings (i.e., K and E) arise from the category of the embedded sentence (i.e., declarative and interrogative).

4.3.3 Public announcement

The next step is to model how utterances change the information and issues associated with the agents. The update of the information state is exactly the same as in standard DEL. That is, the updated model is the result of intersecting the inquisitive state with the proposition $[\varphi]_{M,g}$:

(51) (Public announcement)
$\Sigma_a^{\varphi}(w) = \Sigma_a(w) \cap [\varphi]_{M,g}$ (modified from Ciardelli & Roelofsen 2015, 1664)

See Appendix A.2 for the overview of how IDEL dynamicize inquisitive epistemic logic and some illustrations.

In the current paper, the notion of public announcement is implemented as a context change potential (CCP) (Stalnaker 1968; Heim 1982). Thus, an utterance of φ translates into the logical expression φ, which is mapped to a CCP by the interpretation function. We employ the following interpretation function $[\![\cdot]\!]^{M,g}$, where M is an inquisitive epistemic model and g is a variable assignment as mentioned above in (21), repeated here as (52).

(52) (Context change potential)
a. $[\![\varphi]\!]^{M,g,w}$ is defined only if the input context C is an inquisitive state of agent $g(\odot)$ at world w, i.e., $\Sigma_{g(\odot)}(w)$.
b. If defined, $[\![\varphi]\!]^{M,g,w} = \lambda C.C \cap [\varphi]_{M,g}$, where $[\varphi]_{M,g}$ is the propositional content of φ.

$[\![\varphi]\!]^{M,g,w}$ first checks whether C is an inquisitive state of the deictic center (52-a). Then, it acts as a CCP which updates C with $[\varphi]_{M,g}$ (52-b).

4.3.4 Interim Summary

To summarize, inquisitive epistemic logic offers a framework that can model the agent's knowledge and issues. An issue is defined as a set of information states. Each agent is tagged with an inquisitive state $\Sigma_a(w)$ that represents the issues that the agent a entertains at w. When the knowledge operator K applies to a

models M, states s and assignment functions g, $\langle M, g, s\rangle \models \varphi \Longleftrightarrow \langle M, g, s\rangle \models \psi$.
(Ciardelli & Roelofsen 2015, 1657)

declarative p, a state s supports $K_a p$ just in case p is true everywhere in $\sigma_\alpha(w)$ for all $w \in s$ just like standard epistemic logic. When the entertain operator E applies to an interrogative $?p$, a state s supports $E_a ?p$ just in case $?p$ is supported by any $t \in \Sigma_a(w)$ for any $w \in s$. That is, each state t in which the issues that the agent a entertain at w are resolved supports p or $\neg p$. The crucial fact that is relevant to the current paper is that when E applies to a declarative α, $E_a \alpha$ is equivalent to $K_a \alpha$. Note also that I slightly modify the language of IDEL and add the set of agent variables Var to its syntax and the assignment function g which interprets the variables to its semantics in order to account for the the shiftable property of the epistemic agent of *darou*.

4.3.5 Why IDEL*?*

Before proceeding to the application of IDEL to analyze the linguistic data, it is worthwhile to clarify the motivations for adopting the IDEL framework to analyze *darou*. First, as we have seen in Section 2, the hallmark of the Japanese modal particle *darou* is that it can embed both declaratives and interrogatives. The syntax and semantics of IDEL is readily applicable since the modal operator E can embed both a declarative p and an interrogative $?p$ as defined in (41). Correspondingly, we do not need separate contexts for declarative and interrogative updates. The propositional contents of declaratives and interrogatives are both sets of states. Also, a context to be updated is an inquisitive state which is a set of states. Thus, declarative and interrogative updates are uniformly defined as intersecting the input context with the propositional content.

Second, the seat of knowledge of the proposition embedded under *darou* is the speaker by default but it can be shifted to the addressee when it is accompanied with rising intonation $\uparrow$. It is straightforward to implement this shifting process of the default agent in IDEL, since IDEL, as with standard epistemic logic, models the knowledge and inquisitive states of an agent a. Thus, as proposed in (19), *darou* translates to the IDEL operator $E_\odot$ which encodes the issues that the deictic center $\odot$ entertains. As we will see below, $\odot$ is a free variable the value of which the assignment function g assigns to the speaker by default. Rising intonation $\uparrow$ will modify this assignment so that $\odot$ is mapped to the addressee.

Third, *darou* appears to denote different modals depending on which clause type it embeds: When *darou* embeds a declarative sentence p, p-*darou* expresses the agent's bias; when it embeds an interrogative $?p$, $?p$-*darou* expresses the question that the agent entertains. In terms of IDEL, thus, p-*darou* translates to $K_\odot p$ while $?p$-*darou* translates to $E_\odot ?p$. Thanks to the semantics of IDEL, however, *darou* does not have to be ambiguously defined. We can maintain the uniform semantics of *darou* as $E_\odot$ and correctly derive $K_\odot$ using the equivalence discussed above in (50). (See also Fact 15 in Appendix A.1.)

5 Deriving the interpretations

Equipped with the interpretation function and the machinery of the IDEL, we are ready to derive the intricate semantics of the Japanese modal *darou*. Recall the main proposal that *darou* is an entertain modality, $E_\odot$, where $\odot$ is a deictic center variable the value of which is determined by the assignment function g:

(53) a. For any sentence φ (i.e., a declarative α or an interrogative μ)
φ-*darou* $\rightsquigarrow E_{\odot}\varphi$
b. $g = [\odot \mapsto \text{SPKR}]$

As can be seen, *darou* can embed both a declarative α or an interrogative μ and g maps $\odot$ to the speaker SPKR by default.

Furthermore, as proposed in Section 4.2, rising intonation $\uparrow$ modifies g so that the deictic center $\odot$ is shifted to the addressee ADDR:

(54) $[\![\varphi \uparrow]\!]^{M,g} = [\![\varphi]\!]^{M,g[\odot \mapsto \text{ADDR}]}$

5.1 Falling declaratives

Let us see how these two proposals derive the paradigm summarized above, starting from a falling declarative like (3) repeated here as (55).

(55) John-ga kuru darou↓
Jonn-NOM come DAROU
'John is coming, I bet./Probably, John is coming.'

Darou is an entertain modality $E_{\odot}$, and given Fact (50) when the embedded sentence is a declarative ($p \in \mathcal{L}_!$), $E_{\odot}$ and $K_{\odot}$ are equivalent. Furthermore, falling intonation is semantically vacuous, so the deictic center $\odot$ is mapped to SPKR by g. Recall that $[\varphi]_{M,g}$ is the proposition expressed by a sentence φ, i.e., the set of all states that support φ (see also Definition 10 in Appendix A.1.2).

(56) Falling *darou* declarative
a. LF: p-*darou*$\rightsquigarrow E_{\odot}p \equiv K_{\odot}p$
b. Interpretation
(i) $[\![K_{\odot}p]\!]^{M,g,w}$ is defined if C is an inquisitive state of agent $g(\odot) =$ SPKR at world w, i.e., $\Sigma_{\text{SPKR}}(w)$
(ii) If defined,
$[\![K_{\odot}p]\!]^{M,g,w} = \lambda C.C \cap [K_{\text{SPKR}}p]_{M,g}$

Therefore, (55) denotes a CCP $\lambda C.C \cap [K_{\text{SPKR}}p]_{M,g}$, where p ='John is coming'. After the announcement, 'John is coming' is established in the speaker's information state. The speaker has a bias toward the truth of the sentence, 'John is coming'.

5.2 Falling interrogatives

Let us turn to falling *darou*-interrogative sentences like (8) repeated here as (57).

(57) Marie-wa wain-o nomu darou ka↓
Marie-TOP wine-ACC drink DAROU Q
'I wonder if Marie drinks wine.'

Recall that the entire construction $E_a?p$ is always a declarative even if the embedded sentence is an interrogative. The deictic center remains the speaker:

(58) a. LF: *p-darou ka*$\rightsquigarrow E_{\odot}?p$
b. Interpretation
(i) $[\![E_{\odot}?p]\!]^{M,g,w}$ is defined if C is an inquisitive state of agent $g(\odot)$ = SPKR at world w, i.e., $\Sigma_{\text{SPKR}}(w)$
(ii) If defined,
$[\![E_{\odot}?p]\!]^{M,g,w} = \lambda C.C \cap [E_{\text{SPKR}}?p]_{M,g}$

Thus, (57) denotes the CCP, $\lambda C.C \cap [E_{\text{SPKR}}?p]_{M,g}$. After the update, for any $t \in \Sigma_{\text{SPKR}}(w)$, $\langle M, g, t\rangle \models ?p$. That is, 'whether or not Marie drinks wine' is supported as soon as the issues of SPKR are resolved, which can be paraphrased as: the speaker wonders whether Marie drinks wine.

Note further that the entertain modality E_a does not exclude the case where the agent has a bias towards a certain answer to the question. In other words, updating an inquisitive state with $E_a?p$ and K_ap consecutively does not lead the state to be absurd. That is, $\Sigma_a(w) \cap [E_a?p]_{M,g} \cap [K_ap]_{M,g} \neq \emptyset$. Indeed it is possible for *?p-darou*↓ to be felicitously followed by *p-darou*↓:

(59) Marie-wa wain-o nomu darou ka↓. Un, nomu darou↓.
Marie-TOP wine-ACC drink DAROU Q yeah, drink DAROU
'I wonder if Marie drinks wine. Yeah, I think she does.'

This contrasts with Ciardelli and Roelofsen's wonder modality W_a, defined as: "$W_a\varphi := \neg K_a\varphi \wedge E_a\varphi$" (Ciardelli & Roelofsen 2015, 1659). Thus, the Japanese *darou* is a linguistic realization of the entertain modality E, rather than the wonder modality W.[23]

5.3 Rising declaratives

Recall that a rising *darou*-declarative seems to express a meaning similar to a tag question, repeated here as (60).

(60) Marie-wa wain-o nomu darou↑
Marie-TOP wine-ACC drink DAROU
'Marie drinks wine, right?'

In other words, the speaker is trying to check the addressee's knowledge state or the addressee's bias. First, by Fact (50), we derive $K_{\odot}p$, which signifies the deictic center's bias toward p. Then, the rising contour ↑ shifts the holder of the bias from the speaker to the addressee. This shifting process is implemented as follows: The rising intonation ↑ modifies g so that the deictic center $\odot$ is mapped to the addressee ADDR:

(61) a. LF: *p-darou*$\rightsquigarrow E_{\odot}p \equiv K_{\odot}p$
b. Interpretation
(i) $[\![K_{\odot}p\uparrow]\!]^{M,g,w} = [\![K_{\odot}p]\!]^{M,g[\odot\mapsto\text{ADDR}],w}$
(ii) $[\![K_{\odot}p]\!]^{M,g[\odot\mapsto\text{ADDR}],w}$ is defined if C is an inquisitive state of agent $g^{\text{ADDR}/\odot}(\odot)$ = ADDR at world w, i.e., $\Sigma_{\text{ADDR}}(w)$
(iii) If defined,
$[\![K_{\odot}p]\!]^{M,g[\odot\mapsto\text{ADDR}],w} = \lambda C.C \cap [K_{\text{ADDR}}p]_{M,g^{\text{ADDR}/\odot}}$

[23] I would like to thank an anonymous reviewer for pointing this out.

Thus, (60) denotes the CCP $\lambda C.C \cap [K_{\text{ADDR}}p]_{M,g^{\text{ADDR}/\odot}}$. That is, the speaker attempts to change the addressee's knowledge state such that Marie drinks wine. Let us assume with Stalnaker (1998) that an assertion or public announcement is merely a proposal to update the common ground; so the transformation of the model is not complete unless the other agents agree to the proposal. Thus, when the speaker proposes to update the addressee's information state, the discourse move can be understood as seeking agreement, "Am I right in saying that you know Marie drinks wine?", resulting in a function similar to English tag questions.

5.4 Rising interrogatives

Finally, we address the infelicity of rising *darou*-interrogatives.

(62) #Marie-wa wain-o nomu darou ka↑
Marie-TOP wine-ACC drink DAROU Q

Again, the rising intonation ↑ modifies g, which is altered to map $\odot$ to the addressee ADDR:

(63) a. LF: *p-darou ka*$\rightsquigarrow E_{\odot}?p$
b. Interpretation
(i) $[\![E_{\odot}?p\uparrow]\!]^{M,g,w} = [\![E_{\odot}?p]\!]^{M,g[\odot\mapsto\text{ADDR}],w}$
(ii) $[\![E_{\odot}?p]\!]^{M,g[\odot\mapsto\text{ADDR}],w}$ is defined if C is an inquisitive state of agent $g^{\text{ADDR}/\odot}(\odot) = \text{ADDR}$ at world w, i.e., $\Sigma_{\text{ADDR}}(w)$
(iii) If defined,
$[\![E_{\odot}?p]\!]^{M,g[\odot\mapsto\text{ADDR}],w} = \lambda C.C \cap [E_{\text{ADDR}}?p]_{M,g^{\text{ADDR}/\odot}}$

Thus, the announcement attempts to change the model such that for any $t \in \Sigma_{\text{ADDR}}(w)$, $\langle M,t\rangle \models ?p$, 'the addressee wonders whether Marie drinks wine'. In other words, the speaker is trying to update the addressee's inquisitive state, "I will make you wonder whether Marie drinks wine". This is a pragmatically loaded move since usually, the speaker cannot control the addressee's inquisitive state, i.e., the issues in which the addressee is interested. This is why rising *darou*-interrogatives like (62) are perceived as infelicitous.

If we have an appropriate context, however, a rising interrogative ?*p*-DAROU ↑ becomes possible. For instance, in a quiz show or an instructive/Socratic questioning context, the questioner can felicitously utter a rising interrogative ?*p*-DAROU ↑ to the answerer:

(64) Doitsu-no shuto-wa doko deshou ka↑
Germany-GEN capital-TOP where DAROU.POLITE Q
'Where is the capital of Germany?'

Deshou is the polite form of *darou*. In a quiz show context like (64), the speaker, i.e., the quizmaster, indeed has the power to impose a question on the addressee, i.e., the contestant.

5.5 Summary

To account for the paradigm obtained from the results of the experiments presented in Section 3, I proposed that *darou* is a root-level modal operator $E_{\odot}$, which expresses epistemic knowledge associated to the deictic center, $\odot$. The proposal is divided into three sub-proposals. First, *darou* moves to [Spec CP] to check off its uninterpretable feature, [uROOT], resulting in the logical form $E_{\odot}\varphi$, in which the modal operator $E_{\odot}$ embeds the declarative or interrogative sentence. Second, the rising intonation ↑ is analyzed as an operator which modifies the assignment function so that the deictic center $\odot$ maps to the addressee ADDR. Finally, the semantics of *darou* is assigned in the framework of inquisitive dynamic epistemic logic. In particular, *darou* translates as an entertain modality $E_{\odot}$ and $E_{\odot}\varphi$ expresses that the deictic center is entertaining an issue denoted by φ. When the embedded sentence is a declarative α, $E_{\odot}\alpha$ is equivalent to $K_{\odot}\alpha$. Thus, *darou*-declaratives describe the epistemic state of the deictic center. As can be seen, this equivalence allows us to maintain the uniform semantics for *darou* as an entertain modality. The following table summarizes the interpretations of the four *darou*-sentences:

(65) CCP of *darou*-sentences

	Falling	Rising
Declarative p	*darou*↓ $\lambda C.C \cap [K_{\text{SPKR}}p]_{M,g}$ ('I bet')	*darou*↑ $\lambda C.C \cap [K_{\text{ADDR}}p]_{M,g^{\text{ADDR}/\odot}}$ ('... right?')
Interrogative $?p$	*darou ka*↓ $\lambda C.C \cap [E_{\text{SPKR}}?p]_{M,g}$ ('I wonder')	*darou ka*↑ $\lambda C.C \cap [E_{\text{ADDR}}?p]_{M,g^{\text{ADDR}/\odot}}$ (# or a quiz question)

6 Conclusion

This paper investigated the use of *darou* with different clause types, prosodic patterns and pragmatic contexts. The investigation revealed the intricacy of the interplay between clause types, bias and boundary tones. Experiment I showed that rising *darou*-interrogatives are seriously degraded. Experiment II showed that the other acceptable combinations are used in different contexts, and so have different usages. Falling *darou*-declaratives are used to describe the speaker's own epistemic state. Rising *darou*-declaratives are used to check the addressee's epistemic state. Finally, falling *darou*-interrogatives are used when the speaker is inquiring into his/her own epistemic state, i.e., entertaining an issue.

In order to explain the distribution and interpretation of the four construction patterns, this paper proposed that *darou* is a root-level operator and a linguistic realization of the entertain modality in inquisitive dynamic epistemic logic IDEL, which describes the information state in which the deictic center is entertaining certain issues. Syntactically, *darou* moves to the edge of CP to check off its uninterpretable feature, [uROOT]. The movement derives a logical form in which the modal operator embeds the entire interrogative construction when the sentence is marked with *ka*. The rising intonation ↑ is analyzed as an operator which shifts the deictic center of *darou* to the addressee. Lastly, the semantics of *darou* is uni-

formly defined as the entertain modal in IDEL. The machinery provided by IDEL successfully derives the variations of the interpretations: For a declarative, *p-darou* expresses that the agent has a bias toward the truth of the sentence p, while for an interrogative, ?*p-darou* expresses that the agent is entertaining the issue ?p.

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A Inquisitive Dynamic Epistemic Logic

A.1 Inquisitive Epistemic Logic

Inquisitive epistemic logic describes the inquisitive state of each agent. An issue is defined as a set of states, $I \subseteq \wp(\mathcal{W})$. An issue comprises the states that enclose sufficient information to resolve it. It is assumed that any issue is resolvable in at least one way, so an issue cannot be the empty set. Furthermore, if $t \in I$ includes sufficient information to resolve I, then any $u \subseteq t$ should include sufficient information to resolve I. Thus, an issue must be a downward closed set of information states: $t \in I \& u \subseteq t \Rightarrow u \in I$. These conditions yield the following definition:

Definition 1. An *issue* I is a non-empty, downward closed set of information states. We say that an information state t *settles* an issue I in case $t \in I$.

(adapted from Ciardelli & Roelofsen 2015, 1649)

Figure 8 illustrates four issues over the state $s = \{w_{11}, w_{10}, w_{01}, w_{00}\}$. Following Ciardelli & Roelofsen (2015), only the maximal element of each issue is represented in the diagrams. In order to settle the issue in (a), we have to pick exactly one world as the actual world. In the issue represented by (b), identifying the actual world as being in $\{w_{11}, w_{10}\}$ or in $\{w_{01}, w_{00}\}$ will settle the issue. In (c), identifying the actual world as being in $\{w_{11}, w_{01}, w_{00}\}$ or in $\{w_{10}, w_{01}, w_{00}\}$ will settle the issue. In (d), s already settles the issue, hence it is the trivial issue over s.

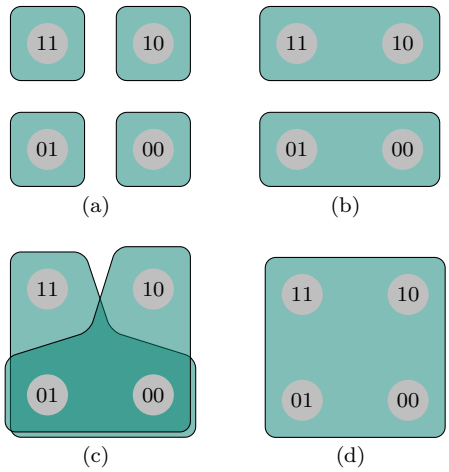


Fig. 8 Issues over the state $s = \{w_{11}, w_{10}, w_{01}, w_{00}\}$ (adapted from Ciardelli & Roelofsen 2015, 1650)

Note that the *information state* of the agent a at w is defined as the union of the inquisitive states of a at w, i.e., $\sigma_a(w) := \bigcup \Sigma_a(w)$. In epistemic logic, each agent is associated with an information state $\sigma_a(w)$ that encodes the information that is available to the agent a at w. In inquisitive epistemic logic, each agent is also associated with an inquisitive state $\Sigma_a(w)$ that encodes the issues that are entertained by a at w. Since $\Sigma_a(w)$ is an issue over $\sigma_a(w)$, $\sigma_a(w) = \bigcup \Sigma_a(w)$. Thus, $\Sigma_a(w)$ represents both the information and inquisitive states of the agent and we do not need $\sigma_a(w)$ as an independent notion in the logical model. Now, let $\mathcal{A}$ be a finite set of agents, such as SPKR, ADDR etc. In the current paper, in order to account for the shiftable property of the epistemic agents of *darou*, we add Var a countably infinite set of variables, such as x, $\odot$, etc., to the syntax. The semantics also includes an assignment function g. Let $\mathit{\Pi}$ be the set of all issues. An inquisitive epistemic model is defined as follows:

Definition 2. (Inquisitive epistemic models) An inquisitive epistemic model for a set $\mathcal{P}$ of atomic sentences and a set $\mathit{\Pi}$ of issues is a tuple $M = \langle \mathrm{Var}, \mathcal{W}, V, g, \Sigma_{\mathcal{A}} \rangle$ where:

- $\mathcal{A}$ is a finite set of agents.
- Var is a countably infinite set of variables. Var and $\mathcal{A}$ are disjoint.
- $\mathcal{W}$ is a set, whose elements are called *possible worlds*, such that $\mathcal{A}$, Var and $\mathcal{W}$ are disjoint.
- $g : \text{Var} \to \mathcal{A}$ is an assignment function.
- $V : \mathcal{W} \to \wp(\mathcal{P})$ is a *valuation map* that specifies for every world w which atomic sentences are true at w.
- $\Sigma_{\mathcal{A}}$ is a set of *state maps* $\Sigma_a : \mathcal{W} \to \Pi$, each of which assigns to any world w an issue $\Sigma_a(w)$, in accordance with:
  Factivity: for any $w \in \mathcal{W}, w \in \sigma_a(w)$
  Introspection: for any $w, v \in \mathcal{W}$, if $v \in \sigma_a(w)$, then $\Sigma_a(v) = \Sigma_a(w)$
  where $\sigma_a(w) := \bigcup \Sigma_a(w)$ represents the *information state* of agent a in w.

(modified from Ciardelli & Roelofsen 2015, 1650-1651)

The factivity condition states that the information stored in the information state is true, so it is knowledge rather than a belief. The introspection condition states that agents are aware what information is known and what issues are entertained. Put another way, if $\Sigma_a(v)$ is different from $\Sigma_a(w)$, the agent a should be aware of the difference between v and w.

Let us look at the model in Figure 9 as an illustration. Our language only has two atomic sentences, p and q and our model consists of four worlds, $\mathcal{W} = \{w_{11}, w_{10}, w_{01}, w_{00}\}$ such that $V(w_{11}) = \{p\}$, $V(w_{10}) = \{p\}$, $V(w_{01}) = \{q\}$, and $V(w_{00}) = \{q\}$. Factivity and Introspection together result in a partition as can be seen in the diagram. As for the information states, $\sigma_a(w_{11}) = \sigma_a(w_{10}) = \{w_{01}, w_{00}\}$ and $\sigma_a(w_{01}) = \sigma_a(w_{00}) = \{w_{01}, w_{00}\}$. Similarly, for the inquisitive states, $\Sigma_a(w_{11}) = \Sigma_a(w_{10}) = \{\{w_{11}, w_{10}\}, \{w_{11}\}, \{w_{10}\}\}$ and $\Sigma_a(w_{01}) = \Sigma_a(w_{00}) = \{\{w_{01}, w_{00}\}, \{w_{01}\}, \{w_{00}\}\}$. Thus, a cannot distinguish w_{11} from w_{10}, but a can tell w_{11} and w_{01} apart.

Note also that information states can be obtained by taking the union of inquisitive states, e.g., $\sigma_a(w_{11}) = \sigma_a(w_{10}) = \bigcup \Sigma_a(w_{11}) = \bigcup \Sigma_a(w_{10}) = \{w_{01}, w_{00}\}$.

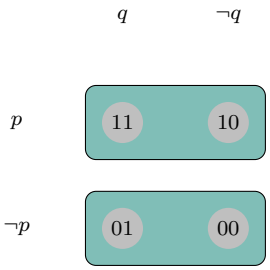


Fig. 9 Σ_a and σ_a

A.1.1 Syntax

The following are the well-formed logical expressions of inquisitive epistemic logic. Note that as argued above, the epistemic agents of *darou*-sentences are shiftable, thus the syntax includes a countably infinite set of variables Var as well as a finite set of agents $\mathcal{A}$. $\mathcal{L}_!$ is the set of declaratives while $\mathcal{L}_?$ is the set of interrogatives:

Definition 3. (Syntax)
Let $\mathcal{P}$ be a set of atomic sentences, $\mathcal{A}$ a finite set of agents, and Var a countably infinite set of variables.

1. For any $p \in \mathcal{P}, p \in \mathcal{L}_!$
2. If $\varphi \in \mathcal{L}_\circ$ for $\circ \in \{!, ?\}$, then $\neg\varphi \in \mathcal{L}_!$
3. If $\alpha \in \mathcal{L}_!$ and $\beta \in \mathcal{L}_!$, then $\alpha \vee \beta \in \mathcal{L}_?$
4. If $\varphi \in \mathcal{L}_\circ$ for $\circ \in \{!, ?\}$ and $a \in \mathcal{A}$, then $K_a\varphi \in \mathcal{L}_!$
5. If $\varphi \in \mathcal{L}_\circ$ for $\circ \in \{!, ?\}$ and $x \in \text{Var}$, then $K_x\varphi \in \mathcal{L}_!$

6. If $\varphi \in \mathcal{L}_\circ$ for $\circ \in \{!, ?\}$ and $a \in \mathcal{A}$, then $E_a\varphi \in \mathcal{L}_!$
7. If $\varphi \in \mathcal{L}_\circ$ for $\circ \in \{!, ?\}$ and $x \in \text{Var}$, then $E_x\varphi \in \mathcal{L}_!$
8. Nothing else belongs to either $\mathcal{L}_!$ or $\mathcal{L}_?$

(modified from Ciardelli & Roelofsen 2015, 1652)[24]

The most relevant to the current paper are the modal operators, the knowledge modality K_a and the entertain modality E_a. Both can embed declaratives and interrogatives and the entire constructions, i.e., $K_a\varphi$ and $E_a\varphi$, are declaratives as a whole.

A.1.2 Semantics

Let us turn to the interpretation of inquisitive epistemic logic. In standard epistemic logic, sentences are evaluated against a world in a model, since the meaning of a sentence is understood as a condition on worlds that make the sentence true. Now, the meaning of an interrogative sentence is to understood as a condition on information states that resolve the issue expressed by the sentence. In the current framework, then, both declaratives and interrogatives are evaluated against information states. Definition 4 defines the conditions when a state s supports (notation: $\models$) a sentence. A state s supports a declarative when it is "*established* or *true everywhere* in s" while s supports an interrogative when it is "*resolved* in s" (Ciardelli & Roelofsen 2015, 1653).

Definition 4. (Semantics) Let M be an inquisitive epistemic model, s an information state in M and g a variable assignment.

1. $\langle M, g, s\rangle \models p \iff p \in V(w)$ for all worlds $w \in s$
2. $\langle M, g, s\rangle \models \neg\varphi \iff$ for all non-empty $t \subseteq s$, $\langle M, g, t\rangle \not\models \varphi$
3. $\langle M, g, s\rangle \models \alpha \vee \beta \iff \langle M, g, s\rangle \models \alpha$ or $\langle M, g, s\rangle \models \beta$
4. $\langle M, g, s\rangle \models K_a\varphi \iff$ for any $w \in s$, $\langle M, g, \sigma_a(w)\rangle \models \varphi$
5. $\langle M, g, s\rangle \models K_x\varphi \iff$ for any $w \in s$, $\langle M, g, \sigma_{g(x)}(w)\rangle \models \varphi$
6. $\langle M, g, s\rangle \models E_a\varphi \iff$ for any $w \in s$ and for any $t \in \Sigma_a(w)$, $\langle M, g, t\rangle \models \varphi$
7. $\langle M, g, s\rangle \models E_x\varphi \iff$ for any $w \in s$ and for any $t \in \Sigma_{g(x)}(w)$, $\langle M, g, t\rangle \models \varphi$

(modified from Ciardelli & Roelofsen 2015, 1653-1654)

Note that the notion of support is persistent:

Fact 5. (Persistency of support)
If $\langle M, g, s\rangle \models \varphi$ and $t \subseteq s$, then $\langle M, g, t\rangle \models \varphi$

(modified from Ciardelli & Roelofsen 2015, 1654)

Note also that for declarative sentences we can recover the notion of truth from the support-based semantics. As far as declarative sentences are concerned, $\langle M, g, s\rangle$ supports α when every world in s makes α true, i.e., the singleton set $\{w\}$ supports α:

Fact 6. For a declarative α, $\langle M, g, s\rangle \models \alpha \iff \langle M, g, \{w\}\rangle \models \alpha$ for all $w \in s$

For declarative sentences, thus, the notion of truth with respect to a world can be retrieved from the support condition. A sentence φ is true at a world w in M with respect to g if and only if the singleton state $\{w\}$ supports φ in M with respect to g:

Definition 7. (Truth)
$\langle M, g, w\rangle \models \varphi \iff \langle M, g, \{w\}\rangle \models \varphi$

(modified from Ciardelli & Roelofsen 2015, 1654)

Definition 7 provides us with the following truth conditions.

Fact 8. (Truth-conditions)

1. $\langle M, g, w\rangle \models p \iff p \in V(w)$
2. $\langle M, g, w\rangle \models \alpha \vee \beta \iff \langle M, g, w\rangle \models \alpha$ or $\langle M, g, w\rangle \models \beta$
3. $\langle M, g, w\rangle \models \neg\alpha \iff \langle M, g, w\rangle \not\models \neg\alpha$

[24] In Ciardelli & Roelofsen (2015), '$\bot$' is used to define negation. '?' introduces interrogative sentences and '$\vee$' is used as a classic non-inquisitive disjunction. '$\rightarrow$' and '$\wedge$' are omitted in the current paper but defined in Ciardelli & Roelofsen (2015).

4. $\langle M, g, w\rangle \models K_a\varphi \Longleftrightarrow \langle M, g, \sigma_a(w)\rangle \models \varphi$
5. $\langle M, g, w\rangle \models K_x\varphi \Longleftrightarrow \langle M, g, \sigma_{g(x)}(w)\rangle \models \varphi$
6. $\langle M, g, w\rangle \models E_a\varphi \Longleftrightarrow$ for any $t \in \Sigma_a(w)$, $\langle M, g, t\rangle \models \varphi$
7. $\langle M, g, w\rangle \models E_x\varphi \Longleftrightarrow$ for any $t \in \Sigma_{g(x)}(w)$, $\langle M, g, t\rangle \models \varphi$

(modified from Ciardelli & Roelofsen 2015, 1654)

Using the truth-conditions in Fact 8, we can obtain the truth set, namely, the set of possible worlds where φ is true:

Definition 9. (Truth set)
$|\varphi|_{M,g} := \{w \in \mathcal{W} | \langle M, g, w\rangle \models \varphi\}$

(modified from Ciardelli & Roelofsen 2015, 1655)

The truth set is the classical meaning of a sentence φ. In the current framework, however, a sentence is evaluated against states rather than possible worlds. Therefore, the proposition expressed by a sentence φ is defined as a set of all states that support φ:

Definition 10. (Propositions)
$[\varphi]_{M,g} := \{s \subseteq \mathcal{W} | \langle g, s\rangle \models \varphi\}$

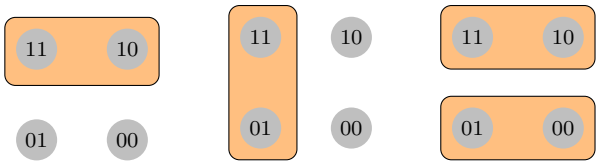
(modified from Ciardelli & Roelofsen 2015, 1656)

The truth set of a sentence can be retrieved by taking the union of the proposition expressed by the sentence:

Fact 11. (Propositions and truth-sets)
For any sentence φ and any model M, $|\varphi|_{M,g} = \bigcup[\varphi]_{M,g}$

(modified from Ciardelli & Roelofsen 2015, 1656)

To illustrate, given the models depicted in Figure 10, the propositions of p, q and $p \vee \neg p$ are $[p]_{M,g} = \{\{w_{11}\}, \{w_{10}\}, \{w_{11}, w_{10}\}\}$, $[q]_{M,g} = \{\{w_{11}\}, \{w_{01}\}, \{w_{11}, w_{01}\}\}$ and $[p \vee \neg p]_{M,g} = \{\{w_{11}, w_{10}\}, \{w_{01}, w_{00}\}, \{w_{11}\}, \{w_{10}\}, \{w_{01}\}, \{w_{00}\}\}$. The truth sets of p, q and $p \vee \neg p$ are $|p|_{M,g} = \bigcup[p]_{M,g} = \{w_{11}, w_{10}\}$, $|q|_{M,g} = \bigcup[q]_{M,g} = \{w_{11}, w_{01}\}$ and $|p \vee \neg p|_{M,g} = \bigcup[p \vee \neg p]_{M,g} = \{w_{11}, w_{10}, w_{01}, w_{01}\}$, respectively. As can be seen, the truth set $|p \vee \neg p|_{M,g}$ cannot represent the internal structure of the interrogative sentence, $p \vee \neg p$.



(a) p (b) q (c) $p \vee \neg p$

Fig. 10 Truth sets and propositions

A.1.3 Example: K_a is applied to an interrogative μ

If K_a is applied to an interrogative μ, $K_a\mu$ is supported in s iff μ is resolved in $\sigma_a(w)$ for any $w \in s$. That is, the agent a has enough information to resolve μ at any $w \in s$. Consider $K_a?p$ as an example. The state depicted in Figure 6 above supports $K_a?p$. $\langle M, g, s\rangle \models K_a?p \Longleftrightarrow$ for any $w \in s$, $\langle M, g, \sigma_a(w)\rangle \models ?p \Longleftrightarrow$ for any $w \in s$, $\langle M, g, \sigma_a(w)\rangle \models p$ or $\langle M, g, \sigma_a(w)\rangle \models \neg p$ $\Longleftrightarrow$ for any $w \in s$, $\langle M, g, \sigma_a(w)\rangle \models p$ or for any non-empty $t \subseteq \sigma_a(w)$, $\langle M, g, t\rangle \not\models p$. Now, in Figure 6, $\langle M, g, \sigma_a(w_{11})\rangle \models p$ and $\langle M, g, \sigma_a(w_{10})\rangle \models p$. Since for any $w \in s$, $\langle M, g, \sigma_a(w)\rangle \models p$, $\langle M, g, s\rangle \models K_a?p$.

A.1.4 Two crucial facts

There are two facts about the relation between K_a and E_a which are important to the current paper. First, let us define the notions of entailment and equivalence:

Definition 12. (Entailment)
We say that a sentence φ entails another sentence ψ (notation $\varphi \models \psi$) just in case for all models M, states s and assignment functions g, if $\langle M, g, s\rangle \models \varphi$ then $\langle M, g, s\rangle \models \psi$.
(modified from Ciardelli & Roelofsen 2015, 1657)

Definition 13. (Equivalence)
We say that two sentences φ and ψ are equivalent (notation $\varphi \equiv \psi$) just in case for all models M, states s, and assignment functions g, $\langle M, g, s\rangle \models \varphi \Longleftrightarrow \langle M, g, s\rangle \models \psi$.
(modified from Ciardelli & Roelofsen 2015, 1657)

Now, for any sentence φ, $K_a\varphi$ entails $E_a\varphi$ because if it is the case that $\langle M, g, \sigma_a(w)\rangle \models \varphi$ for any $w \in s$, then by persistency of support (Fact 5), it must be the case that $\langle M, g, t\rangle \models \varphi$ for any $t \in \Sigma_a(w)$:

Fact 14. For any sentence φ, $K_a\varphi \models E_a\varphi$
(Ciardelli & Roelofsen 2015, 1659)

Moreover, if the embedded sentence is a declarative α, $E_a\alpha$ entails $K_a\alpha$, so $E_a\alpha$ is equivalent to $K_a\alpha$:

Fact 15. For any declarative α, $K_a\alpha \equiv E_a\alpha$
(Ciardelli & Roelofsen 2015, 1659)

Suppose that $\langle M, g, s\rangle \models \alpha$ for any $w \in s$ and for any $t \in \Sigma_a(w)$. Since α is a declarative, it is supported by a state iff it is true everywhere in the state. Thus, it must be true in any $w \in \sigma_a(w) = \bigcup \Sigma_a(w)$. Therefore, for any $w \in s$, $\langle M, g, \sigma_a(w)\rangle \models \alpha$.

A.2 Adding dynamics

Now that we have models and logical expressions to describe information and issues, the next step is to add dynamics to the framework to model how speech acts change the information and issues of the agents. A public announcement of φ with respect to a variable assignment g converts a model $M = (\mathcal{W}, V, g, \Sigma_{\mathcal{A}})$ into the model $M^{\varphi} = (\mathcal{W}^{\varphi}, V^{\varphi}, g^{\varphi}, \Sigma^{\varphi}_{\mathcal{A}})$:

- $\mathcal{W}^{\varphi} = \mathcal{W} \cap |\varphi|_{M,g}$
- $V^{\varphi} = V \restriction_{\mathcal{W}^{\varphi}}$
- $\Sigma^{\varphi}_{\mathcal{A}} = \{\Sigma^{\varphi}_a | a \in \mathcal{A}\}$, where for every $w \in \mathcal{W}^{\varphi} : \Sigma^{\varphi}_a(w) = \Sigma_a(w) \cap [\varphi]_{M,g}$

(modified from Ciardelli & Roelofsen 2015, 1664)

The update of the information state is exactly the same as in standard DEL. That is, the updated model is the result of intersecting the information state with the truth-set $|\varphi|_{M,g}$:

Fact 16. For any sentence φ, agent a, model M, assignment g and world w, we have that: $\sigma^{\varphi}_a(w) = \sigma_a(w) \cap |\varphi|_{M,g}$
(modified from Ciardelli & Roelofsen 2015, 1664)

Thus, if a declarative α is announced, the update amounts to the restriction of the original state to the set of worlds in M where α is true with respect to g:

- $\Sigma^{\alpha}_a(w) = \Sigma_a(w) \cap [\alpha]_{M,g} = \{s \in \Sigma_a(w) | s \subseteq |\alpha|_{M,g}\} = \Sigma_a(w) \restriction_{|\alpha|_{M,g}}$

(modified from Ciardelli & Roelofsen 2015, 1665)

If an interrogative μ is announced, worlds where μ is false are removed from the model and the inquisitive state $\Sigma_a(w)$ is augmented by intersecting it with $[\mu]_{M,g}$:

- $\Sigma^{\mu}_a(w) = \Sigma_a(w) \cap [\mu]_{M,g}$

Intuitively, by announcing an interrogative, the agent a is committed to arrive at a state where μ is resolved.

Let us look at a simple example. In Figure 11, the agent a has only trivial information and a trivial issue in (a). Once an interrogative $?p$ is announced, $\Sigma_a(w)$ is intersected with the proposition $[?p]_{M,g} = \{\{w_{11}, w_{10}\}, \{w_{01}, w_{00}\}, \{w_{11}\}, \{w_{10}\}, \{w_{01}\}, \{w_{00}\}\}$. Thus, $\Sigma_a(w_{11}) \cap [?p]_{M,g} = \{\{w_{11}, w_{10}\}, \{w_{01}, w_{00}\}, \{w_{11}\}, \{w_{10}\}, \{w_{11}\}, \{w_{01}\}, \{w_{00}\}\}$. Next, the announcement of $?q$ transforms (b) to (c). Since $[?q]_{M,g} = \{\{w_{11}, w_{01}\}, \{w_{10}, w_{00}\}, \{w_{11}\}, \{w_{10}\}, \{w_{01}\}, \{w_{00}\}\}$, $\Sigma_a(w_{11}) \cap [?p]_{M,g} \cap [?q]_{M,g} = \{\{w_{10}\}, \{w_{11}\}, \{w_{01}\}, \{w_{00}\}\}$. From (c) to (d), a declarative p is announced. $[p]_{M,g} = \{\{w_{11}, w_{10}\}, \{w_{11}\}, \{w_{10}\}\}$, so $\Sigma_a(w_{11}) \cap [?p]_{M,g} \cap [?q]_{M,g} \cap [p]_{M,g} = \{\{w_{11}\}, \{w_{10}\}\}$. Finally, the announcement of the declarative q removes $\{w_{10}\}$ and we obtain $\Sigma_a(w_{11}) \cap [?p]_{M,g} \cap [?q]_{M,g} \cap [p]_{M,g} \cap [q]_{M,g} = \{\{w_{11}\}\}$.

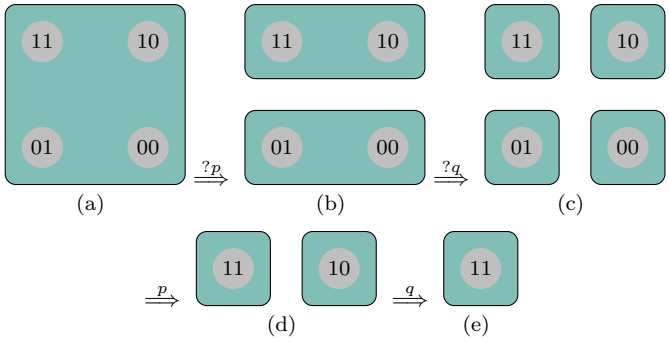


Fig. 11 The effects of a series of simple announcements on a state (Ciardelli & Roelofsen 2015, 1666)

B Experimental Stimuli

(1) a. ANSWER context: A wa yuujin ni dare ga paatii ni kuru to omouka kikarete kotaeta:
'A was asked by a friend who he thinks will come to the party and answered:'
b. SELF-ADDRESS context: A wa dare ga paatii ni kuru ka hitoride kangae te iru:
'A is wondering by himself who is going to come to the party:'
c. AGREE-SEEK context: A wa yuujin ga "dare mo paatii ni konai" to itteiru no o kiite itta:
'A's friend said "No one will come to the party" and A said:'
d. Yamashita-san ga kuru darou (ka)
Yamashita.MR NOM come DAROU Q
'Probably, Mr. Yamashita will come'

(2) a. ANSWER context: A wa, tsuma ni kodomotachi ga nani o taberu ka kikarete, itta:
'A was asked by his wife what children eat, and said:'
b. SELF-ADDRESS context: A wa konban no sarada ni nani o ireru ka, hitori de kangaeteiru:
'A is wondering by himself what to put in this evening's salad:'
c. AGREE-SEEK context: A wa, ninjin o kaubeki ka mayotteiru tsuma ni itta:
'A said to his wife who was wondering whether to buy carrots:'
d. kodomotachi wa, ninjin o taberu darou (ka)
children TOP carrot ACC eat DAROU Q
'Probably, the children will eat carrots'

(3) a. ANSWER context: itsumo syukudai o dasanai A sensei ga mezurashiku syukudai o dasi, ashisutanto ni gakusei ga syukudai o yattekuru to omouka tazunerarete A

wa kotaeta:
'Teacher A, who never assigned homework before, surprisingly assigned some homework, then he was asked by his assistant if he thinks the students will do the homework, and said:'

b. SELF-ADDRESS context: A sensei wa gakusei ni totemo muzukashii syukudai o dashita node shinpaishite kangaeteiru:
'Since teacher A gave the students very difficult homework, so he is wondering:'

c. AGREE-SEEK context: A sensei wa, tesuto chuu ni gakusei ni syukudai o dasiteiinoka mayotteiru ashisutanto ni itta:
'Teacher A said to the assistant who was wondering whether she should give students some homework during the examination period:'

d. gakusei wa, syukudai o yattekuru darou (ka)
students TOP homework ACC do DAROU Q
'Probably, the students will do the homework.'

(4) a. ANSWER context: A wa, hanzai no tayouka ni taishite kuni ga dou taiousurunoka kikarete, kotaeta:
'A was asked how the government handles the criminal diversification, and answered:'

b. SELF-ADDRESS context: A wa, syounenhou nitsuite genjou no houritsu dewa genkai ga aruto hitori de kangaeteiru:
'A is thinking by himself about juvenile law that there is a limitation in the current state law:'

c. AGREE-SEEK context: A wa, jibun no kenri bakari o syuchoushite, genjou no houritsu o hihanshiteiru shimin ni itta:
'A said to citizens who are only claiming their own rights, and criticizing the current state law:'

d. ichinen inaini, atarashii houritsu ga dekiru darou (ka)
one-year within new law NOM enact DAROU Q
'Probably, a new law will be enacted within one year'

(5) a. ANSWER context: A wa, yuujin ni nihon no keiki ni tsuite kikarete kotaeta:
'A was asked by his friend about Japanese economic conditions, and answered:'

b. SELF-ADDRESS context: A wa, korekara no nihon no keiki ni tsuite hitori de kangaeteiru:
'A is thinking about future Japanese economic conditions:'

c. AGREE-SEEK context: A wa, nihon no kinyuuseisaku wa kouka ga arunoka to boyaiteiru yuujin ni itta:
'A said to his friend who is muttering about whether the Japanese monetary policy is effective:'

d. nihon no keiki wa, yoku naru darou (ka)
Japan GEN economic-condition TOP good become DAROU Q
'Japanese economic conditions will become better.'

(6) a. ANSWER context: A wa, asu no tenki o kikarete kotaeta:
'A was asked about tomorrow's weather, and answered:'

b. SELF-ADDRESS context: hideri tsuzuki de mizubusoku nanode shinpaishi, A wa sora o miagete asu no tenki o kangaeteiru:
'A is worried about the water shortage due to a long spell of dry weather, and wondering about tomorrow's weather while looking up at the sky:'

c. AGREE-SEEK context: A wa, taihuu ga chikazuiteirunoni, asu baabekyuu no yoteidatoiu musuko ni itta:
'A said to his son who has a plan of barbecueing tomorrow even though a typhoon is approaching:'

d. asu wa, ame ga huru darou (ka)
tomorrow TOP rain NOM fall DAROU Q
'It will rain tomorrow.'

(7) a. ANSWER context: tairyoku o tsukeru niwa doushitaraiika to tazuneru seito ni A wa kotaeta:
'A answered a student who asked how he should build up his physical strength:'

b. SELF-ADDRESS context: A wa, kisotairyoku o tsukeyouto hon o yominagara kangaeteiru:
'A is thinking of building up basic physical strength while reading a book:'

c. AGREE-SEEK context: A wa, hashirikomi wa tsukareru kara shitakunai to iu sakkaabu no seito ni mukatte itta:
'A said to a soccer club student who doesn't want to jog because it is tiring:'

d. hashirikomi ga kisotairyoku zukuri no kihonn darou (ka)
run-training NOM basic-physical-strength build GEN basic DAROU Q
'Run-training should be a basis for building basic physical strength'

(8) a. ANSWER context: A wa, doushitara ji o utsukushiku kaku koto ga dekiruka to kikarete kotaeta:
'A was asked how to write beautiful characters, and answered:'

b. SELF-ADDRESS context: A wa, enpitsu no mochikata ga waruikara anata no ji wa hetananda to iwarete, hitori de kangaeteiru:
'A is thinking alone, because he was told that his way of holding a pencil is wrong:'

c. AGREE-SEEK context: enpitsu no mochikata o nando oshietemo kichinto shinai musume ni A wa itta:
'A said to his daughter who didn't do it correctly even though he taught her how to hold a pencil many times:'

d. enpitsu no mochikata wa, moji no utsukushisani kankeisuru daou
pencil GEN way-of-holding TOP character GEN beauty relate DAROU (ka)
Q
'I think that the way of holding a pencil is related to the beauty of characters.'

(9) a. ANSWER context: A wa, kaigi no sukejuuru o kikarete kotaeta:
'A was asked about the meeting schedule, and answered:'

b. SELF-ADDRESS context: A wa, kaigishitsu no yoyaku o suru niatari kangaeteiru:
'A is wondering about booking a meeting room:'

c. AGREE-SEEK context: tsugi no kaigi no tocyuu ni kyuukei o irerubekika mayotteiru buka ni A wa itta:
'A said to his subordinate who is wondering whether to have a break in the middle of the next meeting:'

d. tugi no kaigi wa, san jikan kurai kakaru darou (ka)
next GEN meeting TOP three hours about take DAROU Q
'The next meeting will take about 3 hours.'

(10) a. ANSWER context: A wa, kakusa ga syakai no hituyouaku dearu koto o minuki, itta:
'A realized that social inequality is a necessary evil of society, and said:'

b. SELF-ADDRESS context: A wa, kakusamondai taisakuan no subete ni ketten ga arukoto ni kizuki jimonsita:
'A found that all proposed measures for social inequality problems have mistakes, and asked himself:'

c. AGREE-SEEK context: A wa, [kakusamondai no kaiketsu wa kantan] to iu B ni, odoroite kiita:
'A was surprised and asked B who had said "the solution of social inequality problem is easy":'

d. donoyouna seisaku o tottemo kakusamondai wa, kaiketu dekinai darou
whatever policy ACC make disparity-problem TOP settle can't maybe (ka)
DAROU Q
'Whatever policy might be issued, we won't resolve the inequality problem.'

(11) a. ANSWER context: A wa, chianakka no genin nitsuite kikare, kotaeta:
'A was asked about the cause of the deterioration of public security, and answered:'

b. SELF-ADDRESS context: A wa, chianakka no gennin nitsuite kangaeteiru:
'A is thinking about the cause of the deterioration of public security:'

c. AGREE-SEEK context: A wa, [chian ga warukunatta nowa, seiji no sei dewanai] to iu yuujin ni, toitadashita:
'A interrogated his friend who said "The deterioration of public security is not due to politics":'

d. konoyouna syakai ni nattesimattano wa, seiji no sei darou (ka)
such society DAT become TOP politics of because DAROU Q
'It is because of politics that we have this kind of society.'

(12) a. ANSWER context: A wa, enyasu ni naru jouken ga toubun tsuzuku deeta o mite itta:
'A saw data which indicates that the yen will continue to be weak for a while, and said:'

b. SELF-ADDRESS context: A wa, taezu jouge shiteiru ensouba o mite omotta:
'A saw the exchange rate of the yen always going up and down, and thought:'

c. AGREE-SEEK context: A wa, [enyasu wa mou owarida] to syucyousuru yuujin ni, odoroite shitsumonshita:
'A asked his friend in surprise who argues "The depression of the yen is over":'

d. enyasu wa, toubun tsuzuku darou (ka)
weaker-yen TOP for-a-while continue DAROU Q
'The depression of the yen will continue for a while.'

(13) a. ANSWER context: A wa, basu no jikokuhyou to tokei o mikurabete, zannensouni itta:
'A compered the bus timetable with his watch, and said regretfully:'

b. SELF-ADDRESS context: A wa, basutei ni mukatte hashiri nagara omotta:
'A thought while running to the bus stop:'

c. AGREE-SEEK context: A wa, sudeni basu ga itteshimatta noni, basu ka densya kade mayotteiru yuujin ni itta:
'A said to his friend who is wondering whether to ride the bus or train when the bus already has gone:'

d. mou, basu wa detesimatta darou (ka)
already bus TOP left DAROU Q
'Probably, the bus has already left.'

(14) a. ANSWER context: A wa, gaikoku no yuujin ni kotoshi no huyu no tenki o kikarete, kotaeta:
'A was asked by his foreign friend about the weather of this winter, and answered:'

b. SELF-ADDRESS context: A wa, koromogae no jikini huyuhuku no junbi o shinagara kangaeta:
'A thought while preparing winter clothes for updating his wardrobe:'

c. AGREE-SEEK context: A wa, taiwan kara kanada ni hikkosu yuujin ga, atsui kooto o motteinai koto o shitte itta:
'A realized that his friend who moved from Taiwan to Canada does not have a bulky coat, and said:'

d. kotoshi no huyu wa, kyonen yori samuku naru darou (ka)
this-year GEN winter TOP last-year than cold be DAROU Q
'This winter will be colder than last year.'

(15) a. ANSWER context: A wa, saigai ichinengo, hobo hukkou o togeteiru hisaichi o mite omotta:
'A saw that the affected area after one year from the disaster had almost returned to normal, and thought:'

b. SELF-ADDRESS context: A wa, nanjuunen tattemo kaiketsushinai rachijiken no yousu omite omotta:
'A saw some news about an abduction case that has not been resolved even after ten years, and thought:'

c. AGREE-SEEK context: A wa, [seihu wa nanimo shitekurenai] to monku o iudakede doryoku o shinai higaisya o mite omotta:
'A saw a victim who just complains "the government does nothing for me" without any effort, and thought:'

d. higaisya kyusai notameni, seihu wa dekirudakenokoto o shitekita
victim relief for government TOP as-much-as-possible ACC do
darou (ka)
DAROU Q
'For the relief of victims, the government must have done as much as possible.'

(16) a. ANSWER context: A wa, kokuren niyoru busshienjo keizoku no nyuusu o mite omotta:
'A saw some news that the commodity assistance by the United Nations continues, and thought:'

b. SELF-ADDRESS context: A wa, hisaikoku niwa doumeikoku ga sukunai node shinpai ni omotta:
'A wondered because the affected country has few allies:'

c. AGREE-SEEK context: A wa, enjobusshi o akirameteiru hitobito ni, naze sarani enjoshinsei o shinainoka o kiita:
'A asked people who gave up on aid supplies why they do not petition for more aid:'

d. yoriookuno enjobusshi o nozomukoto wa dekiru darou (ka)
more aid-supply ACC wish TOP possible DAROU Q
'It should be possible to wish for more aid supplies.'