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PROSODY AND THE INTERPRETATION OF TAG QUESTIONS*

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Abstract

We provide an account of the alignment of linguistic form and discourse function with respect to English tag questions, adopting as a formal framework Segmented Discourse Representation Theory. SDRT models the discourse function of utterances via their rhetorical connection to the antecedent discourse. We pay particular attention to the prosodic features of tag questions and their contribution to interpretation. This approach to tag questions is appropriate, we argue, as the interpretation of a tag comes down to its rhetorical connection to the host sentence.

1 Introduction

This paper provides an analysis of the alignment of linguistic form – i.e., syntax, semantics and phonology – and discourse function, or the use(s) to which an utterance is put in a given context. We investigate this relationship through a study of reversed polarity tag questions in English, as exemplified by the examples in (1).

(1) a. Julie isn't coming, is she?
b. Julie is coming, isn't she?

Tag questions are a good empirical domain for an investigation of alignment, because they possess a rich and varied set of grammatical features than contribute to their interpretation. First, they are syntactically mixed, consisting of a declarative sentence, or *anchor*, in a paratactic relationship with a reduced interrogative clause, or *tag* (Huddleston and Pullum 2002). This complex linguistic form, we argue, is mirrored by a complex discourse function (Quirk, Greenbaum, Leech and Svartvik 1985).

Second, prosody – intonation, intonational phrasing and stress – plays a pivotal role in the computation of the discourse function of tag questions. Most descriptions, for example, posit a relationship between the final intonational contour of the tag and discourse function (Sadock 1974, Millar and Brown 1979, Rando 1980, a.o.), while others note a dependency between *intonational phrasing* and interpretation (Ladd 1981, McCawley 1988, Huddleston and Pullum 2002). Tag questions, therefore, provide an interesting test bed for investigations into the semantic and pragmatic contribution of intonation.

We frame our analysis in Segmented Discourse Representation Theory (SDRT), an extension of dynamic semantic frameworks, which posits rhetorical relations between discourse segments (Asher and Lascarides 2003). SDRT is a useful framework with respect to the issues discussed above, because to the extent that rhetorical relations are viewed as relational speech act types,

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SDRT *is* a theory of alignment. Our analysis makes particular use of SDRT's shallow logic of cognitive modelling, which models the flow of information *from* linguistic form *to* a model of an agent's beliefs and intentions. Recognizing such beliefs and intentions is essential to recognizing which action a speaker performs in a discourse or dialogue. We argue specifically that tag questions are a conventionalized means of managing the content of the common ground, (roughly) either by requiring feedback from the hearer that the communicative goal of the anchor has been achieved – and consequently settling the content of the common ground with respect to the anchor – or by requesting evidence for or against the anchor. Since final tune is often taken to convey a relationship between the speaker or hearer, the underlying propositional content of an utterance, and the common ground (Gussenhoven 1984, a.o.), it is an important clue in recovering the speaker's intention. Intonational phrasing, we argue, affects discourse *segmentation* and we discuss how segmentation can affect the possible interpretations of a tag.

2 Tag Questions and Linguistic Form

We begin by discussing very generally the grammatical features of tag questions; §2.1 discusses syntax and semantics, while §2.2 discusses phonology.

2.1 Syntax and Semantics

The surface syntax of tag questions consists of a juxtaposition of a declarative sentence, or *anchor*, with a reduced interrogative clause, or *tag*. The tag itself consists of a subject pronoun followed by an auxiliary (or modal) verb sharing the person, number and tense features of the anchor's matrix verb. If the anchor does not contain an axillary or modal verb, the appropriate form of *do* is inserted. The subject pronoun shares person, number and gender features with the subject of the anchor.[1]

We assume the rough syntactic structure in (2), in which the subject pronoun is co-indexed and coreferential with the subject of the anchor and the interpretation of the tag involves an anaphoric component akin cases of VP ellipsis (as in indicated in (2) via coindexation of a zero anaphor ϕ with the VP of the anchor). (2) captures Culicover (1992)'s observation that tags are essentially pronominal.

(2) $[_{S_1}$Julie$_i$ isn't $[_{VP}$ here $]_j\,]$, $[_{S_2}$ is she$_i$ ϕ_j?$]$

While previous approaches agree on the broad syntactic outline in (2), two distinct viewpoints arise with respect to interpretation. The first view – see Quirk et al. (1985) e.g. – assumes that anchors denote propositions and interrogative tags denote full polar questions.[2] The second approach – see Culicover (1992) – analyzes tags as functions from propositions to questions, rendering tags a type of mood marker or illocutionary force modifying device. In §3.1, we

[1]There are two varieties of tag question in English: constant and reversed polarity. The former is characterized by the fact that the polarity of the auxiliary in the anchor and tag are reversed as in the examples in (1). (i) is a constant polarity tag question.

(i) Julie is here, is she?

We focus below on reversed polarity tag questions, since constant polarity tag questions are relatively rare in spoken American English. In 36 tag questions pulled from the *Santa Barbara Corpus of Spoken American English*, there were no instances of constant polarity tag questions.

[2]Following Groenendijk and Stokhof (1984), we assume that questions have a propositional meaning, e.g., that they denote a propositional concept, i.e., a function from indices to propositions.

provide evidence for the first approach. We show that tag questions exhibit properties of *both* assertions and questions. The semantic import of the tag, we argue, arises from its rhetorical relation to the anchor.

2.2 Phonology

Intonational phonology is relevant to the interpretation of tag questions in two ways. First, the direction of the pitch at the end of the tag, i.e. rising vs. falling, influences the kind of question the tag asks. Second, intonational phrasing affects whether or not a neutral interpretation of the tag is allowed. We introduce here the To(nes) and B(reak) I(ndices) labelling scheme (Beckman and Elam 1997), which provides an abstract phonological representation for intonational tunes.

Intonational tunes in ToBI consist of a series of abstract high (H) and low (L) target tones and possess a minimal structure: intonational phrase consist of one or more intermediate phrases and a boundary tone – L% or H% – and intermediate phrases consist of one or more pitch accents and a phrase accent – L- or H-. Pitch accents –L*, H*, L+H*, L*+H, H*+!H – are tonal targets aligned with stressed syllables. The most prominent syllable in the sentence carries the nuclear pitch accent, which is assumed to be the last pitch accent in an intermediate phrase.

Final rising versus final falling intonation is (minimally) related to sequences of phrase accents and boundary tones. L-H% and H-H% sequences are both realized phonetically as a rise – i.e., a low rise versus a high rise – L-L% represents a fall, and H-L% is a high plateau. Note that on this view the unique tonal element associated with a rise is a H% boundary tone. Gunlogson (2003) (following Gussenhoven (1984)) provides an alternative analysis which defines final tunes in terms of the direction of the pitch contour from the nuclear pitch accent to the end of the intonational phrase. On this view, an L* H-L% sequence counts as a final rise, and there is no unique tonal element associated with rising intonation. We side step these issues in what follows and rely on an impressionistic definition of rising versus falling intonation.

The second aspect of phonology important for the interpretation of tag questions relates to intonational phrasing. Ladd (1981) draws a distinction between *nuclear* (annotated with a slash / between the anchor and tag) and *postnuclear* tags (annotated with an equal sign = between the anchor and tag). Nuclear tags, according to Ladd, "have a separate nucleus or nuclear pitch accent, generally proceeded in the rhythm of the sentence by a noticeable pause or intonational boundary", while postnuclear tags "have no separate nucleus, the pitch contour on the tag merely continuing the nuclear contour begun at the preceding nucleus in the main sentence; generally, too, there is noticeably less of a pause or boundary before the tag (p. 167)". Ladd argues that this distinction correlates with an interpretive effect, though he is vague as to what this effect is. We argue below that postnuclear tags admit a neutral question reading, which is absent in nuclear tags. McCawley (1988) and Huddleston and Pullum (2002) make the same observation.

Ladd's description of postnuclear tags is captured in ToBI with a single intonational phrase encompassing both the anchor and the tag. The nuclear pitch accent occurs in the anchor and no pitch accent occurs on any element of the tag. Nuclear tag questions would then consist of either two complete intonational phrases, or one, which itself contains two intermediate phrases. We find Ladd's description of postnuclear tags unintuitive, though we have no instrumental studies to back up these intuitions. It is difficult in our experience not to hear a pitch accent on the auxiliary verb in the tag, and most descriptions of tag questions, see Quirk et al. (1985) e.g., posit such an accent. Of course, it is possible that a postnuclear pitch accent exists, which is what Ladd appears to have had in mind, but this is a controversial claim and ruled out by the grammar of intonational tunes assumed in ToBI. Alternatively, it is possible that the perceived accent on the tag's auxiliary verb results from the alignment of a phrase accent there (Ladd 1996). We

do, however, agree with Ladd and the authors cited above that neutral readings of tag questions contain a weaker boundary between the anchor and tag than do nuclear tag questions. For these reasons, we prefer to recast the nuclear/postnuclear distinction in terms of intonational phrasing as follows: nuclear tag questions contain two complete intonational phrases, one for the anchor and one for the tag. Postnuclear tag questions consist of one intonational phrase that is composed of two intermediate phrases for the anchor and tag. We sketch an analysis below in which these prosodic differences conspire with syntax and semantics to yield two speech acts or one. In either case, the computation of the discourse function of the tag relative to the anchor proceeds in much the same fashion. However, we discuss how postnuclear prosody admits a neutral interpretation that nuclear prosody does not.

3 Tag Questions and Discourse Function

§3 addresses two issues regarding the alignment of the grammatical features from the previous section with discourse function. First, given the presence of both declarative and interrogative components, and the normal mapping of these to semantic interpretation, i.e. propositions and questions respectively, what kinds of discourse functions do tag questions serve? Are they assertions, questions, or both, as Quirk et al. (1985) suggest? The second question concerns the type of response expected by a tag question and how these expectations correlate with the phonological descriptions from §2.2.

3.1 Clausal Syntax, Semantics and Discourse Function

Sadock (1974) provides a number of useful diagnostics for illocutionary force based on co-occurrence restrictions between certain discourse markers and *sentence types* (Sadock and Zwicky 1985). The sentence initial parenthetical expression *after all*, for example, co-occurs with assertions, but not neutral questions, as in (3).

(3) a. A: It's fine if you don't finish the article today.
b. A: After all, your adviser is out of the country.
c. #A: After all, is your ad-visor out of the country?

The discourse markers *by any chance* and *tell me* appear with questions, but not assertions, as shown in (4) and (5).

(4) a. #John, by any chance, owns a car.
b. Does John, by any chance, own a car?

(5) Tell me, {#John owns a car. / does John own a car? }

In addition to distinguishing questions and assertions, *tell me* and *by any chance* distinguish between questions. *Tell me* - as a simple request for a response – is consistent with both neutral and biased question readings, while *by any chance* – as an expression of epistemic uncertainty – selects only neutral questions. As such, it does not appear with biased, or rhetorical questions.

3.1.1 Nuclear Tag Questions.

Applying Sadock's diagnostics to both rising and falling nuclear tag questions supports anlayses that treat them as "double-barreled" speech acts (Ladd 1981, Quirk et al. 1985). The felicity of *after all* in (6) and (7), for example, is evidence that the anchors in (6-b) and (7-b) are asserted.

(6) a. A: The conference should be exceptional this year.
b. A: After all, Julie is coming, / isn't she.

(7) a. A: The conference might be sub-par this year.
b. A: After all, Julie isn't coming, / is she.

(8-a) shows that nuclear tag questions are questions, while (8-b) shows that they are not *neutral* questions, since they fail Sadock's *by any chance* test.

(8) a. Tell me, Jane {is/isn't} coming, / {isn't/is} she.
b. #Jane {is/isn't} coming, by any chance, / {isn't/is} she.

The failure of nuclear tag questions to pass the *by any chance* test is not surprising, given the implications of (6) and (7). If the speaker *asserts* the anchor of a nuclear tag question, it follows that the tag can not be a neutral question, for by committing to the anchor, the speaker commits to a specific answer to the tag.

3.1.2 Postnuclear Tag Questions.

Sadock's tests produce a more nuanced set of observations when applied to postnuclear tag questions. Most notably, the polarity of the anchor appears to affect interpretation. Tag questions with positive anchors have the same distribution as nuclear tag questions: they are assertions, as shown by (9) and (10), and *tell me* questions, (11). However, they can not be neutral questions, as demonstrated by (12).

(9) a. A: Why is Nicholas so sure the conference will be dull?
b. A: After all, Julie is coming=isn't she?

(10) a. A: Pascal's not coming, so why is Nicholas so sure the conference will be a success?
b. A: After all, Julie isn't coming {#too/either}=is she?

(11) Tell me, Jane {is/isn't} coming={isn't/is} she?

(12) #Jane is coming, by any chance=isn't she?

Postnuclear tag questions with negative anchors, on the other hand, are ambiguous between biased and neutral readings. Sometimes they pattern with nuclear tag questions (like positive-anchor postnuclear tag questions) – see the instance of (10-b) with the negative polarity item *either*, but at other times permit a neutral question reading, as in the instance of (13) with the positive polarity item *too*.

(13) Jane isn't coming {too/#either},by any chance=is she?

The disambiguating role of polarity sensitive lexical items like *too* and *either* is important to explaining the difference. As Ladd (1981) notes, the licensing of polarity items in nuclear tag questions is predictable from the morpho-syntactic/semantic properties of the anchor alone: negative polarity items are licit in negative anchors and positive polarity items are licit in positive anchors. A similar observation holds for positive-anchor postnuclear tag questions: PPIs are licensed and NPIs are not. However, the expected correlation breaks down in negative-anchor postnuclear tag questions. Both NPIs and PPIs are licensed. However, the choice of polarity item affects the interpretation of the tag. Negative-anchor postnuclear tag questions with an NPI

pattern with nuclear tag questions; they are biased, as shown by (10-b), (11) and (13). Negative-anchor postnuclear tag questions containing a PPI, on the other hand, are neutral requests for information, as shown by (10-b), which establishes the *absence* of an assertion, and (13).

Ladd (1981), McCawley (1988) and Huddleston and Pullum (2002) all note that the neutral use of a tag question requires postnuclear prosody and a negative anchor. The Sadock's diagnostics verify this observations. But very little discussion of the interpretive role of negation in neutral tag questions is provided in these previous descriptions. Ladd (1981), for example, suggests that postnuclear prosody affects the scope of negation and McCawley (1988) assumes that the negation in neutral tag questions is "fake negation", i.e. an "instance of *n't* that doesn't count as negative for the purposes of syntactic rules that are sensitive to negation". Neither of these admittedly vague proposals suggests why "fake negation" permits a neutral reading.

We for an analysis close to the one espoused by Ladd (1981). Horn (1989) notes that metalinguistic negation, like McCawley (1988)'s "fake negation", neither licenses negative polarity items nor anti-licenses positive polarity items, as shown in (14) (Horn 1989).

(14) Chris didn't manage to solve {some/*any} of the problems, he managed to solve all of them.

The version of (14) that includes *any* sounds contradictory, for example, while the version containing *some* is only felicitous as a correction or denial of the scalar implicature associated with the use of *some*, viz. that Chris did not manage to solve *all* of the problems. Given the similarity of metalinguistic negation and the negation in neutral tag questions with respect to the licensing of polarity items, we assume that the latter negation is also metalinguistic. We understand metalinguistic negation $\sim \phi$ as equivalent with normal with wide scope with respect to an assertion operator, i.e. $\neg Assert(\phi)$[3] This analysis accounts for the observation in (10-b) that the anchor is not asserted.

3.2 Kinds of Questions

§3.1 draws a broad distinction between biased and neutral questions. We showed that nuclear tag questions and some postnuclear tag questions consist of both an *assertion* and a *question*, and are therefore biased. The remaining postnuclear tag questions did not to involve an assertion and are neutral. In this section, we discuss biased and neutral readings in more detail, drawing a distinction *within* the class of biased tag questions correlated with final tune and based on the speaker's degree of belief in the anchor.

3.2.1 Two Kinds of Biased Tag Question

Tag questions convey varying degrees of bias depending on the direction of the pitch over the tag. Falling intonation over the tag, for example, conveys a strong bias toward the proposition expressed by the anchor. Rising intonation, on the other hand, normally conveys some doubt or uncertainty by the speaker regarding the truth of the anchor and is therefore associated with a weak bias. Intuitively, falling intonation tag questions ask for *acknowledgement* of the anchor from the addressee, while rising intonation tag questions ask for confirmation (Rando 1980, Huddleston and Pullum 2002, a.o.).

The constructed dialogues in (15) and (16) illustrate the different uses associated with final intonation. In (15), *A* is trying to complete a task at which he is not proficient, but at which Julie

[3]This is a common analysis in three-valued logics with metalinguistic negation and assertion operators.

is. *B*'s utterance is intended to impugn *A*'s problem solving skills. In this context, (15-b) conveys no doubt regarding the truth of the anchor and the tag is intended to elicit an acknowledgement from *A* that the anchor is true, or at least that it is assumed to be true for the purposes of the present exchange, and therefore that how Julie would accomplish the task is irrelevant.

(15) a. A: [Julie]$_F$ wouldn't do it that way.
b. B: Well, Julie isn't here, / is she.

Huddleston and Pullum (2002) note that this usage is common in contexts where the anchor is obviously true. So, for example, acknowledgement questions are common when the anchor provides the speaker's evaluation of or commentary on a situation.

Tag questions with rising intonation are also biased toward the truth of the anchor. However, it is a weaker bias, as some doubt is expressed. Consider the dialogue in (16).

(16) a. A: Can Julie do it for us?
b. B: Julie isn't here, / is she?
c. A: She snuck in this morning.

B answers (16-a) by asserting that Julie is not present, but the final rise yields only a weak assertion. Intuitively, the tag is a request for confirmation: the speaker has a hunch that Julie is not in and requests evidence for or against this hunch.

We formalize these differences in discourse functional terms. Requests for acknowledgement are modelled on Asher and Lascarides (2003)'s *Acknowledgement* relation. An utterance is an acknowledgement, if it entails that the communicative goal of the utterance to which it is related has been achieved. Acknowledgement questions are related to the antecedent discourse with the relation *Acknowledgement*$_q$, which holds between discourse segments α and β just in case the answer γ to β entails that the goal of α has been achieved. In the indicative cases with which we are concerned in this paper, this communicative goal is normally the transfer of a belief from the speaker to the addressee.

Confirmation questions are requests for evidence or counterevidence on our analysis. In these cases, the anchor is only weakly asserted (thus the weak bias) and answers to the tag are expected to add probability mass to the anchor, or to subtract it. The response in (16-c), for example, provides evidence *against* the anchor. We define an SDRT relation, *Confirmation*$_q$, which captures these intuitions.

3.2.2 Neutral Questions

As shown in §3.1.2, tag questions are sometimes neutral requests for information. The dialogue in (17) shows the kind of discourse context where a neutral reading is natural.

(17) a. A: We need someone who has consulted for us before.
b. B: Julie isn't here = is she?

While this reading is naturally described as "neutral", there often is an expectation by the speaker for a positive answer. Huddleston and Pullum (2002) describe this expectation as an "emotive" component, noting that although the examples in (18) are relatively neutral, they convey a *fear* by the speaker that the positive answer is true. Ladd (1981) makes the same observation when he describes (19) as having a "worried anti-nuke" reading.

(18) a. It isn't raining again, = is it?
b. It isn't my turn already, = is it?

(19) They haven't restarted TMI already = have they?

This emotive component does not always convey a *fear* that the positive answer is true, as in (17-b), so an analysis must allow a wide range of attitudes toward the positive answer. We note in passing here that the existence of this attitude is consistent with our analysis of neutral tag questions as containing metalinguistic negation: conveying that one is not asserting ϕ at the very least introduces ϕ as a topic for discussion or suggests that ϕ is somehow relevant.

4 Some Formal Preliminaries

In §5, we develop an analysis in which the interpretation of tag questions is derived from the rhetorical connection of the tag to the anchor. This discourse functional account imposes two constraints on the formalism. First, it should represent rhetorical relations between utterances and assign them some semantic content. Second, it should say something about how rhetorical relations are inferred. The latter requirement is especially relevant in the context of this paper, as our objective is an account of the alignment of linguistic form and discourse function. Segmented Discourse Representation Theory (Asher and Lascarides 2003) meets each of these desiderata. SDRT models the rhetorical relations between utterances, assigns them a dynamic semantic interpretation and includes a "glue logic" that is responsible for building discourse logical forms. We present the basics of the formalism below.

4.1 Discourse Logical Form

Formally, an SDRS is a triple $\langle A, \mathcal{F}, LAST \rangle$, where A is a set of labels, *LAST* is the last label added to the SDRS, and $\mathcal{F}$ is a function from the set of labels A to SDRS-formulae. SDRS-formulae consist of labelled logical forms for individual clauses, e.g. $\pi : K_\pi$ for a DRS K (Kamp and Reyle 1993), relations between labels – $R(\pi_1, \pi_2)$, and the dynamic conjunction of SDRS formulae. The labels A in an SDRS are thought of as *speech act discourse referents*, and the rhetorical relations between labels are thought of as *relational speech act types*.

For *verdical* relations, $R(\pi_1, \pi_2)$ entails K_{π_1} and K_{π_2}, in addition to the semantic contribution of R, glossed ϕ_R. *Narration*, *Background* and *Result* are examples of veridical relations. If R is a *divergent* relation, on the other hand, $R(\alpha, \beta)$ entails $\neg K_\alpha$ and K_β. *Correction* and *Counterevidence* are divergent relations. Because both veridical and divergent relations entail the content of their right argument, they represent two sub-types of assertion. Relations corresponding to the logical connectives, i.e., *Consequence* and *Alternation*, are *nonveridical*, as they do not entail the truth of the discourse segments that they relate.

SDRT contains a logical system for computing discourse structure based on information available from syntax and compositional and lexical semantics. This logical system has two parts – the first is a glue logic that contains axioms for inferring relations between discourse segments. Because each discourse segment is assigned a unique label, the axioms exploit information about labels given by descriptions of the SDRS $\top$ assembled so far and of the new discourse constituent β to be linked to an available discourse constituent α. These descriptions specify discourse structures in terms of which segments are related to which other segments, and by saying in which larger segment that information is found. Thus, a binary discourse relation R (relating α and β say) is expressed in the description language as a three place predicate symbol $R(\alpha, \beta, \lambda)$, conveying the information that the constituent labelled by β stands in the relation R

to α and that this information is contained within the discourse segment labelled λ.

The axioms and rules of the glue logic exploit standard propositional logic connectives and a weak conditional operator $>$, which serves to represent defeasible rules about discourse structure. The general form of these rules is shown in (20).

(20) $(?(\alpha,\beta,\lambda) \wedge \text{Info}(\alpha,\beta,\top)) > R(\alpha,\beta,\lambda)$

(20) says that if β is to be attached to α in λ and certain information about α, β and the whole discourse structure $\top$ holds, then normally β is attaches with R to α in λ. Such normality conditionals support modus ponens defeasibly. Thus, when the left hand side formula holds, we can defeasibly infer $R(\alpha,\beta,\lambda)$. (Asher and Lascarides 2003) give a complete specification of the glue logic, in particular the defeasible consequence relation $\mid\!\sim$. Defeasible modus ponens is represented using $\mid\!\sim$ as follows:

(21) $A > B, A \mid\!\sim B$, but $A > B, A, \neg B \not\mid\!\sim B$

4.2 Logic of Cognitive Modelling

In order to compute relations in dialogue, SDRT makes use of an extension of the glue logic for reasoning about discourse participants' cognitive states known as the logic of *cognitive modelling*. This extension of the glue logic contains not only predicates relevant for computing discourse structure – propositional connectives and the weak conditional operator $>$ – but also modal operators $\mathcal{B}_A, \mathcal{B}_B, \ldots, I_A, I_B, \ldots$ – where A and B are agents – for belief and intention respectively. Recognizing intentions in dialogue requires at least shallow access to a model of the cognitive states of discourse participants; cognitive modelling provides this information. Thus, the logic includes axioms associating (by default) certain beliefs and intentions with utterances. We provide here a brief introduction to some of the axioms of cognitive modeling and refer the reader to Asher and Lascarides (2003) for more detail.

`Sincerity` and `Competence` associate beliefs with agents based on the content of the discourse. `Sincerity` encodes the first part of Grice's maxim of Quality: say only that which you believe to be true (Grice 1975).[4] In words, if it follows from the glue logic (which we assume forms part of linguistic competence) that β attaches to α with the rhetorical relation R, then normally the speaker of β believes that β attaches to α with R.

- `Sincerity`: $R(\alpha,\beta,\lambda) > \mathcal{B}_{S(\beta)} R(\alpha,\beta,\lambda)$
- `Competence`: $\mathcal{B}_A\phi > \mathcal{B}_B\phi$

together these axioms accomplish the normal communicative goal of assertions, viz. belief transfer. `Competence` says that whatever an agent A believes to be true, relative to a specific discourse or dialogue, is *normally* believed to be true by B.

Cognitive modelling also includes axioms associating default communicative goals with sentence types (Sadock and Zwicky 1985). These goals are also known as speech-act related goals, or SARGs. The default SARG of an indicative sentence, for example, is that the addressee believe its rhetorical contribution to the discourse. This is formalized in `Default Schema`, which states that if it follows from the information contained in the SDRS τ and the fact that β was said that $R(\alpha,\beta,\lambda)$, then normally the speaker intends the hearer to believe $R(\alpha,\beta,\lambda)$.

[4] $S(\beta)$ is the *speaker* of β and $H(\beta)$ is the *hearer*, or addressee.

- `Default Schema:`
  Suppose $Info(\tau) \wedge Done(Say(\beta)) \mid\!\sim R(\alpha,\beta,\lambda)$.
  Then: $Info(\tau) \wedge Done(Say(\beta)) \mid\!\sim \text{SARG}(\beta, \mathcal{B}_{H(\beta)}(R(\alpha,\beta,\lambda))$.

If R is a veridical relation and λ occurs in a veridical segment of the discourse, i.e. $\mathcal{F}(\lambda)$ must be true in order for the discourse as a whole to be true, then it is possible to derive a more specific SARG for indicative sentences, viz. $\text{SARG}(\beta, \mathcal{B}_{H(\beta)}(p_\beta))$.[5] This follows from `Default Schema` and the closure of belief under logical consequence. Recall that for veridical relations $R(\alpha,\beta)$ entails $K_\alpha \wedge K_\beta$. This information is transferred from the logic of information content into the logic of cognitive modelling: $R(\alpha,\beta,\lambda) \rightarrow p_\alpha \wedge p_\beta$. The more specific SARG follows from the axiom `Indicative Related Goals` (Asher and Lascarides 2003).[6]

For interrogative sentences, the SARG is for the speaker to believe an answer to the question. The relevant default is `QRG`. $Sanswer(\alpha, p)$ is a predicate in the logic of cognitive modelling that indicates that the propositional variable p is an answer to the question labeled α in the logic of information content. *Sanswer* is thus appropriately linked to the predicate *Answer* in the logic of information content,which is used to state the semantics of the relation *QAP* (Question-Answer Pair).

- `Question Related Goals (QRG):`
  $Sanswer(\alpha, p) > \text{SARG}(\alpha, \mathcal{B}_{S(\alpha)}p)$

Because these axioms are formulated as defaults, they can be over-ridden in the presence of more specific information. The axiom `Known Answers`, for example, blocks the default goal of a question when an answer is already believed.[7] In the context of an examination, for example, the consequent of `QRG` is blocked, because the examiner presumably knows the answer to his or her question and is interested instead to see if the student knows it.

Finally, we note that SARG's are linked to intentions by certain default axioms. For example, if $\text{SARG}(\alpha,\phi)$, then normally $I_{S(\alpha)}(\delta\phi)$. $\delta\phi$ is an action term formed from the formula ϕ by prefixing the "see to it that" operator. Asher and Lascarides (2003) also assume that the non-accidental, nonmonotonic, doxastic consequences of one's intentions are intended. They note that while this is a rather crude theory of intentions, it suffices to model communicative action.

5 Computing Discourse Function

We now sketch how to compute the interpretation of interrogative tags in our framework.

5.1 Acknowledgement Questions

Nuclear tag questions (and some postnuclear tag questions) with final falling intonation on the tag normally function as requests for acknowledgement and the expected answer to the tag entails that the addressee has adopted the communicative goal, or SARG, of the anchor. We model acknowledgement questions using the SDRT relation $Acknowledgement_q$. The glue logic axiom in (22) encodes the semantics of $Acknowledgment_q$ and provides sufficient reasons for inferring that $Acknowledgement_q$ links two discourse segments.

[5] p_β is a propositional term linked to K_β in the logic of information content by constraints on permissible models which guarantee that K_β and p_β are satisfied in the same worlds.

[6] Formally, `Indicative Related Goals` says that if $Info(\tau) \wedge Done(Say(\beta)) \mid\!\sim R(\alpha,\beta,\lambda)$, then $Info(\tau) \wedge Done(Say(\beta)) \wedge veridical(R) \wedge veridical(\lambda) \mid\!\sim \text{SARG}(\beta, \mathcal{B}_{H(\beta)}(p_\beta))$.

[7] `Known Answers` is formalized with the following default: $(Sanswer(\alpha, p) \wedge \mathcal{B}_{S(\alpha)}p) > \neg\text{SARG}(\alpha, \mathcal{B}_{S(\alpha)}p)$ (Asher and Lascarides 2003).

(22) `Axiom on Acknowledgement Questions`:
$(?(\alpha,\beta,\lambda) \wedge \text{SARG}(\alpha,\phi) \wedge \mathit{Sanswer}(\beta,p) \wedge (\mathcal{B}_{H(\alpha)}(p) > \mathcal{B}_{H(\alpha)}\phi)) >$
$\mathit{Acknowledgement}_Q(\alpha,\beta,\lambda)$

$\mathit{Acknowledgment}_q$ is the default relation linking the tag to the anchor, and in the absence of information to the contrary the tag is interpreted as an acknowledgment question. The antecedent to (22) follows from the axioms of the logic of cognitive modelling and compositional semantics of the anchor and tag alone, without any appeal to extra-linguistic information.

We restrict our attention here to tag questions uttered in veridical contexts. Thus, if τ is the SDRS for the discourse up to the point at which the tag is interpreted, and K_a is the content of the anchor, then $\tau \models K_a$. The constructed dialogue in (23) (repeated from §3.2) exemplifies the relevant usage. For nuclear tag questions, syntactic and phonological cues indicate the presence of two speech act referents, π_1 and π_2, as in (23-b).

(23) a. B: (π_0) Julie wouldn't do it that way.
b. A: (π_1) Julie isn't here, / (π_2) is she.

π_1 attaches to π_0 with a veridical relation R like *Contrast* and (we assume) within a veridical discourse segment. We show that the instance of `Axiom on Acknowledgement Questions` in (24) follows from compositional semantics and the axioms of the logic of cognitive modelling.

(24) a. $(?(\pi_1,\pi_2,\pi) \wedge$
b. $\text{SARG}(\pi_1, \mathcal{B}_B(p_{\pi_1})) \wedge$
c. $\mathit{Sanswer}(\pi_2, p_{\pi_1}) \wedge$
d. $(\mathcal{B}_B(p_{\pi_1}) > \mathcal{B}_B\mathcal{B}_B(p_{\pi_1}))) >$
e. $\mathit{Acknowledgement}_Q(\pi_1,\pi_2,\pi)$

The first conjunct in (24-a) follows from the syntactic relationship that holds between the anchor and the tag. Because tags are anaphorically dependent on the anchor – see §2.1 – they cannot attach higher than *LAST*, given SDRT's assumptions about anaphoric accessibility. (24-b) follows from the veridicality assumptions that we layed out above and `IRG`. Our veridicality assumptions amount to assuming that from $\mathit{Info}(\tau)$ and $\mathit{Done}(\mathit{Say}(\pi_1))$, that $R(\pi_0,\pi_1,\pi)$ follows, where R and π are veridical. This information satisfies the antecedent to `IRG`. Consequently, the SARG of the anchor is (by default) that the addressee believe its content.

The conjuncts (24-c) – (24-d) are more interesting. (24-c) follows from *A* and *B*'s shared knowledge of the compositional semantics of interrogative tags relative to the interpretation of the anchor, as discussed in §2.1. Given that *A* asserts π_1, *B* can infer by `Sincerity` that $\mathcal{B}_A(p_{\pi_1})$. Furthermore, from *A* and *B*'s shared knowledge of the compositional semantics of interrogatives, *B* infers that $\mathcal{B}_A(\mathit{Sanswer}(\pi_2, p_{\pi_1}))$. (24-d) is an *theorem* of the logic of cognitive modelling. Belief is a K45 modality and (24-d) is an instance of the 4 axiom (positive introspection). Therefore, in the absence of conflicting information, $\mathit{Acknowledgement}_q(\pi_1,\pi_2,\pi)$ follows. No deep reasoning about cognitive states was required, nor any situation specific information from world knowledge. The inference follows from conventional knowledge about the flow of information from linguistic form to default ascriptions of beliefs and intentions to discourse participants.

Finally, this analysis accounts for the strong bias of falling intonation (nuclear) tag questions. Because $\mathit{Acknlowledgement}_q$ links π_1 to π_2 in (23-b), a positive response – i.e., that Julie is here – does not count as an answer to the tag, despite the fact that this proposition is *semantically* an answer. This is because the positive response does not entail that the SARG of the anchor has been accepted or achieved.

5.2 Confirmation Questions

The semantic contribution of a final rise blocks the default inference of $Acknowledgment_q$. We sketch how this happens below and discuss the pragmatic effect of final rising tags, viz. their use as confirmation questions.

5.2.1 Final Rise Blocks $Acknowledgment_q$

We use Nilsenová (2006)'s modified analysis of final rising intonation, in which a final rise contributes an expression of epistemic uncertainty. However, whereas Nilsenová treats the rise as a propositional operator, we assume that it is an illocutionary operator. As such, it does not directly interact with propositional information. On our view, final rises express the speaker's attitude toward a proposition and its relation to the common ground with respect to the here and now, rather than provide information about the way that the world is.[8]

(25) `Sincerity for Final Rise`:
$\text{FINAL-RISE}(\alpha) > \mathcal{B}_{S(\alpha)}(\Diamond core\_content(p_\alpha))$

(25) says that if an utterance α ends in a final rise then $S(\alpha)$ normally believes the underlying proposition of α is possible. The underlying proposition associated with an utterance is the proposition that remains after stripping off any indicators of sentence mood.

As an illustration of how final rises block `Axiom on Acknowledgement Questions`, consider the dialogue in (26). π_1 attaches to π_0 with the right veridical discourse relation *QAP* (Question-Answer Pair).

(26) a. B: (π_0) Who is available to review this article?
b. A: (π_1) Jane is here, / (π_2) isn't she?

Lemma 1 follows from `IRG` and the relation between SARG's and intentions.[9] Γ contains the axioms of the logic of cognitive modelling.

Lemma 1. $\Gamma, Info(\tau), Done(Say(\pi_1)) \mid\sim I_A(\delta\mathcal{B}_B(p_{\pi_1}))$

Lemma 2 establishes an intention associated with the tag based on the presence of a final rise to the effect that *A* intends to see to it that *B* believe that the negation of the anchor is epistemically possible. Lemma 2 follows principally from `Sincerity for Final Rise` and the assumption that what follows from the doxastic consequences of one's intentions are also intended. Note that the core content of π_2 is the negation of the core content of π_1.

Lemma 2. $\Gamma, Info(\tau), Done(Say(\pi_2)), \text{FINAL-RISE}(\pi_2) \mid\sim I_A(\delta\mathcal{B}_B(\Diamond\neg p_{\pi_1}))$

Lemmas 1 and 2 together commit the speaker to inconsistent intentions, viz. that the addressee come to believe p_{π_1} and $\Diamond\neg p_{\pi_1}$. These propositions are inconsistent, and therefore cannot be simultaneously believed. Inconsistent intentions are ruled out by the axiom `Admissable Intentions` (Cohen and Levesque 1990). If two actions are inconsistent, then normally they are not both intended.

- `Admissible Intentions`:
$(I_A(a) \wedge \mathcal{B}_A(Done(a) > \neg Done(b)) > \neg I_A(b)$

[8] Our anlaysis is inspired by Faller (2006)'s analysis of evidential morphemes in Cuzco Quechua, which, according to Faller, enter into cognitive modelling.

[9] We omit the formal proofs of Lemmas 1 and 2 due to space limitations.

`Admissable Intentions` blocks either Lemma 1 or Lemma 2. In the latter case, it is still possible to infer *Acknowledgement*$_q$ and the final rise will serve some other pragmatic function, e.g. an indicator of politeness. In the former case, the default inference to *Acknowledgment*$_q$ is blocked, as it no longer follows that the SARG of the anchor is that the addressee believe its propositional content, paving the way for a confirmation question interpretation. We elaborate on this possibility below.

5.2.2 Inferring *Confirmation*$_q$

Recall from the discussion in §3.2 that confirmation questions are associated with a weak assertion of the anchor. This weak bias, we show below, follows from the presence of the final rise on the tag. Returning to (26), *B* infers given the rising intonation on π_2 and `Sincerity for Final Rise` that $\mathcal{B}_{S(\pi_2)}(\Diamond\neg p_{\pi_1})$. Further scalar reasoning yields the implicature that $\mathcal{B}_{S(\pi_2)}(\neg\Box\neg p_{\pi_1})$, which is equivalent to $\mathcal{B}_{S(\pi_2)}(\Diamond p_{\pi_1})$. Therefore, the rising intonation on the tag results in a weak assertion of the anchor.

We assume that the semantics of *Confirmation*$_q$ has a probabilistic core. The intuition is that the answer to a confirmation question should affect the probability assigned to an antecedent proposition by the questioner, be it by increasing it or decreasing it. That is, the answer should in some sense be *relevant* to the proposition to which the question is attached.

A consequence of this analyis, is that the probability of the proposition to which the question is attached can never be 1 or 0, i.e., it cannot be settled in the dialogue. If a speaker is certain – to the extent than any proposition is ever certain – that a given proposition is true, there is no reason to ask for confirmation of it. (Though one *could* ask for acknowledgement.)

Following Carnap (1950), we define a notion of relevance in a discourse τ:

- *relevant*$_\tau(p_\alpha, p_\beta)$ iff either $P_\tau(p_\alpha/p_\beta) > P_\tau(p_\alpha)$ or $P_\tau(p_\alpha/p_\beta) < P_\tau(p_\alpha)$.

With this auxiliary notion in hand, we can proceed to define the glue logic axiom for inferring *Confirmation*$_q$ in (27).

(27) `Axiom on Confirmation Questions`:
$(?(\alpha,\beta,\lambda) \wedge \mathit{Sanswer}(\beta, p) \wedge \mathit{relevant}_\top(p_\alpha, p)) > \mathit{Confirmation}_q(\alpha,\beta,\lambda)$

Because the anchor in (26-b) in effect asserts only that it is *possible* that Jane is here, direct answers to the tag, viz. that Jane is here or that Jane is not here, will both affect the probability of the anchor, either bumping it up to 1 or down to 0. The final rise played a pivotal role in this inference. First, it blocked the default inference to *Acknowledgement*$_q$. Second, it produced a weak assertion of the anchor, which was crucial to inferring *Confirmation*$_q$.

5.3 Neutral Tag Questions

Finally, we saw in §3.2 that some tag questions are neutral. (28-b) is a case in point. *A* (on the intended reading) does not commit herself to the proposition that Jane is here in uttering (28-b) in responding to (28-a). Intuitively, (28-b) attaches to (28-a) with the relation *Q-Elab*. *Q-Elab*(α,β) holds in case answers γ to β elaborate a plan for achieving $S(\alpha)$'s SARG of α. *B*'s SARG in uttering π_0 is to know who is available to review the article and answers to the tag question fill in this knowledge: a positive answer means Jane is available to review and a negative answer that she is not.

(28) a. B: We need someone to review this article ASAP! (π_0) Who is available?
b. A: (π_1) Jane isn't here,= (π_2) is she?

In §3.1.2, we argued that neutral interpretations are only available when the tag question has (i) "postnuclear" phonology and (ii) a meta-linguistic negation operator in the anchor. We describe how these two grammatical features conspire to admit neutral readings.

First, we assume that meta-linguistic negation is an illocutionary, rather than a propositional, operator. That is, it predicates some information of speech acts. Specifically, we take metalinguistic negation to indicate that the speaker is not asserting the proposition in its scope. We capture this with the axiom in (29).

(29) METALINGUISTIC-NEGATION$(\alpha) > \neg(\alpha : \textit{assertion})$

(29) constrains how a speech act discourse referent to which it applies can attach to the antecedent discourse; specifically, it rules out attachment with a relation pertinent to an assertion, i.e. a right-veridical relation. Relations associated with questions, for example *Q-Elab*, are not right-veridical and are consistent with (29).

Another way to think of the contribution of meta-linguistic negation is in terms of cognitive modelling. If a discourse segment does not attach with a right-veridical relation then it does not follow (necessarily) that the speaker believes its propositional content. In the case of tag questions, this means that `Known Answers` does not fire and the SARG of the tag is the default SARG given in `QRG`, viz. for the speaker to know an answer to the question.

What is the relationship between intonational phrasing and neutral interpretations; why can't nuclear tag questions have a neutral interpretation? The answer, we maintain, is related to the role of intonational phrasing in introducing discourse segments. Nuclear phrasing in tag questions forces two speech act discourse referents: one for the anchor and one for the tag. This segmentation is reinforced by the syntactic and semantic assumptions in §2.

Postnuclear tag questions, on the other hand, instantiate *complex speech act types*.[10] We assume that the grammar assigns postnuclear tag questions a "dot type" *assertion* • *question*. The component types of the complex type are exploited whenever there is a type clash. The glue logic predication $?(\alpha, \beta, \lambda)$, for example, assumes that β has a simple type. In the absence of conflicting information, then, postnuclear tag questions are interpreted in the same way as nuclear tag questions, i.e. either as acknowledgement or confirmation questions. Neutral uses, however, arise when the anchor contains a metalinguistic negation, which cancels the assertion per the constraint in (29). Thus, postnuclear phrasing and the presence of a metalinguistic negation operator conspire to admit the neutral reading exemplified by (28-b).

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[10] Reese (in preparation) provides further details on the analysis of tag questions as complex speech act types.

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