

What does *he* mean?

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Abstract

Empirical results on the meaning of accented pronouns often conflict. This is a problem for formal semantic models. In this paper, we intend to broaden the empirical basis of two of these models. First, in a corpus study, we checked whether properties of the antecedent influence whether a pronoun is be accented. We found that pronouns with NP antecedents are more likely to be accented than those with pronominal antecedents. In a production experiment, we investigate whether accented pronouns signal topic shifts. Although this effect is present in our data, it is very weak. We conclude that a comprehensive model of pronoun accentuation will need to account for the fact that in most cases, that accent appears to be optional. In fact, most instances of accented pronouns in our data could be explained as signs of a rhetorical contrast.

Introduction

In order to interpret a personal pronoun, a listener needs to determine which discourse entity or entities the pronoun specifies. Since pronouns themselves carry very little semantic information, the listener needs to tap into a variety of information sources in order to find out which discourse entity a given pronoun specify: lists of salient discourse entities, grammatical conventions, discourse structure, assumptions about the discourse model of the speaker, and so on.

Formal work on pronoun interpretation has focussed on written language. In this paper, we explore how the insights gained so far can be translated to speech, where phrasing and accentuation might provide important cues to resolution algorithms. Most semanticists take accent on pronouns to signal somewhat “unusual” resolution strategies. In particular, accented pronouns are assumed to signal topic shifts. But do the theories developed so far describe successfully how accented pronouns actually used in speech? This is the question we ask here.

Our paper is organised as follows: First, we sketch the theoretical basis of our analyses, the work of [Nakatani, 1997] and [Kameyama, 1997]. Then, we explore to what extent the patterns postulated by the theories can indeed be found in corpus data and experimental data. Finally, we discuss the consequences of our results for semantic and cognitive approaches to resolving accented pronouns.

Theoretical Claims

It is not clear what exactly speakers mean when they accent a third person personal pronoun. Some people apparently accent a pronoun if the distance in clauses between pronoun and antecedent is larger than usual [Givón, 1983]. A number of sample discourses that have been discussed extensively in the literature [Kameyama, 1997, Beaver, 2000] show that when substituted for their unaccented counterpart in a given discourse, accented pronouns are frequently resolved to a different discourse entity. In the following example, most listeners would resolve the unaccented pronoun in (2) to Ian, whereas the accented pronoun in (3) would be resolved to James.

- (1) Ian_i often meets James_j for dinner.
- (2) He_i prefers Italian restaurants.
- (3) HE_j prefers Italian restaurants.

We will now examine two theoretical analyses of accented pronouns.

Nakatani: Shifts in Attentional State

Christine Nakatani develops a model of stressed pronouns in terms of attentional state [Nakatani, 1997]. Her framework is Centering Theory [Grosz et al., 1995]. The goal of Centering is to develop a theory of *local* discourse structure, i.e. to describe what makes a discourse segment coherent. From a psycholinguistic point of view, Centering models how the attentional state of speaker and hearer change during a discourse. Each attentional state contains a set of discourse entities which are the current “centers” of attention – hence the name “Centering”.

In the Centering model, each sentence is associated with a list of the discourse entities which have been realised in that sentence. These discourse entities constitute the list of *forward-looking centers*. The forward-looking centers are ranked according to their salience. The most salient center on the list is called the *preferred forward-looking center* C_p . The most salient entity of the previous utterance U_{n-1} that is realised in the current utterance U_n is the *backward-looking center* C_b . Each sentence has at most one C_b . Transitions between sentences can be classified according to two criteria:

1. whether the backward-looking center of the current sentence is the same as that of the previous sentence

$$(C_b(U_n) = C_b(U_{n-1}))$$

- whether the backward-looking center of the current utterance is also the most salient entity of that utterance, i.e. the preferred forward-looking center ($C_b(U_n) = C_p(U_n)$)

When the C_b is both maintained and $C_p(U_n)$, we get a *continue* transition. When the C_b is no longer $C_p(U_n)$, the transition is classified as a *retain*, and when the C_b changes, we have a *shift* transition. [Brennan et al., 1987] introduce two kinds of shifts: in *smooth* shifts, the new C_b is also C_p , in *rough* shifts, the new C_b is not the most salient entity in the utterance.

In order to determine the connection between accented pronouns and attentional state, Nakatani analysed a monologue by a gay male native speaker of American English in terms of local and global discourse structure. She found 25 accented subject pronouns; accented object pronouns were even rarer. Of these, 7 occurred when the transition was a smooth shift, and 9 co-occurred with shifts to the backward-looking center of the preceding discourse segment. 6 of the 9 remaining cases were contrastive, 3 required limited inference. Within the Centering framework, accent on a subject pronoun means that the speaker has shifted to a new C_b , to a new “main center of attention”. Whether the C_b comes from the same or the preceding segment appears to be irrelevant. The results of [Brennan, 1995] support this analysis. In her spontaneous monologues, pronouns tended to be accented when the antecedent was not the backward-looking center.

Kameyama: Competing Influences

In contrast to Nakatani, [Kameyama, 1997] presents an integrated model of pronoun resolution that draws on several sources. Her approach has the advantage that it sits well with current constraint-based approaches to linguistics such as Optimality Theory [Prince and Smolensky, 1993].

Centering Theory provides the backbone of Kameyama’s work: the discourse entities of each utterance are grouped into a partially ordered list, and when a pronoun occurs, it is resolved to the most salient discourse entity in the preceding utterance that is mentioned again in the current utterance. Kameyama calls this discourse entity the *center*. The salience of the discourse entities in an utterance is determined by several potentially conflicting factors. In Kameyama’s algorithm for pronoun resolution, the first step is to filter out all referents in the attentional state which violate the highest ranked syntactic and semantic constraints. An example for such a high-ranking syntactic constraint is agreement: masculine personal pronouns in English usually refer to male persons.¹ Then, parallelism, attentional structure (salience), and commonsense inference conspire to yield a basic preference order on

¹Cases in which that constraint is violated, e.g. females are mistaken for males, are comparatively rare.

the remaining referents which are compatible with the pronoun. The most highly ranked entity on that list becomes *center*, the preferred antecedent for a pronoun in the next sentence.

When the pronoun to be resolved is accented, this reverses the preference order imposed on the list of potential antecedents: the accented pronoun is then taken to refer to the least prominent DR on that list. Note that the order is only reversed *after* high-ranking syntactic and semantic constraints have been considered, so that the antecedents still in the list are indeed viable alternatives. Kameyama thus predicts that accentuation will have no effect when there is only one potential antecedent. She also predicts that stressing the pronoun will not resolve any ambiguity if all potential antecedents are equally salient.

In her paper, Kameyama focusses on two factors that affect salience: the form of the antecedent, which is captured by the *exp order* hierarchy, and the syntactic function of the antecedent, which is captured by the *gr order* hierarchy. On the *exp order* scale, pronouns are more salient than definite NPs, while on the *gr order* scale, subjects are more salient than direct objects, which are in turn more salient than indirect objects or adjuncts. The most salient discourse entity in U_{n-1} is the most likely antecedent for a pronoun in U_n . For example, Kameyama predicts that if a subject pronoun can be resolved to both the subject and the object of the preceding sentence U_{n-1} , and if both subject and object are definite NPs, then the pronoun in U_n will be resolved to the subject of U_{n-1} if it is not accented, and to the object if it is accented, because the subject is more salient than the object.

Bender, Mayer, and Dogil tested that prediction for German [Bender et al., 1996]. They synthesised various short discourses consisting of two sentences. The first sentences had SVO structure; in the second sentence, the subject was pronominalised. In half of the discourses, the second sentence also contained an object pronoun. The subject pronoun was either unaccented or bore one of a number of potential pitch accents. In a 60-minute experiment, listeners were presented with all possible combinations of discourses. For each discourse, they had to indicate the correct interpretation by pointing to a picture. There were four alternatives per discourse. One picture depicted the situation where the pronominal subject of U_n was resolved to the subject of U_{n-1} , one the situation where the pronoun was resolved to the object of U_{n-1} . The other pictures were distractors. They found that the listeners almost never resolved the pronoun to the object NP, even if it was accented. The experiments can be criticised on numerous counts. In particular, the prominence relations between subject and object in the target sentence may not have been realised appropriately [Mayer, 1997]. Still, the experiment demonstrates that the influence of accentuation on pronoun resolution might be more subtle than introspection and corpus studies suggest.

Conclusion: Which Evidence is Needed?

The evidence we have surveyed in the preceding paragraphs is conflicting. On one hand, the contexts in which accented pronouns occur do differ markedly from those in which unaccented ones occur. However, it is still not clear what the main function of a pitch accent on a pronoun is. Nakatani’s and Brennan’s speakers consistently used them to mark what we term “topic shifts”², and Givón’s speaker uses accents to mark that the discourse entity the pronoun co-specifies with was last mentioned two or more clauses ago. On the other hand, the listeners of Bender, Dogil, and Mayer apparently did not care whether a pronoun was accented or not, they just went for the default interpretation.

In order to untangle this confusion, we first of all need to supplement the published data with other analyses from a variety of speakers with different socio-cultural backgrounds. In this paper, we report results from two main lines of attack, corpus analyses and production experiments. First, in an analysis of the speech of American radio news readers, we tested some hypotheses that follow from Kameyama’s theory. Second, we conducted a production experiment to check to what extent topic shifts influence whether a pronoun will be accented or not.

The Influence of *gr order* on accentuation

Goal of the Study

The goal of this corpus study is to determine some basic conditions under which subject pronouns can be accented. To this end, we examined three speakers from a large corpus of read speech, the Boston University Radio News corpus [Ostendorf et al., 1995]. Since our data comes from read speech, the results may be affected by the speakers’ varying ability to read aloud—just as the monologue data is affected by the idiosyncrasies that the speakers exhibit in their speech.

The part of Kameyama’s theory that is worked out in detail in [Kameyama, 1997] makes predictions about the accentuation of subject pronouns in cases where the antecedent occurs in the preceding sentence. The main problem with testing her hypotheses on corpus data is that in our radio news texts, almost all potentially ambiguous pronouns are disambiguated semantically by the sentence they occur in. Therefore, we can only examine to what extent violations of the two constraints *gr order* and *exp order* can predict whether a pronoun is accented.

Data

We chose the Boston Radio News Corpus because it is widely available and widely used in the speech community. It provides ToBI-labelled samples of seven professional American newscasters who worked for the Boston, Mass., radio station WBUR at the time of the recordings. From the corpus, we analysed the prosodically annotated radio stories from three speakers, f2b,

²Following [Beaver, 2000], we make a terminological shift here and interpret C_b as the *topic* of a sentence.

Table 1: Overview of Radio News Texts

Speaker	f2b	m1b	m2b
No. of Texts	32	9	4
No. of Sequences Analysed	229	45	19
No. of 3rd Sg. Pron. Subj. in U_n	122	22	8
% of These Accented	38.5%	32.8%	0

m1b and m2b. All speakers write their own copy. Table 1 provides summary statistics about the texts we used.

We look at sequences of two units, U_{n-1} and U_n . Following [Kameyama, 1998], our units are tensed clauses, with one exception: tensed relative clauses that modify NPs are assigned to the unit they occur in. We excluded all sequences of two units where the antecedent of the subject did not occur within the analysis window. This ensures that our analyses is restricted to just those contexts for which the theory we are testing can make any predictions. All sequences that conformed to our criteria were labelled according to four features, *grammatical function* of the antecedent in U_{n-1} (subject, object, adjunct), *form of the antecedent* in U_{n-1} (zero/pronoun/other), *form of the subject* of U_n (zero/pronoun/other), and *accentuation of the subject* of U_n (yes/no).³ The annotations were performed by one of the authors, a trained linguist, and cross-checked by the other.

Since the brief reports we are dealing with here frequently present conflicting views and opinions on a certain topic, sentence topics are rarely maintained over several units. Secondly, many sentences are constructed according to the pattern “X said that Y”, where, strictly speaking, “X said” and “Y” are separate clauses. The reason for this is that the journalistic code of conduct requires journalists to name the source of their information. f2b, who writes her own news copy and supplied most of our data, is particularly conscientious in this respect. Therefore, when the current or previous clause is of the form “X said”, we extend our window of analysis to include U_{n-2} . Finally, in comparison to spontaneous speech, these speakers “overaccent”. This is part and parcel of the distinctive, neutral speaking style is required of news readers. Hence, our results are restricted to a specific communication situation.

Results

The results are summarised in Table 2. Speakers do not tend to accent pronouns when their antecedent is not the subject (Fisher’s exact test: $p < 0.6$, $df=1$). Instead, the form of the antecedent, which is covered by Kameyama’s *exp order* constraint, exerts a significant influence: whereas 40% of all subject pronouns with NP antecedents are accented, only 18.5% of pronouns with pronominal antecedents carry a pitch accent (Fisher’s exact test: $p < 0.05$, $df=1$). This result is surprising, given

³We did not calculate κ for our annotations since the features are extremely straightforward.

Table 2: Accentuation of 3rd Pers. Sg. Subject Pronouns

	<i>subject</i>	<i>other</i>	total
<i>pronoun</i>	58%	0.00%	18.5%
<i>not pronoun</i>	41%	22.73%	40%
total	37%	29%	36%

that most formal models operate heavily with salience orderings based on grammatical roles.

A further analysis reveals that although most of these accented pronouns cannot really be analysed as topic shifts, most are involved in some sort of contrast. Take for example text s14, read by f2b, which is about two democratic contenders for the post of state attorney. It has the highest number of stressed pronouns of all texts, five. In four of these cases, the accented pronoun implies a contrast between the two candidates. Only two of the accented pronouns occur in explicit contrasts. In the two other cases, the accent on the pronoun highlights a potential contrast between the two candidates, the exact nature of which has to be inferred from the text.

Does Accent Signal a Topic Shift?

Kameyama predicts that a subject pronoun in an utterance U_n should be accented if it co-specifies with the object of U_{n-1} only if a higher-ranking discourse entity in U_{n-1} would also be a possible antecedent. If there is only one possible antecedent, there should be no accent on the subject pronoun, because it does not make sense to re-order a list with only one element. On the other hand, Nakatani’s data shows that speakers may accent pronouns to mark a topic shift. So, if the main motivation behind accent on pronouns is to signal topic shifts, we would expect speakers to accent pronouns even if they can be resolved unambiguously to the correct antecedent. If accent is a cue to topic shifts in general, we would expect a similar effect when the new topic is expressed by a definite NP.

We examined these questions in a small production experiment. The main hypothesis was that accent is a cue to topic shifts in general: if the subject of U_n co-specifies with the object of U_{n-1} , it is accented, but not when it co-specifies with the subject—even if subject and object differ in gender. We also wanted to find out whether that effect is stronger for pronouns than for full NPs, since the presence of a full NP in subject position is in itself a sufficient cue to a topic shift.

Design

In order to test our hypotheses, we created a set of four-sentence discourses. The first sentence in each discourse, S1, introduces a person P1 in subject position with a proper name. In the second sentence, S2, P1 appears again in subject position, and a second person, P2, is introduced in object position with a proper name. Both persons differ in gender.

The third sentence, S3, is the key sentence. Its structure is varied according to the two variables \pm SHIFT and

\pm PRO:

- \pm SHIFT: The subject of S3 is either P1, i.e. the subject of S2 (+ SHIFT), or P2, i.e. the object of S2 (- SHIFT)
- \pm PRO: The subject of S3 is either a pronoun (+ PRO) or a semantically empty definite NP (- PRO), “the girl” for female, “the guy” for male referents.

Combining these variables yields four experimental conditions: +SHIFT+PRO, +SHIFT-PRO, -SHIFT+PRO, and -SHIFT-PRO

Apart from the subject, no other discourse entities from S2 are mentioned in S3. This way, we avoid potential violations of Centering’s definition of C_b , which states that the highest-ranked center of U_{n-1} that is realised in U_n is the C_b of U_n . The final sentence, S4, maintains the subject of S3. The subjects of S2 and S4 are always pronouns. The key sentences S2 and S3 contained no left-dislocated arguments, and the subject in sentences S2 and S3 is always an agent.

We kept the structure of the sentences as simple as possible so that the subjects had less trouble reading them out loud. We also changed the content of S3 and S4 depending on the subject, so that the discourses were both semantically and syntactically unambiguous. There are four possible combinations of conditions, and for each of these combinations, we created three discourses. A sample set of discourses is given in Figure 1.

Method

We divided these discourses into four lists of six discourses each, so that each list contained each condition at least once. Each of these lists was mixed with a list of discourses for two other experiments on intonational meaning and presented to five readers, yielding a total of 20 subjects. We limited the number of discourses per speaker because the experiment was interleaved with two other production experiments and we aimed to keep the total duration of the experiment below twenty minutes, in order not to strain our subjects’ voices too much. Because of the small scale of our study, we unfortunately cannot present data on subject-specific variation. All in all, we collected 120 discourses, 30 per condition.

All of our subjects were undergraduates at Stanford University who did not major in Linguistics. One or two of the subjects had a slight cold. Although their mother tongue was American English, they came from different parts of country. They were paid for their participation at a standard rate of \$10 per hour. The discourses were recorded in a sound-deadened room. Before the recording was started, the subjects were asked to read through each dialogue. The list of discourses to be analysed later was preceded by four practice discourses. Each discourse was printed in large type on a separate page. The subjects were instructed to read each discourse silently first, make sure they understood what was meant, and then read it out aloud as if they were talking to a friend.

Figure 1: Sample set of four discourses with P1=Julia, P2=Nathan

		S1: Julia _{P1} went to a bar last night.	
		S2: She _{P1} chatted with Nathan _{P2} for a while.	
	-SHIFT		+SHIFT
+PRO	S3	She _{P1} also spent some time at the bar.	He _{P2} had been waiting for this chance for ages.
	S4	Afterwards, she _{P1} was really tired.	He _{P2} had always thought that Julia _{P1} was a nice girl.
-PRO	S3	The girl _{P1} also spent some time at the bar.	The guy _{P2} had been waiting for this chance for ages.
	S4	Afterwards, she _{P1} was really tired.	He _{P2} had always thought that Julia _{P1} was a nice girl.

None of the subjects reported any difficulties in understanding any of the discourses.

Due to misreadings which were not caught at the time of the recordings, five discourses had to be discarded, which leaves us with a total of 115 discourses. We then randomly discarded another seven discourses, in order to achieve an equal number of samples in each condition. This brings the total number of instances per condition down to 27.

We analysed the discourses both acoustically and perceptually. On the acoustic level, we computed mean, maximum, and range (= maximum F0 - minimum F0) of the logarithm of F0 for all subjects of the third sentence of each discourse. This transformation yields an approximately normal distribution of F0 values. F0 was computed using the `get_f0` program of Entropic ESPS Waves ⁴ We transformed mean, maximum and range to z-scores based on the mean and standard deviation of a speaker's F0 during the current discourse. These z-scores were then submitted to a statistical analysis. We assume that accentuation will lead to a higher F0 maximum and a higher mean F0. We did not compare durations, since we did not find a satisfactory normalisation procedure.

On the perceptual level, we determined for all discourses whether the subject of S3 was accented, and whether it had been reduced. The definite NPs count as reduced if a speaker has shortened the nucleus of "guy" or "girl"; the pronouns count as reduced if a speaker has replaced the high front vowel of the citation form with a central vowel. These criteria allow for a wide range of dialectal and idiolectal variation in the realisation of the vowels in the target nouns and pronouns. All judgements were made by a trained phonetician; the transcriptions were checked using sonagrams and pitch contours. Table 3 summarises the frequency of accentuations and reductions of each word. The nouns are almost always accented, and rarely reduced. The pronoun "she" is reduced often, sometimes to just the alveopalatal fricative /j/, and rarely accented.

Results

First, we examine the acoustic results. If our main hypothesis is correct, then both nouns and pronouns should be more prosodically prominent when SHIFT is violated.

⁴The target words were almost never spoken with creaky voice, although the register occurs frequently in our data: almost all female speakers use it to mark the end of a sentence.

Table 3: Frequency of accentuation and reduction

	<i>girl</i>	<i>guy</i>	nouns	<i>he</i>	<i>she</i>	pron.
total	25	29	54	23	31	54
% red.	24%	17%	20%	30%	64%	50%
% acc.	100%	97%	98%	26%	13%	18%

That is, mean and maximum F0 should be higher when the constraint is violated. The raw means presented in Table 4 support this hypothesis for pronouns, but not for nouns. Although the average F0 on pronouns in the +SHIFT-condition is about as high as the average F0 of nouns, this is not necessarily due to a pitch accent. Rather, what we have in many of these cases is a high onset, which is often used to mark paragraph boundaries. For definite NPs, the effect appears to be *reversed*; here, F0 is higher when the topic is maintained than when it shifts.

However, the clear tendencies in Table 4 are not statistically significant. Since the data are not normally distributed, we used the Kruskal-Wallis test to determine whether the presence of a shift significantly affects F0; the number of degrees of freedom is always 1. The test was computed over z-scores, not over absolute values, because z-scores help factor out a large part of the interspeaker differences. For nouns, there is no effect of a shift, both for the z-scores of mean F0 (Kruskal-Wallis $\chi^2=0.0037, p<1$) and for the z-scores of maximum F0 (K.-W. $\chi^2=2.01, p\text{-value}<0.2$). We also do not see an effect for pronouns at the gradient level, neither for mean F0 (K.-W. $\chi^2=1.77, p<0.2$) nor for maximum F0 (K.-W. $\chi^2=1.70, p<0.2$). There is a slight effect on the categorical level: pronouns are more likely to be accented in cases of topic shift (Fisher's exact test, $p<0.1$, $df=1$, power 0.84). In the +SHIFT condition, 30% of all pronouns were accented, in the -SHIFT condition, 8%. Although the percentages appear huge, note that the absolute numbers are small, which leads to the realistic level of $p<0.1$.

Discussion

The patterns we found in the data suggest the hypothesis that speakers may signal topic shifts by accenting pronouns—or at least by making them more prosodically prominent. However, this cue is restricted to pronouns; if a full NP occurs in the subject position, it need not be

Table 4: Effect of conditions on mean and maximum F0 (in Hz; mean \pm standard deviation)

	-SHIFT		+SHIFT	
	mean F0	max F0	mean F0	max F0
-PRO	180 \pm 54	221 \pm 65	179 \pm 53	211 \pm 62
+PRO	173 \pm 77	183 \pm 78	199 \pm 69	212 \pm 85

accented, because the switch from pronoun to full NP is enough.

There are several reasons why these patterns did not turn out to be significant. For one, we need to control the potential emphatic or contrastive foci in S3 more stringently. For example, in the sentence “X had to explain all the algorithms twice.” almost all of our subjects stressed “all”, “algorithms”, and “twice”. But the main problem was that speaking styles vary considerably. Some speakers produced very stereotypical, monotonous intonation contours, while others read the discourses almost naturally. Therefore, we will switch to a design based on spontaneous speech in follow-up experiments, which will also incorporate a dedicated speaker factor. The power of the statistical tests, which was between 0.3 and 0.4, will also need to be increased.

Conclusion

What does it mean to accent a pronoun? The data we have examined, both in the corpus study and the production experiment, do not support either Nakatani’s or Kameyama’s models of pronominal accent. Thus our studies underline the need for further theoretical and empirical work in this area.

In our data, two trends can be discerned: Firstly, any formal semantic theory of accented pronouns needs to deal with the fact that in many cases, this accent may be *optional*. To what extent speaking style influences whether speakers will choose to accent a pronoun, and to what extent accented pronouns aid comprehension, needs to be investigated by future experiments. Secondly, most of the accented pronouns in our corpus data could be interpreted as cues to some sort of contrast. Often, that contrast was not directly obvious from the context; Listeners need to construct a contrast based on their interpretation of a text to accommodate the presence of the accent on the pronoun. We are currently working on an optimality theoretic account of stressed pronouns that incorporates this finding.

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References

- [Beaver, 2000] Beaver, D. (2000). Centering in optimal theory. Department of Linguistics, Stanford University.
- [Bender et al., 1996] Bender, A., Dogil, G., and Mayer, J. (1996). Prosodic disambiguation of anaphoric pronouns in German discourses. In *UCREL Technical Papers, Vol.8 – Special Issue: Approaches to Discourse Anaphora: Proceedings of DAARC-96, Lancaster, July 17-18, 1996*, pages 28–39.
- [Brennan, 1995] Brennan, S. E. (1995). Centering attention in discourse. *Language and Cognitive Processes*, 10(2):137–167.
- [Brennan et al., 1987] Brennan, S. E., Friedman, M. W., and Pollard, C. J. (1987). A centering approach to pronouns. In *Proceedings of the 25th Annual Meeting of the Association for Computational Linguistics*, Stanford, CA, 6–9 July 1987, pages 155–162.
- [Givón, 1983] Givón, T. (1983). Topic continuity in spoken English. In Givón, T., editor, *Topic Continuity in Discourse*, pages 343–364, Amsterdam; Philadelphia, PA. John Benjamins.
- [Grosz et al., 1995] Grosz, B. J., Joshi, A. K., and Weinstein, S. (1995). Centering: A framework for modeling the local coherence of discourse. *Computational Linguistics*, 21(2):203–225.
- [Kameyama, 1997] Kameyama, M. (1997). Stressed and unstressed pronouns: Complementary preferences. In Bosch, P. and van der Sandt, R., editors, *Focus: Linguistic, Cognitive and Computational Perspectives*. Cambridge University Press.
- [Kameyama, 1998] Kameyama, M. (1998). Intrasentential centering: A case study. In Walker, M. A., Joshi, A. K., and Prince, E., editors, *Centering Theory in Discourse*, pages 89–112. Oxford University Press.
- [Mayer, 1997] Mayer, J. (1997). Intonation und Bedeutung. Arbeitspapiere des Instituts für maschinelle Sprachverarbeitung, Stuttgart 4(3), Institut für Maschinelle Sprachverarbeitung, Universität Stuttgart.
- [Nakatani, 1997] Nakatani, C. (1997). *The Computational Processing of Intonational Prominence: A Functional Prosody Perspective*. PhD thesis, Harvard University.
- [Ostendorf et al., 1995] Ostendorf, M., Price, P., and Shattuck-Hufnagel, S. (1995). The Boston University radio news corpus. Technical report, Boston University.
- [Prince and Smolensky, 1993] Prince, A. and Smolensky, P. (1993). Optimality theory: Constraint interaction in generative grammar. Technical Report 2, Rutgers University Center for Cognitive Science RuCCS.