

# PRODUCTION OF DEACCENTING UNDER REPETITION, ENTAILMENT, AND BRIDGING: PHONETIC AND PERCEPTUAL COMPARISONS

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## ABSTRACT

The claim that deaccenting of a constituent can be licensed by an entailment or bridging relation in addition to overt instantiation in the prior discourse context has generally not been the subject of rigorous empirical investigation. In a production study, participants read verbs that were new to the discourse, overtly instantiated in an antecedent, or made available via entailment or a bridging inference. Analysis of  $f_0$ , intensity, duration, and naive judgments of prominence largely failed to detect evidence that verbs made available by inferencing relations were pronounced with less prominence than those that were new to the discourse, whereas verbs that were overtly instantiated in the prior discourse were reliably deaccented. The results call into question the claim that deaccenting can be licensed by inferencing relations and motivate further study of deaccenting under non-identity.

**Keywords:** deaccenting, licensing, inference, emphasis, discourse

## 1. INTRODUCTION

Although the exact implementations vary, all theories of accent in English must account for the close connection between a constituent's discourse availability and its accent status [12, 10, 6, 7, 13, 9, 15]. One proposal is that a constituent can be deaccented if it has been instantiated in a structurally isomorphic position in the prior linguistic context. For instance, in the sentence *Mary saw John, then Bill saw Sue*, the second *saw* can be deaccented because it appears in a prior clause of the form  $x \text{ saw } y$  [13].

Notably, it has been proposed that constituents count as "instantiated" in the discourse both when they have been pronounced and when they are inferable [6, 7, 13, 9]. For instance, Rooth [7] and Tancredi [13] posit that in *She called him a Republican, and then he insulted her*, the verb *insulted* can felicitously be deaccented if it is assumed that calling someone a Republican constitutes insulting them,

meaning *insult* was instantiated in the prior context. Tancredi further suggests that context-specific world knowledge can further mediate judgments of deaccenting felicitousness - a listener at the Republican National Convention would be less likely to accept that *insult* was instantiated in the discourse context than one at the Democratic National Convention.

There has not been rigorous empirical investigation of the felicitousness of the deaccenting of constituents made available by entailment, bridging, or other inference relations. The examples cited in the literature are marked as acceptable solely on the basis of introspective judgments, and it is far from clear that they are of the same status as constituents that are canonically deaccented under exact identity with a linguistic antecedent. The goal of the present paper is to initiate the empirical investigation of deaccenting licensing under inference relations through the analysis of phonetic correlates of accent and naive perceptual judgments of emphasis for verbs that are overtly instantiated in the prior discourse, made available by entailment or a bridging inference, or completely new to the discourse.

## 2. EXPERIMENT 1: PRODUCTION

Experiment 1 examined the production of verbs that were new to the discourse, verbs inferable from the prior discourse via entailment or bridging, and verbs overtly instantiated in the prior discourse. Canonically, a verb that is fully new to the discourse context should be pronounced with emphasis, while a verb that is overtly instantiated in the prior discourse and appears in a structurally isomorphic position should be pronounced without emphasis [4, 5]. The goal of the experiment was to compare the production of inferable verbs to the production of repeated and new verbs to determine whether verbs made available by an inferencing relation can be deaccented.

### 2.1. Design and stimuli

Participants read sentences of the form *SVO and SVO*, where the second verb was the constituent of

interest. The sentences were embedded in carrier paragraphs that did not make any of the critical sentence constituents discursively available. In the critical sentence, the number of syllables prior to the onset of the second *SVO* clause was held constant for all trials. The second-clause subject was always a one-syllable proper name, the second-clause verb was always a two-syllable word with iambic stress, and the second-clause object was always a two-syllable proper name with trochaic stress. These stress patterns were chosen only for consistency between items and are not taken as theoretically meaningful. The second subject was always new to the discourse, while the second object was always repeated.

12 critical items were constructed in 3 conditions. The critical second *SVO* clause was constant by item. The verb in the first clause was manipulated so that the second verb would be completely new to the discourse (*unrelated*), available via an inferencing relation (*related*), or identical to the first-clause verb (*repeated*). In 6 items, the relation between related verbs was one of entailment (e.g., *hugged-embraced*). For the other 6 items, the relation was a possible bridging inference linking the verbs (*charmed-seduced*). These labels are used in spite of the fact that the constituents are not propositions; Schwarzschild [9] presents a strategy for accounting for this. The strengths of the inferencing relations linking the verbs were normed in a separate study (“Given that you know **Ron hugged Laura**, how likely do you think it is that **Ron embraced Laura**?”). The mean inferability score for each group is given in Table 1. In the analysis below, unrelated and repeated verbs are classified in the “entailment” or “bridging” groups for comparison to the corresponding related verbs, but these labels are not theoretically meaningful for unrelated or repeated verbs. Table 1 shows a set of sample stimuli for each inferencing type.

**Table 1:** Sample stimuli for Experiment 1

Verb status	Sentence	Mean verb inferability
Unrelated	Elijah <i>rebuffed</i> Laura, and <b>Ron embraced Laura</b> .	1.8 / 7
Related (Entailment)	Veronica <i>hugged</i> Laura, and <b>Ron embraced Laura</b> .	6.7 / 7
Repeated	Christina <i>embraced</i> Laura, and <b>Ron embraced Laura</b> .	N/A
Unrelated	Madeline <i>offended</i> Noah, and <b>Al seduced Noah</b> .	2.1 / 7
Related (Bridging)	Angelina <i>charmed</i> Noah, and <b>Al seduced Noah</b> .	5.5 / 7
Repeated	Jocelyn <i>seduced</i> Noah, and <b>Al seduced Noah</b> .	N/A

## 2.2. Apparatus and procedure

The participants viewed the carrier paragraphs and critical sentences on a screen controlled by the Psychology program. To ensure that participants were aware of the relationship between the verbs, they were instructed to silently read each paragraph in its entirety and plan how they would pronounce it before reading it aloud. Each participant read all 12 items in each of the 3 verb status conditions in a random order. The study took place in a double-walled sound booth. The participants were recorded using a Shure SM10A head-mounted microphone connected to a Zoom H4n recorder.

## 2.3. Participants

10 native speakers of American English (5 female, mean age 21.9) participated in the study. The participants were compensated with a cash payment or course credit.

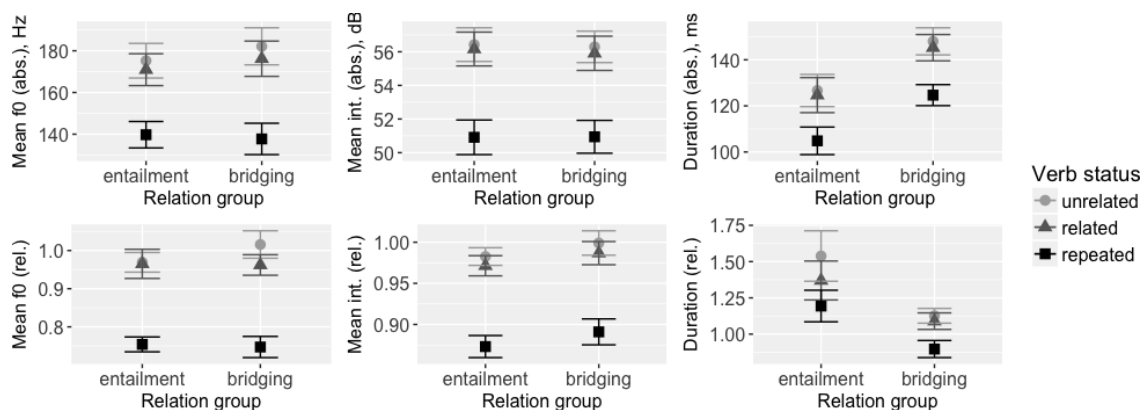
## 2.4. Results and analysis

The recordings were manually checked for errors or disfluencies and then forced aligned using FAVE [8], which determines phone-level boundaries using phonemic word representations from the HTK toolkit [18] and the CMU American English Pronouncing Dictionary [16]. The analysis focused on three acoustic correlates of emphasis:  $f_0$ , intensity, and duration [11, 1, 14]. For the nucleus of each second-clause subject and the stressed-syllable nucleus of each second-clause verb, the ProsodyPro script [17] was used to extract the mean  $f_0$ , the mean intensity, and the duration, with manual correction for creaky voice and other spurious  $f_0$  values.

Figure 1 shows the mean measurements by condition for the second-clause verb’s absolute mean  $f_0$ , mean intensity, and duration, as well as mean  $f_0$ , mean intensity, and duration relativized as a proportion of the value for the second-clause subject. A visual inspection of the plots suggests that the values for repeated verbs are substantially lower than for unrelated and related verbs for all phonetic measurements with the possible exception of relative duration for the entailment items. The values for unrelated and related verbs are generally comparable, although there is an apparent trend that the related values are slightly lower than the unrelated values.

For each of the six phonetic variables plotted in Figure 1, separate linear mixed effects regression models were constructed for the entailment items and the bridging items. Each model had a main effect of verb status and random effects for participant

**Figure 1:** Absolute and relative mean  $f_0$ , mean intensity, and duration by condition. Error bars: Standard error.



and item. In every model except the relative duration/entailment model, there was a significant main effect of verb status (all  $p$ 's < .001). Paired comparisons showed that the measures for repeated verbs were significantly different from those for unrelated verbs (all  $p$ 's < .001) and related verbs (all  $p$ 's < .001). The measures for related verbs were not significantly different from those for unrelated verbs (all  $p$ 's > .2). In the relative duration/entailment model, the main effect of verb status was significant at the  $p = .05$  level. The mean relative duration for repeated verbs was significantly different from that for unrelated verbs ( $p < .05$ ), while the differences between related and unrelated ( $p > .2$ ) and related and repeated verbs ( $p > .1$ ) were not significant.

## 2.5. Discussion

The phonetic analysis for Experiment 1 indicated that repeated verbs were produced with significantly lower mean  $f_0$ , intensity, and duration than unrelated and related verbs, while the phonetic measurements for unrelated and related verbs were not significantly different from one another. These results suggest that repeated verbs were reliably deaccented, while unrelated and related verbs were not. The fact that related verbs were not deaccented calls into question the assertion that deaccenting is licensed when a constituent is made available in the prior discourse context by entailment or a bridging inference.

## 3. EXPERIMENT 2: PERCEPTION

The results of Experiment 1 suggested that related verbs were pronounced with roughly the same emphasis as unrelated verbs, and thus were not deaccented like repeated verbs were. However, the possibility remains that the phonetic variables mea-

sured in the Experiment 1 analysis do not exhaustively describe the emphasis status of the critical related verbs; some other phonetic correlate of emphasis might cause these verbs to be perceived as deaccented, undermining the conclusions of Experiment 1. Experiment 2 investigated this by soliciting judgments of the accent status of the recorded critical verbs isolated from their conditioning contexts.

### 3.1. Design and stimuli

The stimuli were the recorded second *SVO* clauses from the Experiment 1 production study. These clauses were clipped from the original recordings after the word *and* to isolate the critical clause from the conditioning environment, the first-clause verb. Thus, the stimuli retained the 3-condition, 2-group design of Experiment 1, with the hidden conditioning verb determining an unrelated, related, or repeated status for target verb and the “related” inferring relation being entailment or bridging.

### 3.2. Apparatus and procedure

The experiment was conducted on Ibex Farm [3] with participants recruited on Amazon Mechanical Turk. For each experimental item, participants saw the *SVO* clause as written text with an indication of the critical word they should pay attention to. When they pressed a key to indicate they were ready for the trial, the recorded *SVO* clause played and the participant was asked to make a forced choice between rating the critical verb as *emphasized* or *not emphasized*. Each participant rated 9 verbs in different speaker/condition combinations. Each of the 360 recorded verbs from Experiment 1 was rated 5 times, with 300 observations per verb status/relation type pair across all Experiment 1 voices and items.

### 3.3. Participants

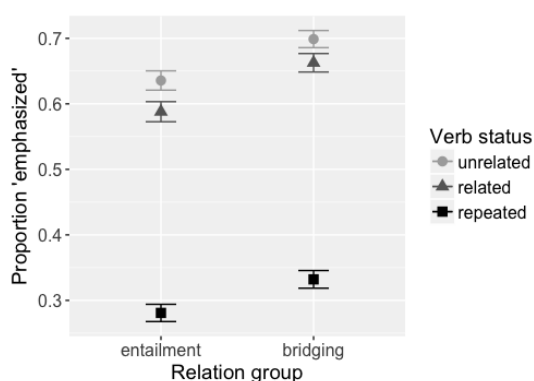
200 participants were recruited on AMT. 10 participants were excluded from the analysis because they self-reported as non-native speakers of English. 13 participants were excluded for failing to answer at least 3 of 4 filler items correctly. For the participants included in the analysis, the mean age was 34.3 and 62 were female. Participants received monetary compensation through AMT.

### 3.4. Results and analysis

Figure 2 shows the proportion of ‘emphasized’ responses by verb status and relation group. A visual inspection of the plot suggests that repeated verbs were perceived as emphasized substantially less frequently than either unrelated or related verbs. Unrelated and related verbs appear to have been perceived as emphasized in roughly equal proportions of trials, although there is a numerical trend toward lower perception of emphasis among related verbs.

For each relation group, a logistic mixed effects regression model was constructed with a main effect of verb status and random effects for item, AMT participant, and speaker voice. Model comparison revealed a significant main effect of verb status in both cases ( $p$ 's < .001). Paired comparisons for both models showed that the proportion of ‘emphasized’ responses was significantly different for repeated verbs compared to both unrelated and related verbs (all  $p$ 's < .001), while the proportions for unrelated and related verbs were not different ( $p$ 's > .2).

**Figure 2:** Proportion of ‘emphasized’ responses by condition. Error bars: Standard error.



### 3.5. Discussion

The results closely tracked the phonetic measurements found in Experiment 1. Participants rated repeated verbs as emphasized much more rarely than either unrelated verbs or related verbs, suggesting

they were deaccented. Related verbs were not found to be significantly less emphasized than unrelated verbs, indicating that they were not deaccented, although there was a numeric trend toward lower emphasis for related verbs.

## 4. GENERAL DISCUSSION

Together, the results of Experiments 1 and 2 suggest that speakers do not deaccent constituents that are made available in the prior discourse context by entailment or a bridging inference. Inferable verbs were produced with  $f_0$  values, intensities, and durations that were not significantly different from those for verbs that were completely new to the discourse, but were significantly different from those for verbs that were repeated from the previous clause. Naive listeners who heard the recorded verbs out of context likewise rated inferable verbs as roughly similar in emphasis to new verbs and distinct from repeated verbs. These results undermine the claim that deaccenting can be licensed by inferencing relations like entailment and bridging, as there is little to no evidence that speakers leveraged these relations when planning their production of second-clause verbs.

We note here the interesting non-significant trend toward lower emphasis on related verbs compared to unrelated verbs in both the phonetic and perceptual data. Further, we are aware of recent work indicating a small trend toward reduced emphasis for discourse-accessible nouns [2]. It may indeed be the case that inferencing relations marginally license deaccenting, although the current results suggest that this effect is nowhere near the magnitude of canonical deaccenting under repetition.

We also note two limitations of the current study as an investigation of deaccenting licensing under inference. First, our results only show that speakers do not deaccent inferable constituents. There may be an asymmetry between production and perception, such that speakers choose not to deaccent inferable constituents, but listeners who hear such a deaccented constituent would rate it as felicitous. Future studies are warranted investigating whether deaccenting is optionally licensed in this way.

Second, the Experiment 1 participants were reading artificial sentences and may not have been aware of the relationship between related verbs and their first-clause counterparts, incorrectly treating them as unrelated verbs. Presumably, speakers producing sentences they planned themselves would be aware of such relationships, so the possibility remains that the present study is limited on the basis of ecological validity and that speakers do indeed deaccent inferable constituents in naturally occurring discourse.

## 5. REFERENCES

- [1] Campbell, N., Beckman, M. 1997. Stress, prominence, and spectral tilt. *Proceedings of ESCA Workshop on Intonation: Theory, Models and Applications*, 67–70.
- [2] Chodroff, E., Arthurs, A., Kurian, P., Pazol, J., Cole, J. 2019. Categorical and gradient effects of information structure on nuclear prominence in American English. Presentation at the 93rd Annual Meeting of the Linguistic Society of America.
- [3] Drummond, A. *Ibex 0.3.8 Manual*.
- [4] Halliday, M. 1967. Notes on transitivity and theme in English, Part 2. *Journal of Linguistics* 1967(3), 199–244.
- [5] Pierrehumbert, J. B., Hirschberg, J. 1990. The meaning of intonational contours in the interpretation of discourse. In: Cohen, P., Morgan, J., Pollack, M., (eds), *Intentions in Communication*. Cambridge, MA: MIT Press.
- [6] Rochemont, M. 1986. *Focus in Generative Grammar*. Amsterdam: John Benjamins.
- [7] Rooth, M. 1992. Ellipsis redundancy and reduction redundancy. *Proceedings of the Stuttgart Ellipsis Workshop*.
- [8] Rosenfelder, I., Fruehwald, J., Evanini, K., Yuan, J. 2011. *FAVE (Forced Alignment and Vowel Extraction) Program Suite*.
- [9] Schwarzschild, R. 1999. Givenness, AvoidF and other constraints on the placement of accent. *Natural Language Semantics* 7(2), 141–177.
- [10] Selkirk, E. O. 1984. *Phonology and Syntax: The Relation between Sound and Structure*. Cambridge, MA: MIT Press.
- [11] Sluijter, A. M., van Heuven, V. J. 1996. Acoustic correlates of linguistic stress and accent in Dutch and American English. *Proceedings of the 4th International Conference on Spoken Language Processing (ICSLP-1996)*, 630–633.
- [12] Taglicht, J. 1982. Intonation and the assessment of information. *Journal of Linguistics* 18(2), 213–230.
- [13] Tancredi, C. 1992. *Deletion, deaccenting, and presupposition*. Ph.D. Thesis, MIT.
- [14] Turk, A. E., White, L. 1999. Structural influences on accentual lengthening in English. *Journal of Phonetics* 27(2), 171–206.
- [15] Wagner, M. 2012. Focus and givenness: A unified approach. In: Kučerová, I., Neeleman, A., (eds), *Contrasts and Positions in Information Structure*. Cambridge: Cambridge University Press, 102–147.
- [16] Weide, R. 1998. *The Carnegie Mellon Pronouncing Dictionary*.
- [17] Xu, Y. 2013. ProsodyPro - A tool for large-scale systematic prosody analysis. *Proceedings of Tools and Resources for the Analysis of Speech Prosody (TRASP 2013)*, 7–10.
- [18] Young, S. J. 1994. *The HTK Hidden Markov Model Toolkit: Design and philosophy*. Entropic Cambridge Research Laboratory, Ltd.