NUCLEAR ACCENT TYPES AND PROMINENCE: SOME PSYCHOLINGUISTIC EXPERIMENTS

Gayle M. Ayers
Department of Linguistics, The Ohio State University

ABSTRACT
Two locations of nuclear accent (early and late) and three kinds of nuclear accent in English were considered. In reaction time measures, nuclear accents were faster than non-nuclear accents. However, downstepped nuclear accents were slower than regular and emphatic nuclear accents, suggesting that downstepped accents are less prominent, and that nuclear accent is not a fully uniform category.

INTRODUCTION
This study examines phonetic prominence of nuclear accent types in English using two experimental tasks: cross-modal naming and phoneme monitoring. These tasks provide a way to observe the influence of sentence intonation on the behavior of listeners, from which we can infer the status of the category nuclear accent and the relationship between accent type and prominence values. In addition, they help inform us of the role of intonation in lexical access and sentence processing.

The test materials are sentences produced as single intonational phrases with early ("A BOAT was near the tower") or late nuclear accent ("A boat was near the TOWER"), and with one of three phonologically distinct nuclear accent types. The question of interest is whether these three types of nuclear accent are all equally prominent (the traditional analysis of nuclear accent as a single qualitative level of stress which is independent of accent type) or whether there are differences between the nuclear accent types (e.g., that downstepped nuclear accents are less prominent [1]).

The three accent types can be characterized by the relationship between the pitch levels on the nuclear accent and the preceding accents. See Tables 1 & 2 for sample materials; the intonation patterns are transcribed using high and low tones for accents and phrase boundaries [2]. Figure 1 shows the mean F0 values (in Hz) of early and late position words in four intonation contour types (sentences from Exp. 4). Measurements were taken at the midpoint of the stressed vowel. Filled circles represent nuclear accents. A regular nuclear accent (R) has a pitch level similar to that of the preceding accent (although it may be slightly lower due to final lowering [3]). An emphatic nuclear accent (M) has a dramatic pitch rise on the nuclear accented word. A downstepped nuclear accent (D) is significantly lower than the preceding accent.

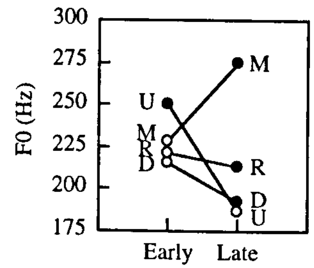

Figure 1. Mean F0 values of emphatic (M), regular (R), downstepped (D), and unaccented (U) contour types.

CROSS-MODAL NAMING
The cross-modal naming task measures the speed of lexical access. It shows effects of lexical priming and sentence position (RT is slower early in the sentence) [4], [5], but effects of intonation have not been systematically explored previously.

Method
Subjects. 84 undergraduate students participated in the two experiments, 42 subjects in each experiment.

Stimuli. 96 critical sentences were used, each containing one prime word. The prime word was either the head noun of the subject (early position) or of the object (late position). Exp. 1 used semantic associate priming, and Exp. 2 used identity priming. Table 1 shows example sentences and targets and the two intonation contour types used: (1) late (regular) nuclear accent, and (2) early nuclear accent.

Table 1. Sample materials used in Experiments 1, 2, and 3. Nuclear vs. non-nuclear accent status in early and late sentence positions. Experiments 1 and 2 used cross-modal naming, and Experiment 3 used phoneme monitoring. The critical words are underlined, and nuclear accented words are in boldface capital letters.

		Exp. 1	Exp. 2	Exp. 3
Early Sentence Position				
(1)	A boat was near the **TOWER**.	Related:	Identical:	/b/
	H* H* L-L%	SHIP	BOAT	
(2)	A **BOAT** was near the tower.	Unrelated:	Unrelated:	
	H* L-L%	SHOP	BOX	
Late Sentence Position				
(1)	The baby saw the **CAT**.	Related:	Identical:	/k/
	H* H* L-L%	DOG	CAT	
(2)	The **BABY** saw the cat.	Unrelated:	Unrelated:	
	H* L-L%	DUST	CLOCK	

Procedure. Subjects were seated at a computer and wore headphones with a microphone mounted on the headset. The sentences were presented over the headphones, and the target words were shown on the computer screen. At the acoustic offset of the prime word, the computer presented the target word and started a millisecond timer. Subjects named (read aloud) the target word, and the sound of the subject's voice stopped the timer and cleared the computer screen.

Results
Figure 2 shows the mean RTs. The data were analyzed in four-way ANOVAs, by subjects (F1) and by items (F2). For greater detail see [6].

In Exp. 1, the main effects of sentence position (early vs. late) and target relatedness were highly significant, as expected. Accent status (nuclear vs. non-nuclear), however, was only marginally significant, with nuclear accents slower than non-nuclear accents ($F1(1,36)=3.8$, $p=.06$; $F2(1,84)=3.0$, $p=.09$). The two-way interaction of Accent status x Relatedness, where the unrelated targets showed a larger effect of accent status than the related targets, was marginally significant by subjects ($F1(1,36)=3.2$, $p=.08$) and significant by items ($F2(1,84)=4.1$, $p<.05$).

In Exp. 2, the two-way interaction of Position x Relatedness and the main effects of Position and Relatedness were highly significant. However, Accent status was not significant ($F1(1,36)=2.4$, $p=.13$; $F2(1,84)=2.0$, $p=.16$).

Considering Exps. 1 & 2 together, Accent status was significant ($F1(1,72)=6.0$, $p=.02$; $F2(1,84)=4.1$, $p<.05$). Accent status x Relatedness was marginally significant ($F1(1,72)=3.3$,

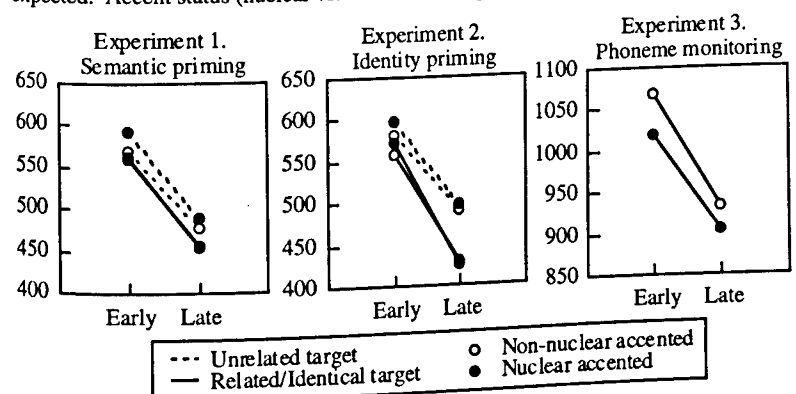

Figure 2. Mean reaction times (in ms) for Experiments 1, 2, and 3.

Table 2. Sample materials used in Experiment 4 (phoneme monitoring). Accent status in early and late sentence position of four intonation contours. Contours are characterized by late position accent status: emphatic, regular, and downstepped nuclear accents, and unaccented (early nuclear accent placement). The critical words are underlined, and nuclear accented words are in boldface capital letters.

			Early	Late
(1)	Emphatic	The poet admired the **CANYON**. H* L+H* L-L%	/p/	/k/
(2)	Regular	The poet admired the **CANYON**. H* H* L-L%	/p/	/k/
(3)	Downstepped	The poet admired the **CANYON**. H* !H* L-L%	/p/	/k/
(4)	Unaccented	The **POET** admired the canyon. H* L-L%	/p/	/k/

p=.07; F2(1,84)=3.3, p=.07). Accent status x Position was marginally significant by subjects; nuclear accents were relatively slower than non-nuclear accents in early position than in late position (F1(1,72)=3.8, p=.06; F2(1,84) =1.8, p=.18).

PHONEME MONITORING

Exps 1 & 2 showed that accent status had very little effect on lexical access. The next two experiments used a task known to be sensitive to differences in accent status. In phoneme monitoring, response times are faster to target phonemes in words with 'sentence stress' than words that are unstressed [7].

Method

Subjects. 100 undergraduate students participated in the two experiments, 20 in Exp. 3 and 80 in Exp. 4.

Stimuli. Target phonemes occurred only once in each sentence, as the initial consonant of a critical word. Exp. 3 used 40 critical sentences with the same intonation contours as Exps. 1 & 2. Sentences had one target phoneme (/p/, /b/, /k/, or /g/) in either early or late sentence position. Exp. 4 used 96 critical sentences with the four intonation patterns described above. The phoneme targets were /p/ and /k/, one in early position and one in late position of each sentence. Sample materials are shown in Tables 1 & 2.

Procedure. Subjects were seated at a computer and wore headphones. The sentences were presented over headphones, and subjects pressed the 'yes' response button when they detected the target phoneme. The computer started a timer at the release burst of the stops, and the button press stopped the timer. In Exp. 3 the target phoneme was specified before each sentence by an auditory phrase, e.g., "Listen for /k/ as in 'car'." In Exp. 4 the target phoneme was specified before each sentence by a visual display of the letter 'P' or 'K'.

Results

Figures 2 & 3 show the mean RTs for Exp. 3 (plotted by accent status and contour type, respectively). The data were analyzed in two three-way

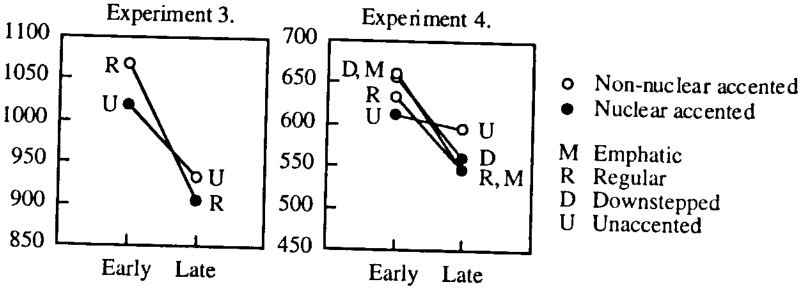

Figure 3. Mean reaction times (in ms) for Experiments 3 and 4.

ANOVAs. The main effect of Accent status was significant (F1(1,18)=5.8, p=.03; F2(1,36)=5.3, p=.03). Nuclear accented words had faster RTs than non-nuclear accented words. Early targets were also significantly slower than late targets. There was no significant Accent status x Position interaction.

The data in Exp. 4 were analyzed in two three-way ANOVAs. The two-way interaction of Position x Contour was highly significant (F1(3,216)=17.4, p<.001; F2(3,264)= 15.3, p<.001) and the main effect of Contour was significant (F1(3,216)=3.2, p=.02; F2(3,264)=2.5, p=.06).

Condition mean contrasts were calculated in order to explore the two-way interaction. In both early and late position the RT to words with nuclear accent was faster than those with non-nuclear accent (Early: F1(1,216)=19.2, p<.001, F2(1,264)=15.4, p<.001; Late: F1(1,216)=32.7, p<.001, F2(1,264)= 31.1, p<.001). As in Exp. 3, early nuclear accented words were faster than the prenuclear accented words of the regular contour (F1(1,216)=5.2, p=.02; F2(1,264)=5.1, p=.02). The prenuclear accented words of the regular contour were also faster by subjects than those of the emphatic and downstepped contours (F1(1,216)=4.9, p=.03; F2(1,264)=2.7, p=.10). In late position, the downstepped nuclear accents were significantly faster than the unaccented words (F1(1,216)=12.9, p<.001; F2(1,264)= 12.9, p<.001), and the regular and emphatic nuclear accents were marginally faster than the downstepped nuclear accents (F1(1,216)=3.5, p=.06; F2(1,264)=2.8, p=.09).

DISCUSSION

In the cross-naming experiments, accent status did not strongly affect lexical access. For lexical priming, basically a word is a word, no matter whether it is nuclear accented or completely unaccented. However, target words that were primed by words with early nuclear accents were named somewhat more slowly than those with prenuclear accents, suggesting that there may be something 'not normal' about early nuclear accent placement. The difference in reaction time is perhaps best explained by the listener's placing greater attention on the early nuclear accented word when it occurs, which subsequently slows down the naming task.

In the phoneme monitoring experiments, phonemes were detected most quickly in nuclear accented words. However, phonemes were detected less quickly in downstepped nuclear accented words than in regular and emphatic nuclear accented words. This suggests that downstepped accents have less acoustic prominence than the other two types of nuclear accents. Also, phonemes in prenuclear accented words of sentences with downstepped and emphatic nuclear accents were detected less quickly than those in sentences with regular nuclear accents, which is yet to be explained.

Nuclear accent type and location do influence sentence processing, and nuclear accent is not a completely uniform category in terms of prominence.

REFERENCES

[1] Horne, M. (1991), "Why do speakers accent 'given' information?", *Proceedings of Eurospeech 91*, vol. 3, pp. 1279-1282.
[2] Pitrelli, J.F., Beckman, M.E., & Hirschberg, J. (1994), "Evaluation of prosodic transcription labeling reliability in the ToBI framework", *Proceedings, 1994 International Conference on Spoken Language Processing*, vol. 1, pp. 123-126. Yokohama, Japan.
[3] Pierrehumbert, J. (1979), "The perception of fundamental frequency declination", *J. of Acoustical Society of America*, vol. 66, pp. 363-369.
[4] Foss, D.J. (1969), "Decision processes during sentence comprehension", *J. of Verbal Learning & Verbal Behavior*, vol. 8, pp. 457-462.
[5] Forster, K.I. (1981) "Priming and the effects of sentence and lexical contexts on naming times", *Quarterly J. of Experimental Psychology*, vol. 33A, pp. 465-495.
[6] Ayers, G.M. (to appear), *Nuclear accent types and prominence: Some psycholinguistic experiments*, Ph.D dissertation, Ohio State University.
[7] Cutler, A. (1976), "Phoneme-monitoring reaction time as a function of preceding intonation contour", *Perception & Psychophysics*, vol. 20, pp. 55-60.