Declarative and Interrogative Intonations by Brain-damaged Speakers of Uygur and Mandarin Chinese

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Abstract

In this study we investigated the declarative and interrogative intonations of Uygur and Mandarin Chinese by right hemisphere brain-damaged (RHD) speakers. We found the two RHD speakers employed the falling tone for both declarative and interrogative sentences. The pitch range of the RHD speakers was more than 1.5 times narrower than that of the healthy speakers. The global F_0 curves of questions did not display the higher level than those of statements. Not a single final rise occurred in the interrogative intonations by the RHD speaker of Uygur, but slight pitch raising of the final syllable occurred in declarative question and wh-question intonations by the RHD speaker of Mandarin Chinese. The utterance onsets were lower in the questions than in the statement by the RHD speaker of Mandarin Chinese, which was manifested in a higher level above the declarative intonation by the RHD speaker of Uygur. Moreover, the raised F_0 minima from the statements to questions did not occur in the intonations of RHD speakers. Finally, the fixed stress pattern in Uygur preserved intact when the speaker of Uygur suffered from intonation damage. The results are in support of the finding that intonation is processed in the right hemisphere.

Index Terms: intonation, brain-damaged, Uygur, Mandarin Chinese

1. Introduction

Intonation refers to the use of suprasegmental phonetic features to convey "postlexical" or sentence-level pragmatic meanings in a linguistically structured way [1]. It has often been noted, for example, that in a vast majority of languages some sort of raised pitch (final or non-final) can be used in contrast with lower pitch to indicate that an utterance is intended as a question rather than as a statement [2]. Thus, we address to the issue of declarative and interrogative intonations in a tone language like Mandarin Chinese by asking the similarities and differences if it is compared with a non-tone language like Uygur with a fixed stress pattern at the final syllable. The typological differences between the two languages may help to highlight the commonalities shared by both. In particular, the interaction of tone with intonation in Mandarin Chinese and the interaction of stress with intonation in Uygur may serve as a reference to recognize the language specific intonation system. Many linguists occupied themselves with the intonation properties of questions in Mandarin Chinese. Some stated that only pitch of final syllable signals sentence type and interrogative intonation could be characterized as a final rising tone[3][4]. Others claimed that questions were realized on a higher global pitch level than the statements [5]. In Uygur, it was reported that the final rise reflected the differences between statements and questions [6]. Therefore, we target the issue by comparing several global and local acoustic cues of declarative and interrogative intonations in these two languages. The differential roles of the left (LH) and right (RH) cerebral hemispheres in the processing of prosodic information have received considerable attention over the last several decades. It was claimed that the LH may come into play whenever prosody was segmentally bound (stress, lexical tone).and suprasegmental sentence level information (i.e., intonation) was processed in the right hemisphere [7]. Therefore, investigating the issue of declarative and interrogative intonations by right hemisphere brain-damaged (RHD) speakers can provide valuable insight into the precise mechanisms underlying functional asymmetry for speech prosody. Specifically, the following issues are explored: (1) Are the questions produced by the RHD speakers of two languages acoustically different from statements in terms of (i) local F_0 (utterance onset height and final rise), and (ii) global F_0 (overall trend and register level)? (2) Is the fixed stress pattern still preserved if the RHD speaker of Uygur suffered from the intonation damage?

2. Method

2.1. Subjects

Two male RHD speakers and two male healthy speakers (HSP) (the latter with no history of previous cerebral disorder or hearing loss) took part in the study. At the time of data collection Subject 1 (Uygur) was 32 years of age and Subject 2 (Han) was 66 years of age. They were all right-handed and were monolingual native speakers of Mandarin Chinese and Uygur respectively. Each speaker had a unilateral right hemispheric cerebrovascular accident in the basal ganglia as indicated by a CT-scan. The RHD speakers were diagnosed as non-fluent speakers with language problems.

2.2. Stimuli

Stimuli consisted of four Mandarin Chinese and four Uygur utterances. Utterances were designed with two intonation patterns (declarative, interrogative) and the following utterance types were singled out for investigation: statement (ST), declarative question (DQ), yes-no question (YQ) and wh-question (WQ). To make intonation extrication from tone possible, words bearing Mandarin Tone 1 were chosen for this study.

Target (Mandarin Chinese):

tʂɑŋpin tɕint^{h}iæn ɕiou ʂoujintɕi (ST)

Zhang Bin is going to fix the radio today.

tʂɑŋpin tɕint^{h}iæn ɕiou ʂoujintɕi (DQ)

Zhang Bin is going to fix the radio today?

tʂɑŋpin tɕint^{h}iæn ɕiou ʂoujintɕi mɑ (YQ)

Is Zhang Bin going to fix the radio today?

tʂɑŋpin tɕintʰiæn ɕiou nɑtʂi ʂoujintɕi (WQ)

Which radio is Zhang Bin going to fix today?

Target (Uygur):

ɑlim bygyn kir ju di (ST)

Alim washed clothes today.

ɑlim bygyn kir ju di (DQ)

Alim washed clothes today?

ɑlim bygyn kir ju di mu (YQ)

Did Alim wash clothes today?

ɑlim bygyn nimɛ ju di (WQ)

What did Alim wash today?

2.3. Recording procedure

The subjects were instructed to read target utterances as a conversational speaking rate in a declarative and interrogative sentence mood. Recordings of the two healthy speakers were made in a soundproof booth at Urumqi radio station. The recording stimuli of HSP were played to RHD speakers by vsplay and the speech samples were recorded using a digital recorder with a sampling rate of 44.1 KHz in an open ward.

2.4. F_0 extraction

On the physical level, intonation was used to refer to variations of one or more acoustic parameters. Of these, fundamental frequency (F_0) was universally acknowledged to be the primary parameter. Using the Praat software (version 5.3.03; Boersma & Weenink, 1992-2011), the pitch of each sentence was extracted. Automatic pitch period detection was supplemented by manual correction of the F_0 values. The final rise in each target sentence and the vowels of the first two words in Uygur target sentences were time-normalized by a custom-written script for the Praat program respectively (http://www.phon.ucl.ac.uk/home/yi/ProsodyPro/_ProsodyPro.zip) and F_0 files were saved by the Praat script.

3. Results and discussion

3.1. Global F_0 curve

For direct visual comparison, F_0 curves of the target sentences by HSP and RHD speakers as a function of utterance type were displayed in Figure 1. The findings of global F_0 showed that what healthy speakers of Uygur and Mandarin Chinese had in common was the strong tendency to feature falling pitch level (from onset to offset) in statement and final rise in both DQ and WQ, which were reported for many languages across the world. Moreover, YQ had falling contours in both two languages, indicating the role of lexical cue to interrogativity. The results of RHD patients indicated that both of them produced the falling pitch in statements and questions, suggesting that they lost the intonation properties of questions. As can be seen from Figure 2, regardless of WQ in which wh-word bearing Mandarin Tone 3, the pitch range of HSP (Uygur) was raised slightly and that of the RHD speakers compressed. The pitch range of RHD speakers was 2.25 and 1.56 times narrower than that of HSP respectively. In the declarative sentence, the pitch range of RHD speaker of Mandarin Chinese was raised and expanded. Therefore, it was 2.2 times wider than the pitch range of HSP. In contrast, the pitch range of RHD speaker of Uygur was 1.38 times narrower than that of HSP speaker of Uygur. In the interrogative sentences, the pitch range of RHD speakers was 2.25 and 2.12 times narrower than that of HSP respectively. Figure 2 also displayed that the global F_0 curves of interrogative intonations was raised and expanded from ST in the intonations by HSP of Uygur, while only that of WQ was raised and expanded from ST in the intonations by HSP of Mandarin Chinese. By contrast, the global F_0 curve of questions and statement did not differ significantly in the intonations by RHD speakers.

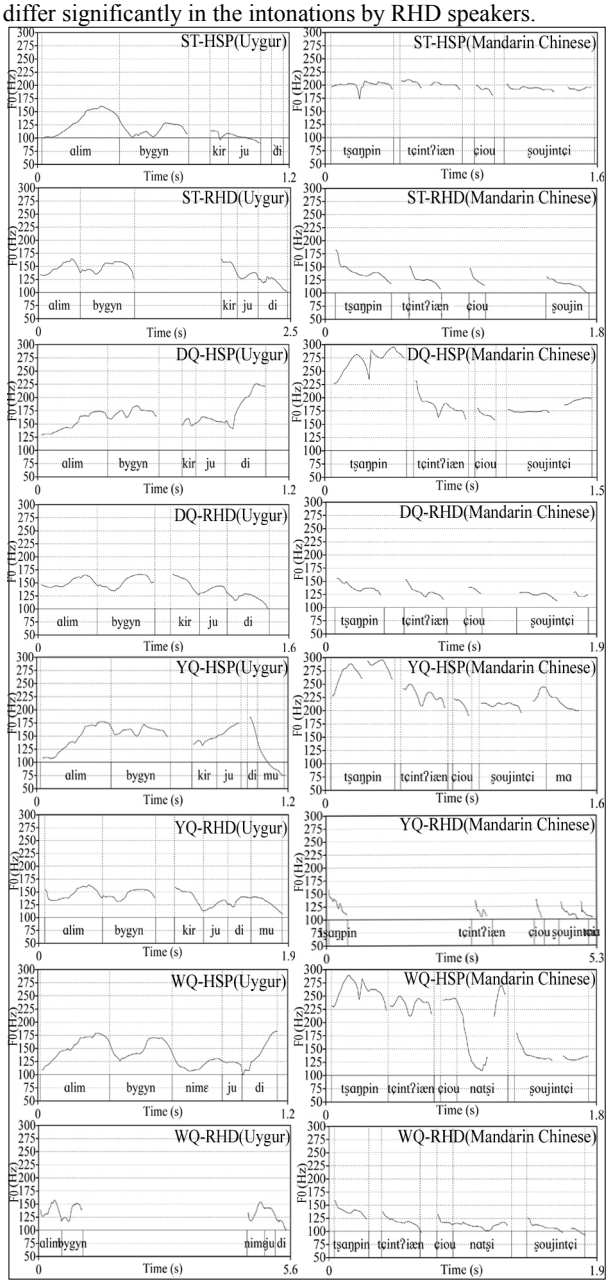

Figure 1: *The global F_0 curve of each utterance.*

3.2. Register level

Register level was reflected by the minimum F_0 value in a given utterance. Table 1 displayed the register level as a function of utterance type. In the utterances of HSP (Uygur), the minimum in ST was lower than the minima in the set of

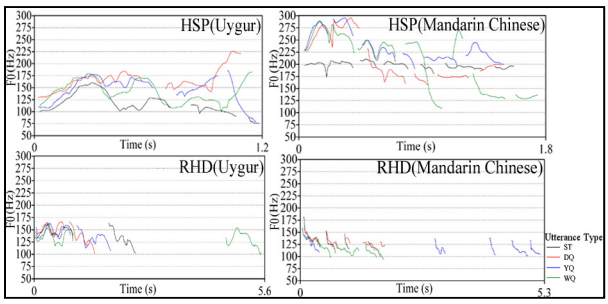

Figure 2: *The pitch range of each speaker.*

questions. This upward shift of register level was taken to confirm that questions stand out from neighboring statements by raised pitch levels. The HSP of Mandarin Chinese displayed the order that WH<DQ<ST<YQ. The upward shift of register level was limited which was due to the effect of tones. In the utterances of RHD speakers, the minimum in the statement was lower than YQ for Uygur speaker and than DQ for speaker of Mandarin Chinese. The minima in other set of questions varied insignificantly for RHD speakers.

Table 1. *Register level (minimum F_0)(Hz).*

Utterance type	HSP (Uygur)	RHD (Uygur)	HSP (Mandarin Chinese)	RHD (Mandarin Chinese)
ST	75.17	102.59	172.99	99.60
DQ	129.32	101.45	158.23	112.84
YQ	75.22	106.97	191.34	97.30
WQ	99.07	99.41	109.17	93.72

3.3. Utterance onset height

The utterance onset height as a variable was used to determine whether, overall, the F_0 values of the utterance onsets were higher in the questions than in the statements. Table 2 displayed F_0 values of utterance onsets in statements and questions. The F_0 values of utterance onsets in questions were higher than those in the statements for both HSP and RHD speaker of Uygur. The results indicated that a difference in register at the starting point was a feature that distinguished assertive intonation from interrogative intonation [8]. However, the F_0 values of utterance onsets of questions were lower than that of statement for RHD speaker of Mandarin Chinese.

Table 2. *Utterance onset F_0 (Hz).*

Utterance type	HSP (Uygur)	RHD (Uygur)	HSP (Mandarin Chinese)	RHD (Mandarin Chinese)
ST	99.81	133.68	197.46	181.87
DQ	129.34	146.34	226.82	157.99
YQ	109.09	154.39	227.19	158.29
WQ	108.82	139.46	230.61	155.23

3.4. Final rise

An utterance was assumed to have a final rise when pitch in the last (unstressed) syllable was auditorily perceived as going up and when this upward movement was reflected in the pitch curve. Figure 3 displayed the F_0 curves of the final rises in different sentence types. There were final rises that occurred in YQ and WQ of HSP and the final rise was realized lowest in WQ, in DQ highest. In YQ, the neutral-tone question particle ma and the question particle mu occurred in Mandarin Chinese and Uygur respectively. We observed that not a final rise occurred in YQ in these two languages, but the pitch raising of content words before the question particle. The findings of RHD speakers showed that there was not a single final rise that occurred in the declarative and interrogative intonations of Uygur, but slight final rises in DQ and WQ for RHD speaker of Mandarin Chinese.

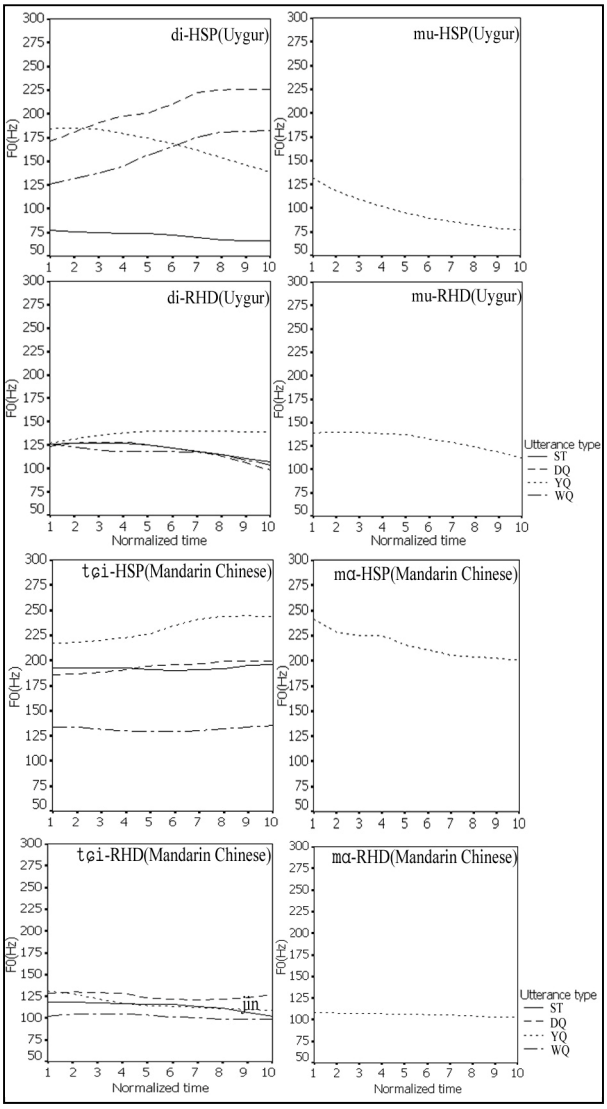

Figure 3: *The F_0 curve of final rise.*(The last syllable of ST was jin by RHD speaker of Mandarin Chinese.)

3.5. Effect of fixed stress on intonations

The declarative/interrogative intonation should be investigated of other intonational functions like focus. All the target sentences of Uygur uttered were brought into broad focus. It appeared that the noun phrase (NP) and adverbial components of declarative and interrogative intonations were affected by the fixed stress at the final syllable, for the F_0 contours of them were found to be raised. It was reported that in languages with

fixed stress position and no phonemic contrasts in tone or length, the cues relevant to stress would be primarily indicated by a change of F_0 [9] and the investigation of the disyllabic word stress supported this finding in Uygur and suggested that duration was also one of the most important acoustic cues than intensity [10]. Thus, the F_0 contour and the duration of the first and second syllables of these two components were used to determine the effect of stress on intonations. Figure 4-5

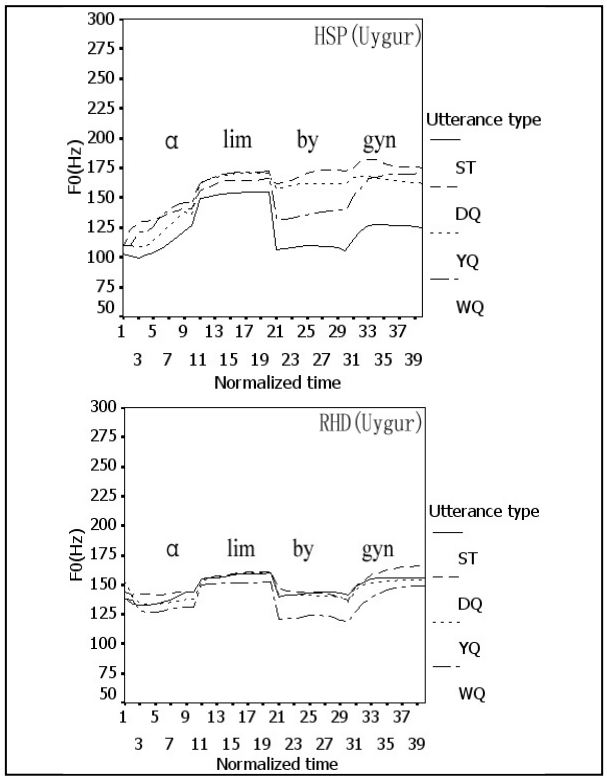

Figure 4: *The F_0 curve of NP and adverbial components.*

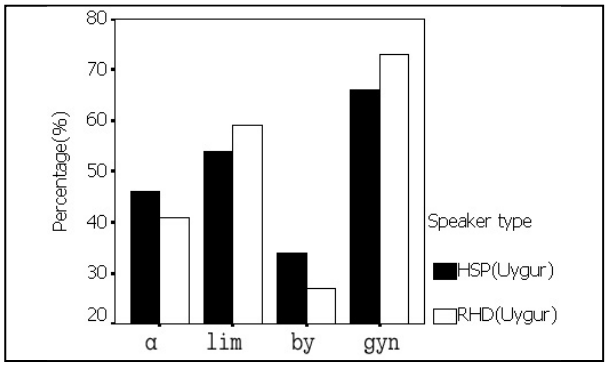

Figure 5: *Percentage of syllable duration.*

displayed the F_0 contour of each vowel and percentage of syllable duration (mean syllable duration/mean word duration) in the NP and adverbial components of all sentence types. As can be seen, the words still had a lexical pitch accent on their final syllables, which was confirmed by one-way ANOVA analysis. There was a syllable type effect on F_0 values in two components [HSP:$F(1,79)=262.72$, $P<0.001$, $F(1,79)=8.81$, $P<0.05$; RHD:$F(1,79)=320.19$, $P<0.001$, $F(1,79)=70.90$, $P<0.001$]. In both NP and adverbial components, the percentage of duration in the second syllable was much larger than that in the first one, indicating that stress played a critical role in determining the global pitch shape of declarative and interrogative intonations in Uygur.

4. Conclusions

Through examination of F_0 contours in Mandarin Chinese and Uygur declarative and interrogative intonations by the speakers with right hemisphere damage, we found that the declarative and interrogative intonations all displayed a falling tone, supporting that suprasegmental sentence level information (i.e., intonation) was processed in the right hemisphere. The pitch ranges of RHD speakers compressed and were more than 1.5 times narrower than HSP. The global F_0 curves of questions did not display the higher level than those of statements. Moreover, not a single final rise occurred in the declarative and interrogative intonations of RHD speaker of Uygur, but slight final rises in DQ and WQ by RHD speaker of Mandarin Chinese.

Our findings also revealed that the utterance onsets were lower in the questions than in the statement by the RHD speaker of Mandarin Chinese. In contrast, the RHD speaker of Uygur still remained the higher utterance onsets of questions than that of statement as the HSP of Uygur. The upward register level from statement to questions did not occur in the intonations of RHD patients. In addition, the results of the F_0 contours and percentage of syllable duration in the NP and adverbial components indicated that the fixed stress pattern preserved intact when the RHD speaker of Uygur suffered from intonation damage.

5. References

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