

THE FLUCTUATION SCALE OF THE INTONATION OF STATEMENT AND DECLARATIVE QUESTION IN ENGLISH

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ABSTRACT

Based on the concept of intonation pattern and the method of fluctuation scale, this paper qualitatively and quantitatively conducts a preliminary research focused on the pitch representations of the sentence and tone group ranges of statement and declarative question in English and makes a comparatively detailed study on the pitch movements between the two intonation moods. The findings point out method of fluctuation scale are effective means to analyze the pitch movement of English intonation and to find the universality of the intonation moods.

Keywords: intonation pattern, sentence range, tone group range, fluctuation scale

1. INTRODUCTION

The study of English intonation initiates the systematic study on human language intonation, and modern study on English intonation influences different language intonation researches. From the beginning of English intonation labeling to the descriptive representation of English intonation, these up-to-now studies have made detailed research on the conceptive recognition of the representation of English. However, they lack deeper vision of the underlying correlations between different intonation prosodic units to get the better understanding of the intra-movements of intonation. This study aims to reveal the dynamic correlations of the underlying hierarchical English prosodic units preliminarily.

Following the concept of intonation pattern initiated by Feng Shi [3], who proposes the analyzing method of fluctuation scale to study the Chinese intonation, the paper will use this new method to explore the pitch movement of statement and declarative question in English experimentally to study the inter-relation and inter-fluctuating of different prosodic units and the similarity and differences between English statement and declarative question.

2. EXPERIMENTAL METHOD

Due to the complexity of intonation, the experimental sentences in this research basically focus on the key syntactic pattern in English, that is, the SVO pattern to avoid the influences of other factors. There are 3 sentences as follows:

- (1) You go to school/, play sports/ and swim in the pool.
- (2) Alice enjoys coffee/, listens to music/ and writes novels.
- (3) The students visit the company/, listen to a lecture/ and ask questions.

Four speakers come from Leads University in Britain, two males and two females. They speak standard British English without accent of English dialects. They are undergraduates between 19-21 years old. Each speaker naturally and neutral-focusedly reads every sentence in one mood three times; we calculate the mean value of the three-time pitch ranges in one sentence, then we calculate the mean value of all the sentences in one mood. And each sentence is read in two different moods respectively. We have $4 \times 3 \times 3 \times 2 = 72$ sentences.

We use Praat5.046 and the Speech-Lab devised by Nankai University to extract pitch and carry out statistical analysis.

The studies conducted by Nolan [6] and Aijun Li [1] reveal that semitone is probably one suitable unit to reflect the psycho-acoustic relationship in the study of intonation. Therefore, the calculations in this paper are mainly based on hertz and then converted into semitone. The equation of converting the hertz to semitone is as follows:

$$(1) \quad St = 12 * \lg(f/fr) / \lg 2$$

("f" stands for hertz, "fr" stands for the reference frequency, male and female are set as 55 hertz and 64 hertz respectively)

Based on the data scaled by semitone, we convert them to percentage. The calculating of percentage is a relativized method. The calculating way is as follows:

$$(2) \quad Ki = 100 * (Gi - Smin) / (Smax - Smin)$$

$$(3) \quad Kj = 100 * (Gj - Smin) / (Smax - Smin)$$

$$(4) \quad K_r = K_i - K_j$$

(G_i stands for the semi-tone value of the top line of each tone group, G_j stands for the semi-tone value of the bottom line of each tone group; S_{max} stands for the semi-tone value of the top line of the whole sentence, S_{min} stands for the semi-tone value of the bottom limit of the whole sentence; K_i stands for the percentage of the top line of the sub-range, K_j stands for the percentage of the bottom line of the sub-range, K_r is the percentage value of the pitch range of the sub-range).

With percentage data, we could further make quantitative calculations focused on fluctuation scale of different hierarchy in intonation structure, like full range (sentence range), sub-range (tone group range) in the two different intonation moods.

3. EXPERIMENTAL PROCESS

3.1. The experimental analysis of the sentence range

Following the tone group concepts of Halliday [4, 5], Cruttenden [2] and Roach [7], we divide the sentences into initial, middle and last tone groups (see the sentence division in 2.), and the highest and the lowest values in all of the tone groups constitute the top and bottom of the full range and when the highest value subtracts the lowest value, we get the range of the whole sentence as follows.

Table 1 points out the full ranges (in Hertz) of the four speakers' declarative questions are wider than those in statements, especially for the two females. Except M1, the full range of females' in the two moods are wider than those in males'. While semitone displays less sharp differences and makes the comparison possible, this is the beginning of our calculation.

Table 1: The full range of statement (S) and declarative question (D) of four speakers'.

		M1	M2	F1	F2
S	Hz.	69.3	31.8	58.2	77
	St.	11.0	6.1	5	6.5
D	Hz.	87.0	77.0	143.5	148.0
	St.	10.2	11.1	12.0	11.8

3.2. The experimental analysis of the tone groups

In 2. and 3.1, each sentence consists of 3 tone groups. Similarly, we get the sub-range of each tone groups, see table 2 below.

In both moods, the ranges of the last tone groups are the widest, and the last range span

reaches 100% in declarative question, which indicates maximum expansion of the last group.

Table 2: The sub-range of statement (S) and declarative question (D) of four speakers'.

		Herz			Semitone			Percentage(%)		
		1	2	3	1	2	3	1	2	3
S	M1	63.9	34.0	64.5	9.9	5.4	10.5	89	49	95
	M2	25.7	19.4	27.8	4.7	3.7	5.4	78	60	89
	F1	38.7	32	39.6	3.2	2.8	3.6	63	56	71
	F2	56.4	48.3	52.1	4.5	4.1	4.6	69	62	72
D	M1	70.2	58.6	87.0	8.2	6.8	10.2	80	66	100
	M2	48.0	45.5	77.0	7.1	6.9	11.1	64	63	100
	F1	104.7	88.2	143.5	8.6	7.2	12.0	71	60	100
	F2	106.0	105.0	148.0	8.3	8.1	11.9	70	68	100

1--initial tone group; 2--middle tone group; 3--last tone group

3.3. The comparative study on the fluctuation scale between English statement and declarative question

The traditional ways of intonation analysis, such as pitch-maximum, pitch-minimum and pitch excursion usually describe the individual's intonation movement phenomena and tendencies with less focusing on the underlying different pattern between different moods. Here, we apply Q value and fluctuation scale to explore the comparative intonation pattern in different moods. The calculating method is as follows:

$$(5) \quad Q_x = K_x - K_{(x+1)}$$

($x=1,2,3,\dots$ it's the sequence order of every tone group in the sentence; K is the relativized percentage value of the sub-range of each tone group)

In order to compare the two moods feasibly in the same dimension, we put each speaker's semitone data in the two moods together, then choose the highest and lowest values as the two poles of the pitch range, and calculate their percentage and fluctuation scales, see below:

Table 3: The comparative study of full range and sub-range of statement and declarative question (%).

		M1	M2	F1	F2
S	whole	69(0-69)	47(0-47)	42(25-67)	54(18-72)
	initial	62(7-69)	35(13-47)	27(40-67)	38(34-72)
	middle	34(18-53)	30(10-40)	56(33-57)	34(29-63)
	last	66(0-66)	38(0-38)	30(25-55)	39(18-57)
D	whole	64(36-100)	81(19-100)	100(0-100)	100(0-100)
	initial	51(43-95)	52(32-83)	71(19-90)	70(21-90)
	middle	43(49-92)	51(28-79)	60(25-85)	68(23-91)
	last	64(36-100)	81(19-100)	100(0-100)	100(0-100)

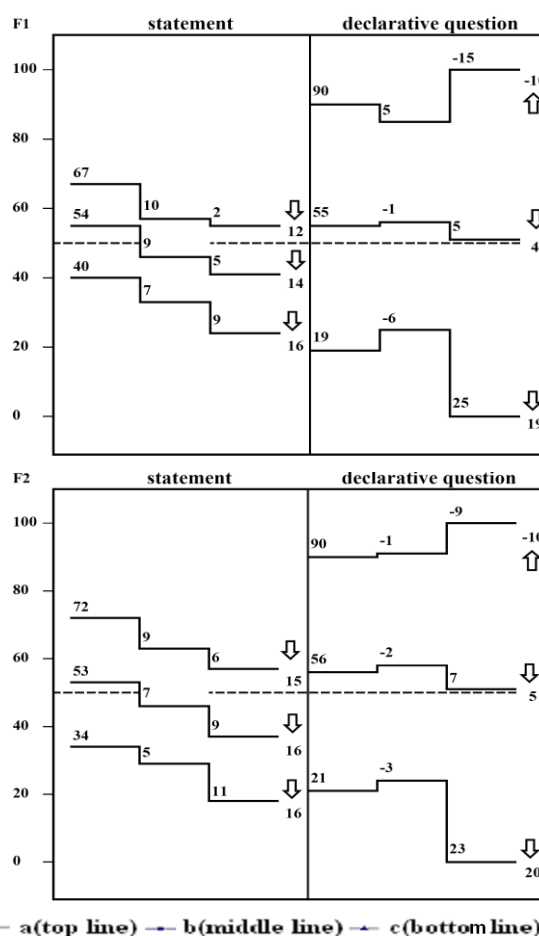
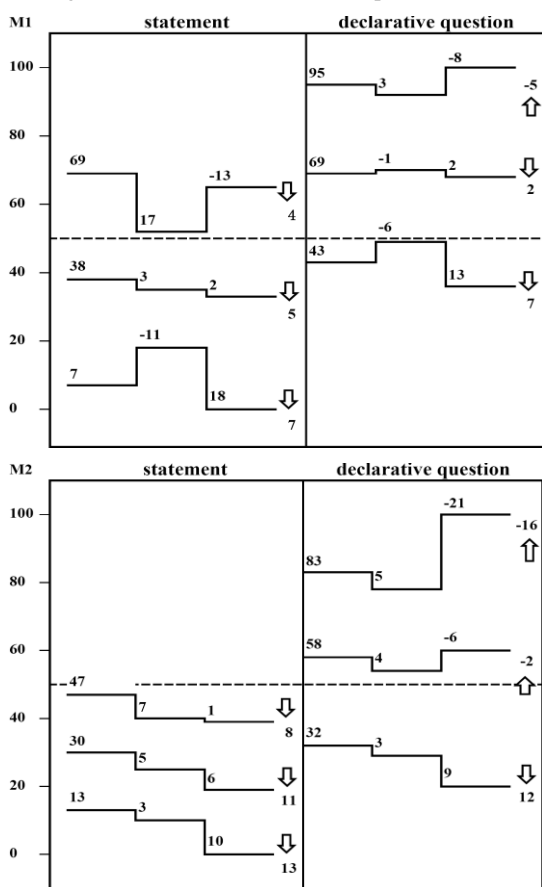
So we can get the different fluctuation scale between English statement and declarative question as follows.

Table 4: The comparative study of fluctuation scale of statement and declarative question (%).

speakers		statement				speaker		declarative Question			
		fluctuation scale	Q0	Q1	Q2			Q	fluctuation scale	Q0	Q1
M1	a	69	17	-13	4	M1	a	95	3	-8	-5
	b	38	3	2	5		b	69	-1	2	1
	c	7	-11	18	7		c	43	-6	13	7
M2	a	47	7	1	8	M2	a	83	5	-21	-16
	b	30	5	6	11		b	58	4	-6	-2
	c	13	3	10	13		c	32	3	9	12
F1	a	67	10	2	12	F1	a	90	5	-15	-10
	b	54	9	5	14		b	55	-1	5	4
	c	40	7	9	16		c	19	-6	25	19
F2	a	72	9	6	15	F2	a	90	-1	-9	-10
	b	53	7	9	16		b	56	-2	7	5
	c	34	5	11	16		c	21	-3	23	20

Table 4 represents the comparative interactions between English statement and declarative question in the same dimension. Qb stands for middle line, which is the mean value of top line (a) and bottom line (c). With that, we can get the different intonation pattern of English statement and declarative question to make further discuss. See the following figure.

Figure 1: The comparative graph of intonation pattern of English statement and declarative question.



→ a(top line) → b(middle line) → c(bottom line)

The above figure clearly and vividly displays the inter-action between the prosodic units in English statement and declarative question. The values in the first tone group are the beginning positions of the top, middle and bottom line in intonation pattern and the following value of each line indicates the correlation between different tone groups. When the value is positive, it means the next tone group declines the corresponding

percentage compared with the preceding tone group, vice versa. Besides, the arrow in each graph indicates the movement tendency of the top, middle and bottom line through the whole moods respectively. If the arrow points down, it means the line declines as a whole, vice versa.

Firstly, we can observe that most values between the correlated tone groups in English statement are positive (there are two negatives in M1's). And all the arrows in the four speakers' statements point down. All these indicate the declination tendency is the main characteristic of statement definitely. While for the four speakers' declarative question, almost all the four speakers' line positions are higher than those of the statement, and there are much more negative values. The values of the top lines in the last tone groups are all negative, while the four speakers' bottom lines of the last tone groups are all positive. These prove that the increase and expansion of the whole pitch range are the intonation features of the declarative question. Except M1, for the other three, the full range and the sub-range of declarative question are wider than those of the statement prosodic units.

Secondly, except M2 in declarative question, the Q values of the bottom lines in all the other intonation pattern are the biggest, furthermore, the Q2 values of the bottom line in the last tone groups are also the biggest (except M2 in declarative question), all these indicates that bottom line plays important role in the prosodic movements in the intonation, especially the bottom line in the last tone groups in the neutral-focus sentences.

Thirdly, compared with the pitch range of the middle tone group in statement, that of the middle tone group in English declarative question are much more narrower to act as a transitive sound period to help reach the sharpest sound contrast in the last tone group of declarative question.

Finally, middle line (Qb value), which is usually invisible in the experimental pitch graph representation, indicates the underlying differences between the two different moods. First, for the middle lines in statement, the two males' middle lines are under 50%, while the two females' initial middle lines are above 50% and the middle and last middle lines are under 50%. And the figure precisely points out that all the middle lines of the four speakers in declarative question are above 50%. The above indicates that the marked functions the middle line plays when distinguishing the two functional moods.

Moreover, the four speakers' absolute Q values of the middle lines in statement are larger than those in declarative question, just as M1: $5 > 1$; M2: $11 > -2$; F1: $14 > 4$; F2: $16 > 5$, which means middle line in English statements fluctuates heavier than that in English declarative question. That is because the middle line in English statement declines one prosodic unit after another, while in declarative question it is determined by the interplay between the uprising top line and declining bottom line to reach the dynamic balance.

4. CONCLUSION

This paper makes a comparative study on the English statement and declarative question with the concept of intonation pattern. From hertz to semitone, to percentage and finally to Q value, this study presents intonation from different angle. The results indicate that due to the different intra-fluctuation of prosodic units in different prosodic hierarchy and different moods, underlying intonation pattern goes differently: the feature of English statement is the domination of pitch declination while the increase and expansion of the pitch range are the two core characteristics of English declarative question; middle line (Qb value) plays a marked function in intonation to distinguish different moods and the range of middle prosodic units aids the realization of declarative question mood. And, in neutral-focused sentences, the bottom line of the last tone group plays important roles in the prosodic movements in English intonation.

5. ACKNOWLEDGEMENTS

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