Perception of Narrow Focus by Bilingual Speakers

Author: Shinobu Mizuguchi[1], Yukiko Nota[2], Koichi Tateishi[3]
Affiliation: [1]Kobe University, [2]ATR Promotions, [3]Kobe College
Email Address: [1]mizuguti@kobe-u.ac.jp, [2] ynota@atr.jp, [3] tateishi@mail.kobe-c.ac.jp

ABSTRACT

We consider the perception of narrow/contrastive focus by bilingual speakers in neural terms. Gandour et al. [1] investigated neural substrates underlying perception of narrow focus in Mandarin Chinese (L1)/English (L2) bilinguals. The focus identification ratio is lower in English (86.2%) than in Chinese (95.8%), and greater activation for L2 than L1 occurred in the bilateral anterior insula and superior frontal sulcus. They claim that the activity in the anterior insula is graded in response to the task difficulty in L2.

We conducted a perception experiment of narrow focus of Japanese and English with Japanese (L1)/English (L2) bilinguals. The focus identification ratio is lower in Japanese (86.2%) than in English (98.6%). Our fMRI experiment on 22 subjects shows greater activation for L2 than L1 occurring in bilateral superior temporal gyri and left precentral gyrus, along with longer reaction time in L1. Our experiment suggests that the acoustic realization of focus differs among languages, which is revealed in neural processing. Though much needs to be clarified, greater neural activity is not due to the task difficulty in L2 but to the acoustic properties of a language, contra Gandour et al. [1]

Keywords: narrow/contrastive focus, perception, L1/L2, neural basis, fMRI

1. INTRODUCTION

Focus is the information in the sentence that is assumed by the speaker not to be shared with the hearer (cf. Jackendoff [2]). The literature (cf. Halliday [3] and many others) classifies focus into 'broad focus (BF)' and 'narrow focus (NF)'. The former, for instance, can signal the foci *the shed*, *painted the shed*, or the whole sentence in (1), depending on the context. The latter narrows the possible range of foci to a particular constituent such as only *the shed*.

(1) John painted *the shed* yesterday. (Halliday [3])

We will consider NF in this paper; we will restrict ourselves to contrastive focus (cf. (2), (3)) in particular and see whether or not languages vary in how NF is acoustically realized and processed.

Gandour et al. [1] considered whether the neural substrates are shared or segregated in multilingualism and they employed functional MRI to investigate the neural basis of perception of sentence focus in Mandarin Chinese (L1) and English (L2). They recruited 10 late-onset, medium proficiency Chinese-English (C/E, henceforth) bilinguals, and used sentence-pairs with two potential locations of sentence focus (initial and final) both in Chinese and English, recorded by a male speaker of Mandarin and English. In the experiment, subjects were required to judge whether the focus location was in the initial or final position by pressing the corresponding mouse button.

The whole-brain cluster analysis revealed extensive overlapping activation between Chinese (L1) and English (L2) stimuli in frontal, parietal and temporal areas, but C/E bilinguals exhibited significantly greater bilateral activity in the anterior insula (aINS) ($F_{1,9}$ =12.15, p<0.01) and aSFS ROIs ($F_{1,9}$ = 18.54, p<0.005) when presented with English stimuli as compared to Chinese stimuli.

Behaviorally, the NF identification ratio is lower in English (86.2%) than in Chinese (95.8%), and Gandour et al. [1] suggest that the activity in the anterior insula is graded in response to the task difficulty in L2.

Gandour et al.'s finding and conclusion are interesting and suggest the difficulty of L2 perception. What is missing, however, is a consideration of how NF is realized acoustically. Lee et al. [4] and many others studied prosodic cues to contrastive focus and they found that the acoustic realization of contrastive focus differs across languages. They found that the focus identification ratio is high in languages with strong acoustic cues, while the accuracy ratio is low in languages with weak acoustic cues. In the next section, we will introduce Lee et al. [4] and our replicated perception experiment on contrastive focus in Japanese and English.

2. LINGUISTIC BACKGROUND

2.1. Perception Experiment on Narrow Focus

Lee et al. [4] conducted a cross-linguistic perception experiment of contrastive focus, using ten digit numbers of the form XXX-XXX-XXXX, where one number in the series was produced with focus under a Question-Answer sequence as in (2). Given only the response portion, participants were asked to identify which number was focused.

(2) A: Is Mary's number 215-418-5623?
B: No, the number is 215-417-5623.

They found that focused digits, as compared to unfocused digits, exhibit greater duration, intensity and pitch in Mandarin Chinese and American English, but not in Korean and Tokyo Japanese (cf. Table 1). This shows that languages can adopt different strategies when their speakers communicate the location of contrastive focus with the purely prosodic means of pitch, intensity and duration.

Table 1: Median z-score values of focused digits (adapted from Lee et al. [4])

	South Kyungsang Korean	Seoul Korean	Tokyo Japanese	Suzhou Wu	Standard French	Mandarin Chinese	American English
Production	median z-score values of focused digits						
duration	0.64	0.13	0.10	0.48	1.73	1.19	0.95
intensity	-0.26	0.24	-0.24	0.53	0.97	0.36	1.28
pitch	1.00	0.62	0.60	0.61	1.17	3.13	2.96
Perception identification rate	55.6%	44.6%	-	-	-	94.9%	97.3%

Weak — Prosodic Focus Marking — Strong

For languages for which Lee et al. [4] found strong acoustic cues (i.e. American English and Mandarin Chinese), high accuracy was obtained in the perception study. However, for languages with weaker prosodic marking, namely Seoul Korean and South Kyungsang Korean, low accuracy was obtained in the perception study. They concluded that the stronger the prosodic marking is, the higher the focus identification ratio is.

Lee et al. [4] did not conduct an identification experiment on Japanese, so we conducted a perception experiment on Japanese.

2.2. Precursor: Perception Experiment of Contrastive Focus with J/E Bilinguals

We replicated Lee et al. [4]'s perception experiment of contrastive focus of Japanese with Japanese (L1) and English (L2) (J/E, henceforth) late-onset bilinguals. We also conducted a perception experiment of contrastive focus of English with J/E bilinguals, to see the differences or similarities in perception between Japanese and English. We predicted that Japanese would be low in identification accuracy, since Japanese has weaker focus marking cues than English (cf. Table1).

2.2.1. Method and Materials

The method was the same as the perception experiment by Lee et al. [4]. We used Japanese tokens as in (3) and English tokens as in (2) as our materials, recorded by a male speaker of Tokyo Japanese and a male speaker of Midwest American English.

(3) A: Yamada-san-no bango-wa
Yamada-Mr/Ms-GEN number-TOP
215-418-5623-desu-ka?
215-418-5623-copula-Q
'Is Yamada's number 215-418-5623?'
B: Ie. 215-418-6623-desu.
no -copula
'No. (It) is 215-418-6623.'

Given only the response portion, participants were asked to identify which number was focused. They heard 30 utterances in each language which were presented in a random order. Since we conducted the two experiments on separate occasions, we had two groups of participants: one for the Japanese experiment (M2, F20, mean age 20.45, SD=0.87) and the other for the English experiment (M13, F5, mean age 20.5, SD=1). They reported no auditory difficulties, and we do not believe different groups of participants have affected our results. The experiment was conducted in a quiet room where the audio stimuli were projected from a room speaker.

2.2.2. Results and Discussion

Table 2 shows the results; the mean contrastive focus identification ratio was 86.2% in Japanese and 98.6% in English.

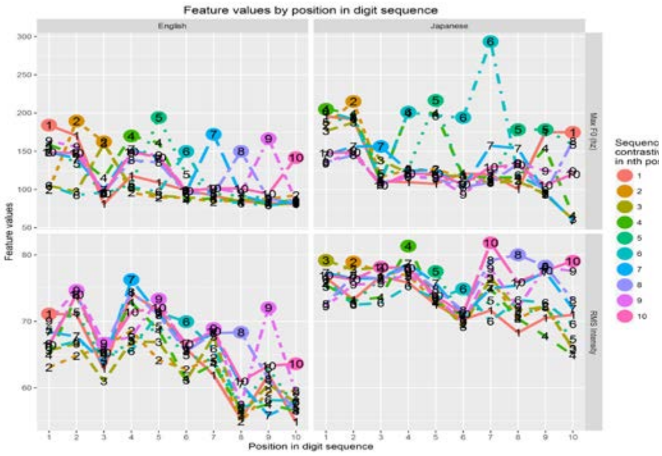
Table 2: Contrastive focus identification ratio in a ten digit number string in Japanese and English utterances.

	Target Word Position (% accuracy)										
	1	2	3	4	5	6	7	8	9	10	Ave.
Jap.	100	88	91	97	98	92	65	91	82	58	86.20%
Eng.	100	100	100	100	100	98	100	98	96	94	98.60%

Our prediction is borne out; Japanese contrastive focus is more difficult to identify than English contrastive focus, even though Japanese is the L1 of the participants.

Figure 1 shows the feature values by position in the digit sequences used in our experiment, telling that the F0 maximum and the Intensity correspond with the focus position in English, but not in Japanese.

Figure 1: Feature values by position in digit sequence



This is, we believe, why J/E bilinguals identify contrastive focus of English, their L2, more easily than Japanese, their L1, and it leads us to claim that the perception of contrastive focus is affected by acoustic cues, not by the L1/L2 distinction.

Gandour et al. [1] investigated the processing of sentence focus in Chinese and English, both of which have strong acoustic cues (cf. Table 1). We interpret that their finding of the extensive overlapping activation between Chinese (L1) and English (L2) stimuli in frontal, parietal and temporal areas as being possibly driven by similar acoustic cues between the two languages.

Japanese and English contrastive foci are, on the other hand, differently cued acoustically, and we suspect focus processing is not the same between Japanese and English. We conduct an fMRI experiment on focus processing of Japanese (L1) and English (L2) to investigate whether the neural substrates are shared or segregated between these two languages.

3. FMRI EXPERIMENT ON FOCUS IN JAPANESE (L1) AND ENGLISH (L2)

3.1. Method and Materials

22 right-handed J/E bilinguals (M11, F11, mean age = 26.7, SD =11.1) were recruited. Our participants were all late-onset J/E bilinguals and the average of their TOEFL scores was 595 (SD = 55.7).

We used the 10-digit number materials used in our precursor perception experiment mentioned in Section 2. We used numbers, not lexical words, in our experiment, to minimize language-specific accentual phrasing. 20 Japanese and 20 English materials were given in a pseudo-randomized order through a headphone. Half of the materials contained contrastive focus, and the other half contained broad focus. Average trial duration was about 4 sec. and the response interval was 2 sec.

Before the experiment, participants sat for a practice session and were instructed about the distinction between contrastive focus and broad focus, and how they sound like in Question-Answer dialogues, as in (2) and (3). They only listened to the answer part in the experiment and were asked to identify whether the utterance sounded as contrastive focus or broad focus. They were given a device with two buttons and asked to press the left button for contrastive focus and the right button for broad focus with their index finger and middle finger of their right hand, respectively.

We used a 3T MRI scanner and the data was analysed with SPM12.

3.2. Results

3.2.1 Behavioral Results

Table 3 shows the behavioral responses recorded during the fMRI experiment.

Table 3: Focus identification ratio

	English (L2)	Japanese (L1)
Broad Focus	95.19% (SD=0.05)	99.09% (SD=0.01)
Contrastive Focus	90.06% (SD=0.11)	80.02% (SD=0.19)

This result is compatible with our precursor experiment in Table 2 and shows that the contrastive focus identification ratio of Japanese (L1) is lower than that of English (L2). The difference is significant in a t-test ($t(38) = -1.78$, $p=0.042$).

3.2.2 fMRI Results

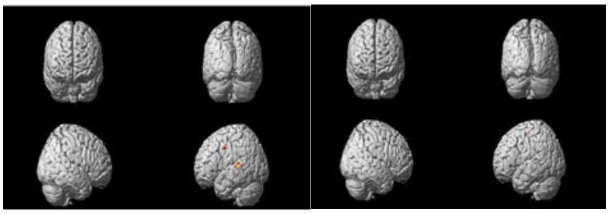
Table 4 shows the difference between contrastive focus and broad focus (NF and BF in Table 4, respectively) and the network of regions which were significantly involved in English and Japanese.

Table 4: Activation peaks provided by the random-effect group analysis for NF vs. BF (p<0.05, FWE corrected)

Contrast	Anatomical description	z-score	x,	y,	z
NF>BF (English)	Precentral gyrus	5.26	-52,	-4,	42
	Superior temporal gyrus	5.24	-54,	-38,	10
	Superior temporal gyrus	4.93	58,	-6,	-3
NF>BF (Japanese)	Precentral gyrus	4.96	-38,	-22,	60
NF>BF (English - Japanese)	Superior temporal gyrus	5.49	-54,	-14,	0
	Superior temporal gyrus	5.04	60,	-18,	4
	Precentral gyrus	5.01	-50,	-2,	40

Figure 2 shows the activated regions, revealing that not much overlapping activation is observed between Japanese (L1) and English (L2).

Figure 2: Cerebral activity involved in the NF vs BF contrast in English (left) and Japanese (right) (random-effect group analyses, p<0.05, FWE corrected)



4. DISCUSSION AND CONCLUSION

Gandour et al. [1] conducted a narrow focus identification of Experiment on Chinese (L1) and English (L2), and their behavioral data shows that narrow focus is more accurately identified in the speaker's L1, and reaction times are longer in their L2 (cf. Table 5), contra ours.

Table 5: Identification ratio and reaction time

	Gandour et al. [1]			our study		
	L1 (Chi)		L2 (Eng)	L1(Jap)		L2 (Eng)
Identification ratio (%)	95.8	>	86.2	80.0	<	90.1
Reaction time (ms)	552.4	<	670.7	467.3	>	451.6

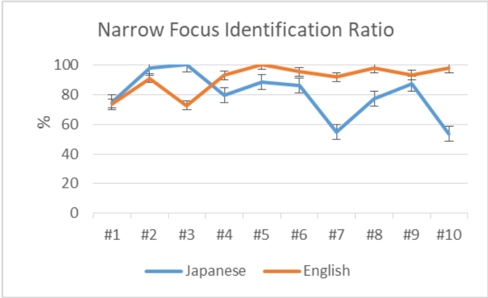
With our findings presented in this paper, we provide an alternative explanation; the behavioral differences found by Gandour et al.[1] and the present study were due to differences in the acoustic cues of Chinese, Japanese and English. Recall Table 1, which shows that Chinese and English have stronger acoustic cues than Japanese. It is no surprise that languages with stronger acoustic cues are easier to perceive.

Japanese is a pitch language with its accent realized by a falling H*-L bi-tonal contour. It has accented (A, e.g. *roku'* 'six') and unaccented (U, e.g. *san* 'three') words which are lexically determined. Mizuguchi and Tateishi [5] argue that narrow focus on unaccented words is more poorly identified than narrow focus on accented words in Japanese. Due to the accent rules of Japanese, the 10-digit phone numbers XXX-XXX-XXXX of our experiment materials are realized with the prosodic structure (4).

(4) [[UAA] [UAA] [[UA][UA]]]

Figure 3 shows that the narrow focus identification ratio in our fMRI experiment varies depending on the position.

Figure 3: Narrow focus identification ratio per position in our fMRI experiment



We suspect lexical restriction on pitch interferes with the phonetic cues of focus and makes focus identification difficult in Japanese.

Perrone-Bertolotti et al. [6] examine the cerebral regions involved in the perception of narrow focus and broad focus in French. Behaviorally, narrow focus is identified at a rate of 93.92% and broad focus is identified at a rate of 98.35%. They found that the network of regions was significantly more involved in the narrow focus than in the broad focus condition, and the processing is a right-hemisphere dominant dual network.

We share the observation by Perrone-Bertolotti et al. [6] that broad focus is more accurately identified (cf. Table 3), but their findings with French are incompatible with our findings with Japanese; Figure 2 shows that not much neural network is involved to process contrastive focus in Japanese, and Table 4 reveals that different regions are activated in Japanese than in French.

We have investigated whether the neural substrates are shared or segregated among languages in this paper. Our findings are that, contra Gandour et al. [1], the perception identification of narrow focus is higher not in L1 but in L2, and, contra Perrone-Bertolotti et al. [6], not much neural activation is involved in narrow focus processing in L1. We suspect the neural activity reflects the acoustic realization of focus, not an L1/L2 distinction. We need more cross-linguistic acoustic and neural research before we get to know what is truly involved in human prosody processing.

5. ACKNOWLEDGEMENTS

We thank Rieko Okada and Michinao Matsui for discussion. We also are in debt to the anonymous referees of the ICPhS committee for comments. Our deepest gratitude goes to Tim Mahrt for data analysis and discussion. This study is supported by the Japan Society for Promotion of Science (JSPS) grant #15K02480, given to Shinobu Mizuguchi.

6. REFERENCES

[1] Gandour, J., Tong, Y., Talavage, T. Wong, D. Dzemidzic, M., Xu, Y., Li, X. and Lowe, M. 2007. Neural basis of first and second language processing of sentence-level linguistic prosody. *Human Brain Mapping*. 28, 94-108.

[2] Jackendoff, J. 1972. *Semantic Interpretation in Generative Grammar*. Cambridge, Mass.: The MIT Press.

[3] Halliday, M.A.K.,1966-1968. Notes on transitivity and theme in English Part 1 – Part 3. *Journal of Linguistics* Vol.1, 37-81, Vol.2, 199-244, Vol.3, 153-308.

[4] Lee, B. Y-Cheol, Wang, S., Chen,M., Adda-Decker, A., Nambu, S., Liberman, M. 2015. A crosslinguistic study of prosodic focus. *Proceedings of ICASSP 2015 and 2015 IEEE International Conference*, 4754-4758. http://dx.doi.org/10.1109/ICASSP.2015.7178873.

[5] Mizuguchi, S. and Tateishi, K. 2018. Focus prosody in Japanese reconsidered. *Proceedings of the 92nd Annual Meeing of the Linguistic Soceity of America*. http://dx.doi.org/10.3765/plsa.v3i.4291.

[6] Perrone-Bertolotti, M., M. Dohen H. Lœvenbruck, M. Sato, C. Pichat, M. Baciu. 2013. Neural correlates of the perception of contrastive prosodic focus in French: A functional magnetic resonance imaging study. *Human Brain Mapping*. 34, 2574-2591. http://dx.doi.org/10.1002/hbm.22090.