



The effect of language dominance on the selective attention of segments and tones in Urdu-Cantonese speakers

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Abstract

To perceive a second language (L2), non-native speakers not only have to focus on phonological, lexical and grammatical knowledge, but also need to develop a good mastery of L2 strategic knowledge, including selective attention and language planning. Previous research has found that non-tonal speakers are overtly attentive to segments, while tonal language speakers give more attention to tones. However, it is unclear how different dominant language speakers distribute their attention when processing both segments and tones in non-native speeches. In the current study Cantonese native speakers, Cantonese-dominants, and Urdu-dominants participated in an attention distribution experiment in Cantonese. The results show that the Urdu-dominants retain their L1 attentional strategy in the processing of Cantonese stimuli, classifying the stimuli along segments, while the Cantonese native speakers are more attentive to tones. Moreover, the Cantonese-dominants perform either in monolingual mode or bilingual mode according to different tasks, showing a perceptual flexibility in highly proficient and experienced listeners. The results reveal that language dominance plays a vital role in listeners' attention distribution. The research also supports the ASP model and hypothesis on bilinguals, proposed by [1].

Index Terms: Attention distribution, early multilingual speakers, language dominance, selective perceptual routine.

1. Introduction

Selective attention refers to a sensory skill in a cognitive process where listeners make a selection of certain sub-syllabic dimensions while ignoring the irrelevant information. To perceive L2 intelligibly, listeners not only need a large store of L2 language knowledge (e.g. phonology, lexicon, grammar), but also have to master L2 strategic knowledge. When perceiving a speech sound, tonal speakers pay simultaneous attention to both segmental and tonal dimensions, as they tend to use pitch information as the primary cue in lexical and sentential meaning [2]. Whereas when processing a non-native tonal language, non-tonal speakers may find it hard to give attention to tone due to the absence of a sensitivity towards tone [2]. Recently, it has been reported that tonal sensitivity is expected to be gradually acquired by non-tonal speakers as tonal L2 experiences and proficiency improve [3] [2]. But it is still unclear how sensitively and automatically non-tonal speakers will be able to allocate their attention to a tonal L2, even when they have developed into highly proficient and fluent target language users.

In the Automatic Selective Perception (ASP) model [4], the feature of speech perception is a purposeful and information-seeking activity. Through this activity, adult

listeners can use a highly over-learned and highly automatic program to detect the most reliable acoustic parameters, which specify their first language systems. Such an over-learned and highly automatic program is called a selective perceptual routine (SPR) in the ASP model. For example, tonal speakers can develop an internalized SPR for the distribution of cognitive attention to different linguistic dimensions of speech. With the assistance of such SPR, native speakers are able to automatically extract sufficient information from various linguistic conditions. Recently, more and more neurocognitive and behavior studies on ASP indicate that a more automatic SPR would be available for non-native learners when more L2 proficiency is accumulated [2] [3].

[2] invited native tonal Mandarin adult speakers, non-tonal Dutch speakers (who had never learned Mandarin), and Dutch-speaking learners of Mandarin to participate in an ABX task in which the target syllable in disyllabic non-words varied along tonal or segmental dimensions. Their results supported that Mandarin speakers were attentive to both segmental and tonal information in the processing of Mandarin stimuli, whereas native Dutch speakers mainly depended on the segmental dimension. A developmental trajectory of L2-specific selective attention for learners was revealed, showing that beginners were more likely to ignore tonal information compared with advanced learners [2].

Prior studies on selective attention have focused on whether L2-specific attentional strategy could be acquired by less experienced learners or by adult learners [4]. However, it is still unclear whether the learners are able to acquire an L2-like attentional strategy on achieving a high L2 dominant bilingual degree defined the dominant language as the “more proficient” or “further developed [5]” language for bilinguals. The dominant language of bilinguals can be either their L1 [6] or their L2 [1], whichever has been primarily and regularly utilized by language speakers in daily conversations. [7] suggested that language dominance can be interpreted through dominance scores according to the questionnaire survey of the Bilingual Language Profile (BLP). The BLP allows us to access bilinguals' dominance on the following aspects: age of acquisition of L1 and L2 (language history); frequency and context of use (language use); competence in different skills (language proficiency), and attitudes toward each language (language attitudes). These factors are organized into four modules with equal weightings. The BLP method has been widely introduced in bilingual studies and in empirical and laboratorial linguistic studies [8].

Views vary tremendously as to how bilinguals accommodate their weaker and stronger languages. The “one-activation” view suggests that speakers weaker and stronger languages are separately activated, without interfering with each other [8]. Bilingual speakers are regarded as a

population which combines each independent language. In contrast, the “co-activation” view suggests that bilinguals show simultaneous activation of both languages even when processing only one. [6] found that an early exposure to a new language is not sufficient to overcome the influence of L1 when perceiving L2 categories.

In the domain of second language acquisition, as an extension of Perceptual Assimilation Model to L2 perceptual learning, PAM-L2 [9] predicts that non-native listeners may assimilate L2 contrasts into L1 categories, or establish new categories for the unassimilated L2 sounds. [1] attempted to extend the L2 acquisition models to account for the case of bilingual speakers, proposing that L1 and L2 systems are both well developed, but it is not excluded that there exist a L1/L2 overlap, within which some phonetic properties are shared between L1 and L2. [1] emphasizes the “flexible” role in language dominance of bilingual speakers in speech processing. [10] states that “a bilingual speaker is not two monolinguals in one,” and that bilinguals should be considered as a unique and configured population very different from a monolingual one [1]. It is posited that such bilingual “flexibility” allows listeners to perform as a monolingual speaker or a bilingual speaker according to their tasks, or the language mode in which they are immersed, and that bilingual speakers would perform differently in terms of different experimental trials.

In the application of ASP model, previous studies showed how native speakers, late adult learners [4] and experienced learners [2] develop an L2 SPR. However, it is not clear what L1 or L2 dominant bilingual speakers will be like in developing such a higher-order L2 SPR. The current study aims to fill this gap. Three research questions are addressed: (1) How do early bilingual speakers allocate their selective attention to segmental and tonal dimensions when processing L2 contrasts? (2) What is the role that language dominance plays in the process? (3) Can the framework of PAM-L2, and its extension on bilinguals [1] et al., 2012) account for the experimental results? To investigate the above questions, native Cantonese speakers, Cantonese-dominant and Urdu-dominant bilingual speakers are invited to undertake a revised ABX task from [2]. Urdu speakers were immigrants who arrived in Hong Kong at an early age. In the current case, their L1 is Urdu, and Cantonese was regarded as their L2.

2. Method

2.1. Participants

Thirty-six bilingual speakers whose first language is Urdu and 20 native Cantonese speakers (10 female, 10 male) took part in the experiment. Both the bilingual participants (mean age = 12.1 years, SD = 3.2) and native Cantonese speakers (mean age = 13.3 years, SD = 2.1) were year one students, who were healthy, right-handed and did not suffer from any hearing difficulties. The classification of participants as Urdu dominant or Cantonese dominant was determined by their responses to the BLP questionnaire [7]. Eventually, 18 Urdu-dominants (11 female and 7 male) and 18 Cantonese-dominants (10 female and 8 male) are selected as participants in the experiment, according to the global language dominance scores in the four modules of the BLP. Language dominance scores (LDSs) ranged largely from -55.4 (strongly L2 dominant) to 121 (strongly L1 dominant), as shown in Figure 1.

The multilingual participants were exposed to Urdu during the first one or two years of their lives. The Cantonese-dominants immigrated to Hong Kong at an early age of 4.3 years old (range: 1 ~ 6), started learning Cantonese at the age of 4.9 years (range: 2 ~ 6), while the Urdu-dominants arrived Hong Kong at an early age of 7.7 years old (range: 5 ~ 10), started learning Cantonese at the age of 8.1 years (range: 5 ~ 13). The multilingual students only used Urdu at home, and utilized both English and Cantonese as instruction languages at school.

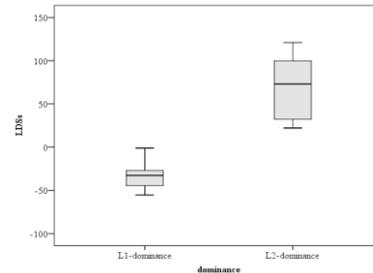


Figure 1: The distribution of language dominance scores according to the Bilingual Language Profile.

2.2. Stimuli

As shown in Table 1, two pairs of CVCV nonce words /kasu-/tafu/ and /bisu-/diso/ (in the current study, /b/ and /d/ referred to voiceless unaspirated stops) were selected with Cantonese Tone 2 (high-rising) or Tone 4 (low-falling) on the initial syllables, and the second syllable for each disyllabic nonce word was neutralized as Cantonese high-level tone. Similarly to the stimuli in [2], three native Cantonese speakers (two female, one male) were invited to record the disyllables with Boom microphone, in the audio booth at Hong Kong Polytechnic University. The nonce words were provided in Roman script and Cantonese tone marks. These native speakers, who were previously trained in the pronunciation and the Cantonese scripts of the nonce words, were asked to produce the disyllables in a natural speaking speed. The recordings were saved with a sampling rate of 44,100 Hz.

Table 1: Arrangement of stimuli in ABX trials. The number between syllables represents a Cantonese tone mark; 1, 2, and 4 stand for Tone1, Tone 2, and Tone 4 in Cantonese, respectively.

Condition	A	B	X
Segment-and-tone	<u>ka2su1</u>	<u>ta4fu1</u>	<u>ka2su1/ta4fu1</u>
	<u>ka4su1</u>	<u>ta2fu1</u>	<u>ka4su1/ta2fu1</u>
	<u>bi4so1</u>	<u>di2fo1</u>	<u>bi4so1/di2fo1</u>
	<u>bi2so1</u>	<u>di4fo1</u>	<u>bi2so1/di4fo1</u>
Segment-or-tone	<u>ka2su1</u>	<u>ta4fu1</u>	<u>ka4su1/ta2su1</u>
	<u>ka4su1</u>	<u>ta2fu1</u>	<u>ka2su1/ta4fu1</u>
	<u>bi4so1</u>	<u>di2fo1</u>	<u>di4fo1/bi2fo1</u>
	<u>bi2so1</u>	<u>di4fo1</u>	<u>di2fo1/bi4fo1</u>

ABX test was adopted as experimental method, with two conditions: segment-and-tone condition and segment-or-tone condition [2]. In the segment and tone condition, participants were required to identify target X that matched with either A or B in both segment and tonal dimensions. In the segment or

tone condition, in which target X matched with either the segmental or tonal dimension, participants chose freely between the two. The distribution of attention could therefore be observed from the results. The speakers were shuffled in each ABX combination instead of it being produced by the same speaker, in order to increase phonetic variability and listeners' memory load. The stimuli order can be ABX or BAX, and for each task, we got 16 ABX stimuli (two non-word pairs \times two Cantonese tones \times two AB orders \times two matches with A or B).

2.3. Procedure

The experiment was carried out through Praat experiment. Each participant was seated in front of a computer (Lenovo ThinkCentre desktop, i5 core, USB interface: 3.0) in a quiet classroom in the local secondary schools. Instructions were given only in Cantonese and all participants were properly briefed about the task procedure. They were asked to listen to three syllables, A, B, and X and indicate if X sounded more similar to A or B by a mouse click on a "1" or "2" shown on their computer screen. In each trial there was a 600ms interval between standard A and standard B, and X appeared after a 900ms pause [2]. The inter-stimuli interval between two trials was 2,500ms, and if the subject failed to respond within the interval, the stimulus would be shown again later on, so there would be no missing data in the experiment. Four-minute familiarization trials in the segment-and-tone condition were given to the listeners before a formal experiment started. For each individual, there were five-time repetition for each stimuli, resulting in 160 ABX trials (16 ABX stimuli \times 2 tasks \times 5 repetitions) in total. The responses and reaction time were collected with the experimental program.

3. Results

We calculated response rate according to the percentages of "correct" or "segment" responses out of the five responses for each participant and each ABX stimulus for the segment-and-tone and the segment-or-tone conditions respectively. On the basis of sample size and the distribution of data, the logistic mixed-effect model and the linear mixed-effect model (LMMs) were performed separately for both responses and reaction time in R using the lme4 package [10] in terms of the test field of individual response rate. All p values were corrected with Bonferroni adjustment for multi-comparisons. The LMM model incorporated fixed effects of subject group (natives, L1-dominants, L2-dominants), experimental trial (segment-and-tone, segment-or-tone), as well as their interaction. For random effects, by-subject and by-item intercepts were included.

Figure 2 depicts the average response rates/reaction time for native and bilinguals, and the results of LMM for response rate/reaction time is presented in Table 2. According to LMM, there was significant main effects and an interaction in terms of the subject group and condition for response rates ($\beta = 22.54$, $SE = 0.89$, $df = 1734$, $t = 25.07$, $p < .001$) and reaction time ($\beta = 0.2$, $SE = 0.06$, $df = 8887$, $t = 33.4$, $p < .001$), suggesting that native and non-native listeners performed differently across two ABX tasks.

For the segment-and-tone condition, the post-hoc Tukey test suggested that the differences between the Cantonese native group and the Cantonese-dominant group were not statistically significant. This suggests that generally, the Cantonese-dominant bilinguals were able to accurately

identify Cantonese stimuli as quickly as the Cantonese native speakers did in the segment-and-tone condition.

In comparison with the Cantonese-dominant bilinguals, the Urdu-dominant participants evidently needed ($z = 0.14$, $p < .001$) more time ($M = 1.72s$, $SD = 0.96$) to respond to the Cantonese stimuli, with significantly ($z = 4.29$, $p < .001$) lower accuracy rates/response rates ($M = 74.6\%$, $SD = 15.2$). This indicated that Cantonese proficiency and experience facilitated the Cantonese-dominant bilinguals to perceive L2 stimuli more phonologically.

For the segment-or-tone condition, only 41.1% ($SD = 11.62$) Cantonese native speakers classified the stimuli along "segments", far fewer ($z = 3.33$, $p < .001$) than the Cantonese-dominant bilinguals with a percentage of 62.5% ($SD = 12.1$) for "segments". This illustrated that although the Cantonese-dominant bilinguals obtained a comparable performance with the native speakers in the trial of segment-and-tone, they still performed significantly differently from the native speakers group.

Around 73.1% ($SD = 19.35$) of Urdu-dominant participants redistributed their attention more frequently ($z = 3.19$, $p = .0093$) to the segmental dimension when classifying Cantonese non-words than the Cantonese-dominant bilinguals did. Compared to the Cantonese-dominant bilinguals, the Urdu-dominant participants were evidently more attentive to the segmental information.

Moreover, it is noteworthy that the Cantonese-dominant bilinguals ($M = 2.17s$, $SD = 0.81$) responded much more slowly than both the native speakers ($M = 1.78s$, $SD = 0.25$; post-hoc: $z = 1.26$, $p = .0093$) and the Urdu-dominants ($M = 1.86s$, $SD = 0.58$, $z = 1.81$, $p = .0186$). The slow response for the Cantonese-dominants revealed a larger cognitive effort in making a decision on the stimuli. No statistical difference was reported in reaction time between the Urdu-dominant bilinguals and the native speakers, suggesting that the Urdu-dominants were not necessarily subject to interference by the weaker language.

A comparison of the results of the two experimental trials shows that the Cantonese natives ($z = 1.27$, $p < .001$), the Cantonese-dominant bilinguals ($z = 2.43$, $p < .001$) and the Urdu-dominant bilinguals ($z = 2.87$, $p < .001$) spent more time giving a response in the segment-or-tone task than in the segment-and-tone task, since the latter task was more cognitively demanding for the listeners.

Table 2: The LMM results for response rate and reaction time.

Fixed effects	Response rates					Reaction time				
	β	SE	df	t	p	β	SE	df	t	p
Interception	157.67	4.81	129.55	32.82	<.001	0.09	0.05	71.71	1.66	<.001
Subject group	28.22	2.26	129.55	12.51	<.001	0.43	0.03	71.42	16.89	<.001
Trial type	65.98	1.91	1734	34.46	<.001	0.89	0.01	8887	68.48	<.001
Subject group \times Trial type	22.54	0.89	1734	25.07	<.001	0.2	0.06	8887	33.4	<.001
Random	variance SD					vari SD				
I subject	116.31	10.79				0.02	0.14			
I item	65.32	7.66				0.09	0.01			
Marginal R^2	0.58					0.54				
Conditional R^2	0.78					0.73				

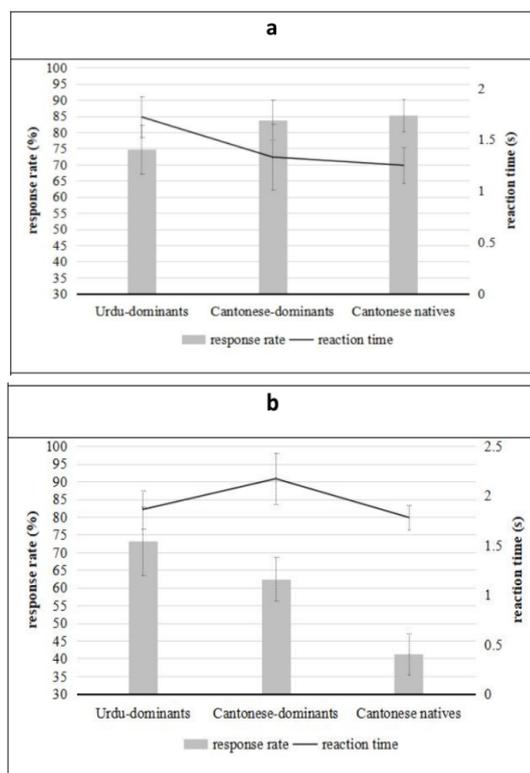


Figure 2: The mean accuracy/response rates (in the gray bars) and reaction time (in the dark line) for the segment-and-tone (panel a) and segment-or-tone (panel b). The minor y-axis shows the response time and the main y-axis illustrates the response rate. The error bars show 1/2 of standard deviations.

4. Discussion and Conclusion

The current study examined how the bilingual speakers distributed attention to segments and tones when processing Cantonese.

Compared with segment-or-tone condition, in the segment-and-tone condition, both accurate tonal and segmental information were provided, resulting in a comparatively low cognitive demand for the listeners. In this condition, no statistical difference was detected between the performance of the Cantonese-dominants and that of the Cantonese natives, while the Urdu-dominant bilinguals achieved significantly lower accuracy and required far more reaction time to make responses compared with the other two subject groups. Thus, the result supports the finding in [6] claiming that language dominance impacts the processing of L2 speeches, and the L2-dominant (Cantonese-dominant in the current study) speakers are able to perform in a more L2-like way, compared with the L1-dominants. This is because L2-dominant bilinguals are usually more proficient and experienced in their L2 language use, age of learning, and length of residence [7].

In the segment-or-tone condition, around 41.2% of the Cantonese native speakers classified the stimuli along the tonal dimension, resulting from their native attentional strategy. In Cantonese, tones convey lexical meanings in a syllable, so in order to extract the meanings carried by tones, Cantonese speakers are required to pay much of their attention

to the tonal aspect. This result coincides with the findings in [2], which studied the case of Mandarin, and demonstrated that tonal language speakers distribute their attention across both tonal and segmental dimensions in the perception of their native languages.

The bilinguals, especially the Urdu-dominants, mainly classified the stimuli along segmental dimensions, which agrees with the performance of the Mandarin learners in [2] study whose L1 was Dutch, suggesting that that compared with the tonal native speakers, the bilingual speakers paid more attention to the segments than to the tones. Furthermore, it also reveals that the Urdu-dominants had far more interference from their L1 attentional strategy, depending more on segments than the Cantonese-dominants did in processing Cantonese stimuli. The results support [4]'s research, suggesting that non-native listeners can obtain a more automatic selective perceptual routine in L2 as they gain L2 experience; however, even L2 dominant bilinguals still cannot completely overcome the interference of the attentional strategy of their L1.

The Cantonese-dominants performed similarly to the Cantonese natives in the trial of segment-and-tone, and showed differences from the native speakers when exposed to the segment-or-tone trial. Therefore, the Cantonese-dominants can be regarded as Cantonese speakers in the first task, and they shift to bilingual status in the second task. This suggests that even L2 dominant speakers cannot perform exactly like native speaker, which is in line with the previous findings of [6]. Furthermore, it also coincided with the research of [1], proposing that highly experienced bilinguals show a perceptual flexibility when conducting different tasks. PAM-L2 cannot account for such flexibility. It also suggests that the bilinguals should be treated as a unique language group instead of being regarded as native speakers of both languages.

The executive function of selective attention correlates with the selective perceptual routine, suggested by ASP model. The earliest systematic Cantonese learning for the bilingual middle school students started in the classroom. Teachers may teach explicit knowledge, such as how to distinguish tones, use vocabulary, and organize sentences grammatically; however, they often neglect tacit knowledge teaching, such as attentional strategy and meta-cognitive knowledge, important for students to develop a native-like attentional strategy. In the executive domain of language processing, native speakers have already developed a mature and automatic strategy to deal with a task although they are usually unaware of it. However, the bilinguals, who never pay attention to it or have not developed a Cantonese-specific attentional strategy, will naturally refer to their native language system, and make responses based on their L1.

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