ORIENTING ATTENTION WHILE TRAINING HINDI SEGMENTS

Susan G. Guion and Eric Pederson

Department of Linguistics, University of Oregon
guion@uoregon.edu and epederso@uoregon.edu

ABSTRACT

The current experiment tests for an effect of attention during phonetic learning by manipulating attentional allocation to different aspects of the phonetic signal during training. In an identification task, two native English speaking participant groups were trained on novel Hindi words containing unfamiliar consonants and vowels. Both groups were presented with the same auditory stimuli. One group was instructed to attend to the Hindi consonants and the other to the Hindi vowels presented in these words. The group oriented toward consonants showed greater consonant discrimination ability than the group oriented toward vowels in a post-test/pre-test comparison.

Keywords: attention, Hindi, second-language, SLA

1. INTRODUCTION

The current study explores the role of attention in the learning of novel phonetic categories by adults. It is well known that listeners have difficulties with some non-native phonetic contrasts due to prior native-language experience [1, 2, 7]. Presumably listeners have developed an orientation of their attentional resources adapted to the particulars of the native language and this acquired processing can lead to interference in learning novel phonetic contrasts. A growing body of research is investigating the role of attention in learning.

The role of directed attention in learning is well established for visual stimuli [4, 6], reading acquisition [14], and adult acquisition of grammar [19, 20]. Many have also postulated an important role for attention in phonetic learning [10, 11] and laboratory training can effectively modify the ability to discriminate non-native phonetic categories [3]. Other studies have manipulated characteristics of the stimuli on the assumption that such manipulation aids the listener in directing attention to some acoustic cues in preference to others [12, 15]. Similarly, some studies have manipulated training conditions to allow comparison of specific acoustic cues, with the assumption that listeners would then attend to these cues [5, 8].

Note, however, that while previous studies posit an attentional component to learning and use stimuli that promote attention to certain cues, none directly manipulate listeners' attention during training. However, an earlier study [9] explicitly manipulated attention via training instructions. Listeners attended to either phonetic or semantic information of identical words from an unfamiliar language. Those instructed to attend to phonetic information showed greater phonetic learning.

Posner and Peterson [18] divide attention into three systems: alertness, orienting, and detection. Alertness is the executive control modulating resources toward the orienting. Orienting is the commitment of attentional resources to class-specific sensory stimuli. Orienting toward a class increases the chance of detection within that class. When a target is detected, that target is available for further processing.

Orienting presumably increases the likelihood of detection of the relevant acoustic cues, the processing in short term memory [18], and the transfer of the episode to long-term memory [13, 20]. It is hypothesized that greater orienting of attention to a class of stimuli during training will improve learning for that class of stimuli.

The current study manipulates endogenous (internally directed) orienting of attention via varying instructions during training of unfamiliar phonetic categories from Hindi. English monolinguals were randomly assigned to two groups oriented toward either consonants or vowels with the prediction that orienting to one class will increase learning of that one class.

2. METHOD

2.1. Participants

Forty-two (35 female) monolingual English speakers (mean age 22.4) participated for course credit. None had lived in a non-English speaking region for more than six months, nor formally studied another language for more than three years, nor had any appreciable exposure to any South Asian language. All reported normal hearing. Participants were randomly assigned to one of two groups: consonant-attending (N=21) and vowel-attending (N=21). Participants were unaware of the existence of the other group.

2.2. Materials

2.2.1. Material for discrimination tests.

Hindi vowel discrimination was expected to be fairly accurate, as the contrasts employ duration and quality differences similar to those employed in English. In contrast, consonant discrimination was expected to be less accurate, as some of the Hindi contrasts employ phonetic distinctions known to be difficult for English speakers [16].

Table 1: Hindi minimal pairs used in the discrimination test

Vowel contrasts		Consonant contrasts	
[a] vs. [aː]		[b] vs. [bʱ]	
kʰan̪ 'floor'	kʰaːn̪ 'ear'	baːv 'wind'	bʱaːv 'existence'
ʈap 'hood'	ʈaːp 'hoof'	biːl 'swampland'	bʱiːl 'tribal name'
kal 'soft'	kaːl 'time'	baːl 'child'	bʱaːl 'forehead'
gat 'previous'	gaːt 'body'	buːr 'sawdust'	bʱuːr 'fountain'
[e] vs. [o]		[d̪] vs. [ʈ]	
bel 'vine'	bol 'verse'	d̪aːl 'lentil'	ʈaːl 'pile'
n̪ek 'excellent'	n̪ok 'tip, point'	d̪er 'interval'	ʈer 'shout'
pel 'a shove'	pol 'large gate'	d̪ev 'god'	ʈev 'habit'
kʰep 'cargo'	kʰop 'hole'	d̪an̪ 'bang'	ʈan̪ 'clang'
[i] vs. [iː]		[k] vs. [g]	
siɽ 'craziness'	siːɽ 'ditch'	kaɲdʒ 'hair'	gaɲdʒ 'baldness'
sil 'flat stone'	siːl 'dampness'	kul 'herd'	gul 'rose'
ris 'offence'	riːs 'envy'	koʈ 'fort'	goʈ 'hem'
bin̪ 'without'	biːn̪ 'flute'	kor 'point'	gor 'a grave'
[o] vs. [a]		[t̪] vs. [t̪ʰ]	
kop 'anger'	kap 'trembling'	t̪an̪ 'body'	t̪ʰan̪ 'udder'
top 'cannon'	tap 'heat'	t̪al 'surface'	t̪ʰal 'land'
tor 'your, thy'	tar 'moist'	t̪aːm 'suffering'	t̪ʰaːm 'pillar'
por 'joint'	par 'feather, wing'	t̪oɽ 'fracture'	t̪ʰoɽ 'heart of plantain stem'
[u] vs. [uː]		[t̪] vs. [ʈ]	
kuʈ 'tall herb'	kuːʈ 'summit'	t̪ak 'as much as'	ʈak 'gaze'
pur 'town'	puːr 'full'	t̪iːs 'thirty'	ʈiːs 'pain'
ʈuk 'little'	ʈuːk 'piece'	t̪aːl 'applause'	ʈaːl 'pile'
ʃuk 'parent'	ʃuːk 'bristle'	t̪ar 'moist'	ʈar 'shout'

A female Hindi speaker produced minimal pairs for the discrimination test (Table 1). These represented the following Hindi initial stop contrasts: [b]-[bʱ], [d̪]-[ʈ], [k]-[g], [t̪]-[t̪ʰ], [t̪]-[ʈ] and the following medial vowel contrasts: [a]-[aː], [e]-[o], [i]-[iː], [o]-[a], [u]-[uː]. Each word was said three times, digitally recorded, and each production was edited into a separate wav file.

2.2.2. Material for identification training.

A training paradigm used multiple talker stimuli. Categories formed with more varied stimuli are typically more robust and able to generalize to novel stimuli [3, 17].

Four other native Hindi speakers (2 female) read 27 monosyllabic words beginning with one of eight consonants [k g ʈ t̪ t̪ʰ d̪ b bʱ] and with one of eight medial vowels [a aː i iː u uː e o]. The same set of words was used for both consonant and vowel training. Each word was repeated three times by each speaker, digitally recorded, and edited into separate files. Different words were used for the training and discrimination test.

2.3. Procedure

The procedure used a discrimination pretest-posttest with intervening training. Participants came to three sessions over the course of two weeks. In the first session, the pretest was administered, followed by training. The second session continued the training and in the final session, there was a final training, a short break, and then the posttest was administered.

2.3.1. Training

Both groups of participants were trained in an identification task using the same stimuli presented binaurally over headphones. There were three training sessions, each consisting of four blocks of 81 trials (the three repetitions of 27 words). The consonant-attending group was given explicit instructions to attend to Hindi consonants and the vowel-attending group was given explicit instructions to attend to Hindi vowels in a forced-choice identification task with feedback. The choices consisted of eight buttons displaying arbitrarily-assigned non-orthographic characters.

2.3.2. Discrimination test.

An identical discrimination test was used for both the pre- and posttest with counterbalanced blocks. An AXB categorial discrimination procedure was used to test the five Hindi consonant and five Hindi vowel contrasts listed in Table 1.

Participants heard a series of three stimulus words over headphones. For each triad, the first and third were the two contrastive words of a minimal pair. The middle word was a different production of either the first or the third word. Half of these trials used minimal pairs differing by the initial consonant and the other half used minimal pairs differing by the medial vowel. There was no signaling of the type of contrast tested for each trial and feedback was not given.

The test consisted of 160 trials (10 contrasts X 4 minimal pairs X 4 trials) in two pseudo-randomized, counterbalanced blocks. The inter-stimulus interval was 2 seconds and the inter-trial interval was 2 seconds after response. The participants were to decide whether the middle word was more like the first or the last word.

3. RESULTS

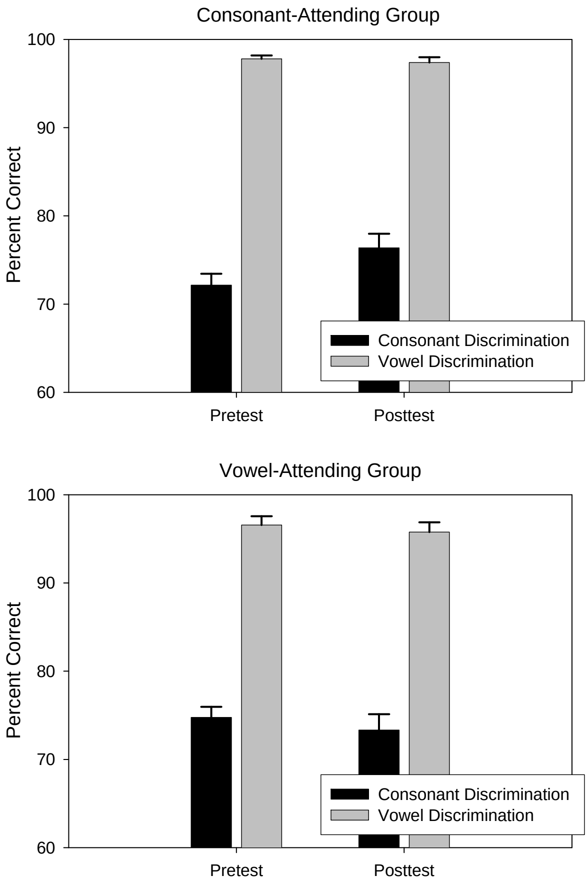
Examining the pretest, the two groups showed no difference in their discrimination scores prior to training. The mean number correct (out of 16) for each contrast for each participant was entered into separate ANOVAs (α=.05 throughout) for vowel and consonant contrasts with the between-subjects factor of Group (consonant-attending vs. vowel-attending) and the within-subject factor of Contrast (5 vowel and 5 consonant contrast types). For both vowel and consonant contrasts, the main effect of Group was not significant [vowels $F(1,40)=1.31$, consonants $F(1,40)=2.22$], nor was there an interaction between Group and Contrast [vowels $F(4,160)=1.68$, consonants $F(4,160)=0.25$]. However, the main effect of Contrast was significant [vowels $F(4,160)=4.56$, $p=.002$, consonants $F(4,160)=49.78$, $p<.001$]. This indicates that some contrast types were more accurately discriminated than others for both vowel and consonant contrast types. As predicted, the combined groups responded to the vowel contrasts more accurately in the pretest (97% correct) than the consonant contrasts (73% correct).

The effect of training on discrimination was investigated by comparing the pre- and posttest scores. In separate ANOVAs, one for vowel and one for consonant contrasts, the effects of Group and Contrast were tested.

The difference in vowel scores between the posttest and the pretest was submitted to an ANOVA with the between-subjects factor of Group (consonant-attending vs. vowel-attending) and the within-subjects factor of Contrast ([a]-[aː], [e]-[o], [i]-[iː], [o]-[a], [u]-[uː]). There was no effect of Group [$F(1,40)=0.16$] nor Contrast [$F(4,160)=1.38$] and Group and Contrast did not interact [$F(4,160)=1.01$]. This lack of a training or group effect for the vowels was expected given their already high pretest scores (97% correct).

The difference in consonant scores was also submitted to an ANOVA with the factors of Group and Contrast ([b]-[bʱ], [d̪]-[ʈ], [k]-[g], [t̪]-[t̪ʰ], [t̪]-[ʈ]). There was a significant effect of Group [$F(1,40)=5.03$, $p=.03$] but no effect of Contrast [$F(4,160)=0.71$], nor was there an interaction between Group and Contrast [$F(4,160)=0.47$]. These results indicate that orienting attention during training affected the learning of the consonant contrasts. See Figure 1.

Figure 1: Percentage correct on pretest and posttest for the consonant and vowel-attending groups.



The difference in mean scores on consonant contrasts between posttest and pretest indicates no effect of training for the vowel-attending group and improved performance for the consonant-attending group. Each group was examined to determine whether there was a significant difference between pre- and posttest scores for consonants. The pretest and posttest consonant discrimination scores were submitted to paired, one-tailed t-tests. For the vowel-attending group, no significant difference between the post- and pretest scores was found [$t(20)= -.76$]. For the consonant-attending group, a significant difference between the post- and pretest scores was found in the predicted (positive) direction [$t(69)=2.49$, $p=.01$]. These results indicate that orienting attention toward consonants facilitated learning of the trained consonant contrasts.

4. DISCUSSION

This study confirms that orienting attention during phonetic training facilitates learning of the specific class of stimuli to which the participants are instructed to attend. For consonant discrimination, the group instructed to attend to consonants during training had higher scores than the group instructed to attend to vowels. On the other hand, due to ceiling effects, there was no differential learning effect for the vowels.

The mechanisms of phonetic learning merit further exploration. Previous training studies have manipulated the types of stimuli [e.g., 15], but not allocation of attention to those stimuli. This experiment simply varied the instructions to attend to certain class-specific stimuli. Presumably, these instructions created varying endogenously-controlled orienting of attention across the two groups. Orienting has differential effects on the detection and manipulation of the stimuli in working memory [18], and/or likelihood of transfer to long-term memory [13].

It is noteworthy that the simple method of participant-directed orienting of attention can have a measurable effect on phonetic learning even across a short training period. This method holds promise for continuing investigation of the role of attention in phonetic learning.

5. REFERENCES

[1] Best, C. (1995). A direct realist view of cross-language speech perception. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research* (pp. 171-204). Timonium, MD: York.

[2] Best, C., McRoberts, G., and Sithole, N. (1988). The phonological basis of perceptual loss for non-native contrasts: Maintenance of discrimination among Zulu clicks by English-speaking adults and infants. *J. Exp. Psy.: Hum. Percept. & Perform., 14,* 345-60.

[3] Bradlow, A. R., Pisoni, D. B., Akahane-Yamada, R., & Tohkura, Y. (1997). Training Japanese listeners to identify English /r/ and /l/: IV. Some effects of perceptual learning on speech production. *J. Acoust. Soc. Am., 101*, 2299-2310.

[4] Carlson, R. A. & Dulany, D. E. (1985). Conscious attention and abstraction in concept learning. *J. Exp. Psy.: Learn., Mem., & Cog., 11*, 45-58.

[5] Christensen, L. A., & Humes, L. E. (1997). Identification of multidimensional stimuli containing speech cues and the effects of training. *J. Acoust. Soc. Am., 102,* 2297-2310.

[6] Curran, T., & Keele, S. W. (1993). Attentional and nonattentional forms of sequence learning. *J. Exp. Psy., 19*, 189-202.

[7] Flege, J. E. (1995). Second-language speech learning: Theory, findings and problems. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research* (pp. 233-273). Timonium, MD: York.

[8] Francis, A. L., & Nusbaum, H. C. (2002). Selective attention and the acquisition of new phonetic categories. *J. Exp. Psy.: Hum. Percept. & Perform., 28,* 349-366.

[9] Guion, S. G., & Pederson, E. (2007). Investigating the role of attention in phonetic learning. In O.-S. Bohn & M. Munro (Eds.), *Language experience in second language speech learning: In honor of James E. Flege* (pp. 57-77). Amsterdam: John Benjamins.

[10] Iverson, P., & Kuhl, P. K. (1995) Mapping the perceptual magnet effect for speech using signal detection theory and multidimensional scaling. *J. Acoust. Soc. Am., 97,* 553-562.

[11] Iverson, P., Kuhl, P. K., Akahane-Yamada, R., Diesch, E. Tohkura, Y., Kettermann, A., & Siebert, C. (2003). A perceptual interference account of acquisition difficulties for non-native phonemes. *Cognition, 87,* B47-B57.

[12] Jamieson, D.G., & Moroson, D.E. (1986). Training non-native speech contrasts in adults: Acquisition of the English D-T contrast by francophones. *Perception & Psychophysics, 40,* 205-215.

[13] Logan, G. D., Taylor, S. E., & Etherton, J. L. (1996). Attention in the acquisition and expression of automaticity. *J. Exp. Psy.: Learn., Mem., & Cog., 22*, 620-638.

[14] McCandliss, B. D., Beck, I. L., Sandak, R., & Perfetti, C. (2003). Focusing attention on decoding for children with poor reading skills: Design and preliminary test of the Word Building intervention. *Scientific Studies of Reading, 7*, 75-104.

[15] McCandliss, B. D., Fiez, J. A., Proropapas, A., Conway, M., & McClelland, J. L. (2002) Success and failure in teaching the [r]-[l] contrast to Japanese adults: Tests of a Hebbian model of plasticity and stabilization in spoken language perception. *Cognitive, Affective, and Behavioral Neuroscience, 2*, 89-108.

[16] Polka, L. (1991). Cross-language speech perception in adults: Phonemic, phonetic, and acoustic contributions. *J. Acoust. Soc. Am.*, *89*, 2961-2977.

[17] Posner, M., & Keele, S. (1968). On the genesis of abstract ideas. *J. Exp. Psy., 77*, 353-363.

[18] Posner, M. I., & Peterson, S. E. (1990). The attention system of the human brain. *Annual Review of Neuroscience, 13,* 25-42.

[19] Schmidt, R. (1990). The role of consciousness in second language learning. *Applied Linguistics, 11*, 129-158.

[20] Tomlin, R. S., & Villa, V. (1994). Attention in cognitive science and second language acquisition. *Studies in Second Language Acquisition, 16*, 183-203.