J Psycholinguist Res (2009) 38:447–457
DOI 10.1007/s10936-009-9099-1

Listening with an Accent: Speech Perception in a Second Language by Late Bilinguals

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Published online: 4 March 2009

Abstract The goal of the present study was to examine functioning of late bilinguals in their second language. Specifically, we asked how native and non-native Hebrew speaking listeners perceive accented and native-accented Hebrew speech. To achieve this goal we used the gating paradigm to explore the ability of healthy late fluent bilinguals (Russian and Arabic native speakers) to recognize words in L2 (Hebrew) when they were spoken in an accent like their own, a native accent (Hebrew speakers), or another foreign accent (American accent). The data revealed that for Hebrew speakers, there was no effect of accent, whereas for the two bilingual groups (Russian and Arabic native speakers), stimuli with an accent like their own and the native Hebrew accent, required significantly less phonological information than the other foreign accents. The results support the hypothesis that phonological assimilation works in a similar manner in these two different groups.

Keywords Speech perception · Accent · Bilingualism · Hebrew · Arabic · Russian

Introduction

The mechanism by which the structure of the native language affects second language processing is unclear (e.g., Best and Strange 1992). Such a mechanism might involve phonetic (segmental and suprasegmental), phonological, lexical, and/or other linguistic and extralinguistic processes (Guiora 1994). However, the adaptation of the phonetic categories of L2 seems to be a necessary component of second language acquisition, and, consequently, bilinguals who attain a high level of proficiency in their L2 are able to exploit the phonetic categories of that language in speech production and perception (Goetry and Kolinsky 2000). Categorical perception is attained in infancy, with exposure L1, and it seems to become neurologically "wired" (Zhang et al. 2005). Interestingly, categorical

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perception of L2 may change in infancy, but this change is strongly related to social interaction rather than to L2 exposure alone (Kuhl et al. 2003). Thus, new category formation or change is probably done more intensively by early bilinguals than by late bilinguals (MacKay et al. 2001; Sebastian-Galles and Bosch 2002). Cross-language speech perception research has shown that listeners' abilities to discriminate non-native contrasts are constrained by the phonemic distinctions employed in their native language (Guion et al. 2000; Harnsberger 2001; McAllister et al. 2002).

Recent research in the area of speech perception has suggested that there are differences in the phonetic perception of the speech signal between native and nonnative speakers (for reviews see Bent and Bradlow 2003; Best 1994; Flege 1992; Leather 1999; Werker 1994). These findings suggest that adult second language learners often use an assimilation process by which they perceive and produce L2 sounds via their L1 phonological system (e.g., Best 1994; Iverson et al. 2003; Major 1999).

Further evidence for such an assimilation process comes from a case study we described (Eviatar et al. 1999) in which a Russian–Hebrew bilingual aphasic woman showed a dissociation between her ability to perceive her L2 (learned in adulthood) when it was spoken by a native speaker versus when it was spoken by a speaker with an accent like her own. We interpreted this as supporting the hypothesis that late second language learners perceive L2 sounds via the phonological categories of their native language, and that this assimilation procedure can be differentially damaged, such that L2 speech that conforms to L1 phonology is better perceived than native-like L2 speech. This interpretation is further supported by an interesting dissociation in the writing abilities of the patient. In L1, she was able to write to dictation sentences of up to eight words. In L2, she would start at the right side of the page (the correct writing direction for Hebrew), but would write the Hebrew words in Russian letters. We suggest that this reflects the assimilation of L2 phonemes to L1 phonological categories, which allowed her to access the appropriate graphemes in the Russian orthography, but not in the weaker (to begin with) Hebrew orthography.

In this study we tested the hypothesis that speech in L2 is more easily perceived by late bilinguals when its phonemic features are similar to those of their native language than when it is native-like. We used the gating paradigm developed by Grosjean (1980), in which participants are exposed to increasing amounts of a speech stimulus, and at each 'gate', are asked to identify the stimulus. This procedure allows the identification of the point at which a word is recognized, and yields the amount of perceptual information that is required for lexical access of a speech stimulus. Recent studies using this paradigm have investigated the perception of guest words in bilingual speech (e.g., Grosjean 1988; Li 1996). These authors have focused on the perception of code-switched words from one language within discourse in another language. The questions asked was at what point is the guest word correctly identified, and what phonological information would be relevant to correct word identification. The results indicated that when the guest words are spoken with native-like phonology, they were recognized earlier than when their phonological form was altered to fit that of the base language.

Here we were interested in a somewhat different question: Is perception of L2 easier for adult acquirers when the phonology is similar to that of their native language than when it is not accented? Following the assimilation theory of L2 phonology learning (Best 1994; Flege 1992; Leather 1999; Werker 1994), we have suggested that it was this assimilation process that was differentially damaged in our bilingual aphasic patient (Eviatar et al. 1999). In this study we focused on successful Russian- and Arabic-speaking bilinguals, who have mastered Hebrew (L2) to the extent that they function in it at present as University students (high level functioning). Additionally, we included a

control group of native Hebrew-speaking students. If it is the case that adult L2 learners 'hear with an accent' as well as speak with one, we expected to find that all groups of subjects would need less perceptual information to identify speech spoken in an accent like their own.

The Linguistic Status of Hebrew, Arabic and Russian in Israel

The language situation in Israel represents a fully complicated case that includes coexistence of two official state languages (Hebrew and Arabic), English, that is widely used in different contexts, and a number of other languages being the native languages of large groups of immigrants from different countries (e.g., Russian). However, Hebrew is the dominant language in the country and it serves as the principal language for communication between different groups of Israeli citizens.

The present study examines the perception of accented speech in two prominent groups of bilinguals in Israel: Arabic- (ethnic minority) and Russian-speaking (immigrants) Israeli citizens.

The Arab population in Israel has been characterized by internalization of a marginal civic identity, alongside a marginal ethnic identity, so that they resolve the inherent contradiction between their civic (Israeli) and ethnic (Arab, Palestinian) identities by separating the two, rather than by reconciling them (Suleiman 2002; Abu-Rabia 1998). Abu-Rabia (1998), who studied interactions between attitude towards L2 and reading comprehension in L2, found that the motivation of Arab students to learn Hebrew was primarily instrumental rather than integrative. That is, Hebrew is regarded only from a technical point of view (as an important instrument of communication), but not as the way of integration into Israeli society that mostly is understood as Jewish society. Ibrahim and his colleagues (Ibrahim and Aharon-Peretz 2005; Ibrahim 2006) have directly examined the status (proficiency and psychological status) of Spoken Arabic, Literary Arabic, and Hebrew in native Arabic speaking high school students. They showed that both Hebrew and Literary Arabic have the status of a second language in these participants, and that responses to written Hebrew and Literary Arabic were equivalent, indicating equal proficiency in reading the two languages. However, when the stimuli were presented orally, responses to Hebrew were slower than to stimuli in both Literary and Spoken Arabic. Thus, although the facility of Arab students in Hebrew and in Literary Arabic is equivalent with visual stimuli, when the stimuli are spoken, the status of Hebrew as a second language is quite clear.

Russian-speaking people comprise the most recent large immigrant population in Israel. Russian is thought to be a valued, prestigious immigrant language with high literacy, developed media, numerous newspapers, and as a result, high language maintenance (Abu-Rabia 1999). Moreover, in this group, linguistic affiliation seems to be more important than religious or national ideology (Abu-Rabia 1999). Some researchers (e.g., Kozulin and Venger 1994) showed that Russian-speaking newcomers display a tendency toward integration in the institutional and quotidian spheres, but not in the cultural sphere. However, such societal attitudes of this immigrant group seem not to hinder, but rather to contribute to successful Hebrew learning (Beenstock 1996; Eisikovits 1995; Mesch 2003).

Thus, we focus on cognitive aspect of L2 perception looking at the influence of L1 on the perception of accented/non-accented L2 speech in Hebrew using Arabic- and Russian-speaking populations.

Method

Participants

Sixty adults with normal speech and hearing aged from 18 to 26 years (mean age 21.8) participated in the experiment: 20 native Hebrew speakers, 20 native Russian-speaking immigrants (who had learned Hebrew after the age of 13), and 20 Arabic-speaking Israeli natives (who generally begin to learn Hebrew in second grade, i.e., approximately at age of 7–8). All were students at University of Haifa (Haifa, Israel), where the language of instruction is Hebrew. All the bilinguals had passed a Hebrew proficiency exam upon entering the university.

Materials and Procedure

The stimuli consisted of 40 Hebrew sentences that were constructed such that the last word was always a noun (e.g., 'When the school-children were wild during recess they started to throw _____ (shoes/books/food/gravel)'). Each sentence was paired with four different endings. A translation of the stimuli is listed in Appendix A. The final words were equated on their predictability from the preceding sentence by piloting among both native and bilingual populations (20 participants). Gated words did not contain any cognates between Hebrew/Russian and Hebrew/Arabic. These sentences were recorded by four speakers, one a native Hebrew speaker (in so-called Tsabari, i.e., a normative dialect of Hebrew) and by three speakers with readily identifiable accents: an American accent, an Arabic accent, and a Russian accent. The perception of these speakers' speech (their accentedness) was pretested on 30 listeners (10 Hebrew-, 10 Russian-, and 10 Arabic-speaking). The listeners were asked to identify accent type (American, Russian, Arabic, or native-like) and to indicate accent degree (very strong/strong/ medium/slight/without accent) and voice characteristic (very pleasant/pleasant/medium/unpleasant/very unpleasant). A repeated measures ANOVA (GLM) did not reveal a significant main effect of identification of accent type, accent degree (for Russian, Arabic, and American accents only), and voice characteristic. Also there was no significant main effect of group (listeners) in these three measures. That is, an accent type was identified correctly in all cases, and degree of accentedness in non-native accented Hebrew was approximately similar for listeners in all three cases. In this case, the mean rating of voice characteristic for all four speakers was 3.5 (SD = .2)., i.e., something between medium and pleasant.

The test was comprised of the 40 sentences, with 10 sentences in each of the four accents. The sentences were recorded using a Sure Beta 87 microphone in a sound treated room. The sentences were digitized using the Computerized Speech Research Environment software (Avaaz Inovations, Inc., CSRE4.0), and gated versions of each sentence were constructed (following Grosjean 1980), with gate 0 revealing no phonological information from the word, gate 1 revealing the first 40 ms of the word, gate 2 having an additional 40 ms, etc., accumulating until the end of the word was reached. The stimuli were presented via an Alesis RA-100 amplifier, and Alesis Monitor-1 speakers at a comfortable loudness level. In the experiment itself, the participants heard each sentence with the gates in sequence, and each time, had to write what they thought the last word was. The first time was a guess, as they received no information about the word, then, with successive presentations, they wrote their guesses. When they had written the correct word three times without changing their minds, or when the end of the word was reached (the final gate), the experimenter started the next trial. The experiment was conducted individually in a sound treated room.

Results

There were two independent variables: a between-groups factor, the native language of the participant (Arabic, Hebrew, and Russian), and a within-groups factor, the accent of Hebrew language in which the stimuli (sentences) were presented (Arabic/Israeli-*Tsabari* Hebrew/Russian/American English). The dependent variable was the proportion of acoustic information from the word, measured in milliseconds (ms), that was necessary to recognize it correctly three times in a row. This was defined as: (the value of the gate at which the word was identified correctly the third time)*40 (ms)/(the total length of the word). We used a 3 (three native languages: Arabic/Hebrew/Russian) $\times$ 4 (four Hebrew language accents: Arabic/Native Hebrew/Russian/American English) mixed design with accent of the stimuli as a within groups factor and native language of the participants as the between-groups factor. The two factors resulted in significant main effects: native language, $F(2, 56) = 16.06$, $p < .0005$, with native Hebrew speakers needing the least amount of exposure to the words (average 43%), Russian speakers needing more (46%), and native Arabic speakers needing the most (49%). There was also a main effect of stimulus accent, $F(3, 168) = 8.40$, $p < .0001$, with the native Hebrew accent requiring the least amount of exposure (43%), followed by the Arabic accent (44%) and the Russian accent (44%), the American English accent required presentation of the largest proportion of the word to be recognized (51%). Most importantly, the repeated measures ANOVA revealed a significant interaction between the factors, $F(6, 168) = 5.88$, $p < .0001$. This interaction can be seen in Figs. 1 and 2, where Fig. 1 illustrates the mean amount of phonological information needed by the bilingual

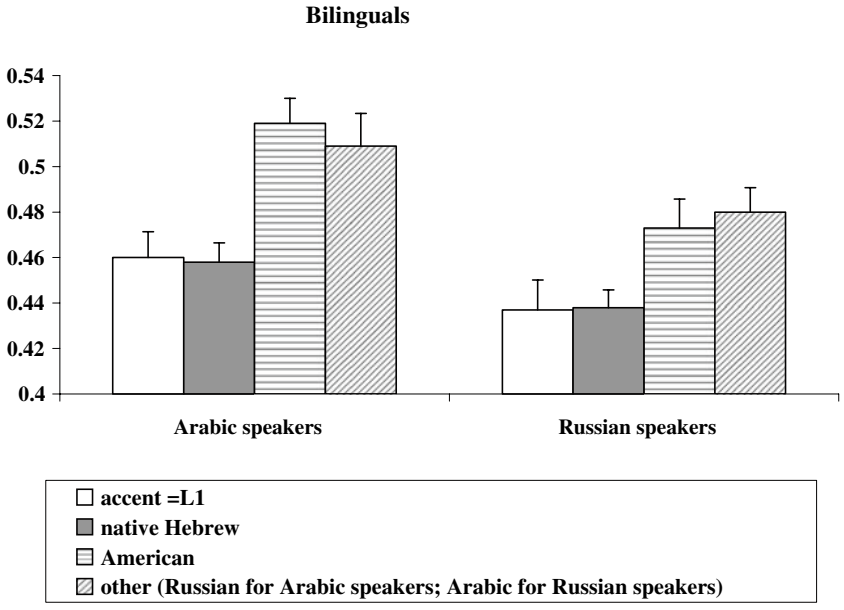

Fig. 1 Interaction of native language and stimulus accent in proportion of the word necessary for recognition in bilinguals. (For the Russian speakers, the 'other' accent is Arabic, while for the Arabic speakers, the 'other' accent is Russian. Both groups required more phonological information to recognize Hebrew spoken in an accent different from native, or their own.)

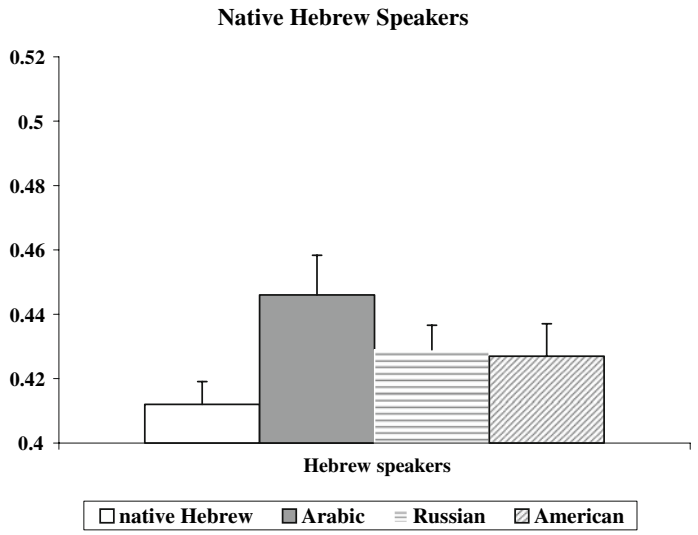

Fig. 2 Interaction of native language and stimulus accent in proportion of the word necessary for recognition in native Hebrew speakers

participants in each of the experimental conditions, and Fig. 2 illustrates the mean amount needed by native Hebrew speakers.

Effects of Accent

Recall that the hypothesis was that each language group would require the least amount of phonological information for stimuli spoken in an accent like their own. With a view to test the relationships between participants' native language and type of accent, planned comparisons were carried out for all three language groups and all four types of accent separately. Planned comparisons (GLM) between groups in four accent conditions are presented in Table 1.

As can be seen in Table 1, both groups of bilingual participants required less information to perceive words in an accent like their own and in the native Hebrew accent, than in other accents. This pattern is shown in Fig. 1 where we charted the same data, but categorized the accents in L2 as similar or different from L1. Planned comparisons revealed that for Arabic speakers, the significant simple effect of stimulus accent ($F(3) = 11.63$, $p < .0001$) is due to the American English and Russian accents, which required significantly more information for word identification than the Arabic and Hebrew accent conditions, which do not differ from each other. The Russian speakers also showed an effect of accent ($F(3) = 5.51$, $p < .005$). However, the advantages for the Russian and native accents was evident only in the Arabic/Russian and Arabic/Hebrew contrasts, where the differences overall were marginal. Hebrew speakers were not sensitive to accent differences ($F(3) = 2.47$, $p < .07$), but needed significantly less information for the Hebrew accent than for the Arabic accent.

Effects of Native Language

Table 2 lists the results of planned comparisons between the groups within each accent condition.

Table 1 Planned comparisons between accent types in three participants' groups

Contrasts between accents	Groups					
	Arabic native speakers		Hebrew native speakers		Russian native speakers	
	$F(1)$	p	F	p	F	p
Arabic vs. Russian	**4.67**	**.04***	1.12	.3	3.96	.06
Arabic vs. Hebrew	.01	.9	**4.72**	**.04***	3.65	.07
Arabic vs. American	**6.75**	**.02***	1.53	.2	.09	.8
American vs. Russian	.19	.7	.03	.9	2.85	.1
American vs. Hebrew	**7.34**	**.01***	.88	.4	2.59	.1

Significant and marginal effects are marked in bold

Table 2 Planned comparisons between groups in four accent conditions

Contrasts between groups	Arabic accent		Russian accent		American accent		Native accent	
	F	p	F	p	F	p	F	p
Hebrew vs. Russian speakers	**4.29**	**.04***	.18	.68	**8.49**	**.006***	**5.66**	**.02***
Hebrew vs. Arabic speakers	.79	.39	**21.12**	**.0001***	**33.24**	**.0001***	**16.87**	**.0001***
Arabic vs. Russian speakers	1.48	.23	**17.0**	**.0001***	**8.35**	**.006***	3.06	.09

Significant and marginal effects are marked in bold

It can be seen that the advantage of the native Hebrew speakers over the L2 speakers was significant in the Native and American accent conditions. In the Arabic accent condition, their advantage was significant over the Russian speakers, and they were as good as the native Arabic speakers. In the Russian accent condition their advantage was significant over the Arabic speakers, and they didn't differ from the native Russian speakers. Thus, when all three groups were listening to accented Hebrew in an accent that is *not* like their own, native speakers needed less phonetic information than nonnative speakers.

There are also differences between the two groups of L2 speakers. Figure 1 reveals that in all but the Arabic accent condition, Russian speakers needed less phonetic information than Arabic speakers. Table 2 reveals that this advantage was significant in the American accent, and marginal in the native accent condition.

Discussion

We suggested that speech perception of L2 would be easier for late bilinguals when its phonemic features are similar to that of their native language than when they are native-like. The results confirmed the first part of this hypothesis. That is, when the accent was like the participants' own accent, they needed less phonological information to perceive the gated word than when it was in any other accent. However, there were no significant differences between familiarly accented and native-accented speech (the native-like Hebrew accent). Seemingly, this means that although native-accented speech is not easier for bilingual listeners than their own accent type, native-accented speech does not present any additional difficulties for

perception. This last fact does not contradict the general assumption that L2 phonemes are perceived via an assimilation process to L1 phonological categories (Best 1994; Flege 1992; Leather 1999; Werker 1994). Such a mechanism of L2 perception may explain the advantages both for familiarly accented and for native-accented speech in L2. Phonemic features of L2 are assimilated via the phonological system of L1 first of all, with the aim to perceive this native-accented speech. Adult bilinguals seem to be directed to such native-accented speech and to have more experience just in such speech perception. However, because their phonological system is 'artificial', they meet with fewer difficulties perceiving speech accented like their own than with an accent that is not familiar to them. In addition, frequency of exposure probably plays a role. Non-native speakers have much more exposure the native accent or one similar to theirs, than to another foreign accent.

We also found absolute differences between the two groups of second language speakers. We suggest two possible accounts for these findings. The first is the phonetic complexity of the participants' native language and the closeness of the two phonological systems (L1 and L2). Seemingly, this factor (complexity) may explain, at least partly, the relative success of the Russian group. On the one hand, since both Hebrew and Arabic are Semitic languages, phonological similarities between them should facilitate mutual perception. However, historically, language bifurcation occurred a few thousands years ago and phonological changes in both languages are considerable (Aikhenvald 1990; Davis 1980). Thus, the phonological closeness of the two languages may not be so significant. Phonological complexity on the other hand, may be relevant. Compared with Hebrew and Arabic, Russian is characterized by a highly complicated phonological system (Akhmanova 1971; Shimron 1993). For example, Hebrew and Arabic syllables mostly have a CV (consonant-vowel) or (occasionally) CCV composition, whereas Russian includes many CCV and even CCCV syllables. This phonological complexity has a positive influence on the development of phonological awareness at the phoneme level in Russian-speaking children (Zaretsky 2002). It may be suggested, therefore, that the general complexity of the Russian phonological system may positively influence the speech perception ability of Russian-speaking bilinguals.

The second factor might be the experience of perceiving speech with different accents. This factor appears to be relevant to Hebrew-speaking natives who are exposed to Hebrew spoken with different accents by the many immigrant groups in Israel. Russian-speaking immigrants may also have a more rich experience in perception of native Hebrew and other accents than Arabs because they are more integrated into the Hebrew-speaking society (e.g., they live in the same areas and learn in the same schools as Hebrew-speaking citizens). Accordingly, experience in mutual communication in Hebrew language may be more extensive in immigrants from the former Soviet Union than in Israeli Arab citizens.

Conclusions

In this study we examined the manner in which the phonological system of a native language can influence perception in a late learned second language. We chose samples from two bilingual populations who differ in native language and its relationship to L2, but who are similar in other personal characteristics (age, education, etc.). The results of this study reflect the richness and complexity that can be seen in the phenomenon of bilingualism. The results support the hypothesis that phonological assimilation works in a similar manner in these two groups, as they show us the same patterns (see Fig. 1). A closer look to the Israeli society reveals that there are native Hebrew speakers (L1) in Israel with an Arabic-like accent. In future studies it would be important to compare these Jewish Israelis with Arab Israelis

to assess the extent to which the Arabic-like accents and their perception and evaluations (re: IRI) are personally, culturally and/or politically bound. Finally, as mentioned in the introduction, motor and perceptual aspects of L1 and L2 accent are at least partially neurologically "wired" through the process of acquisition in early childhood. It would be interesting and insightful to see, using brain imaging and neurophysiologic techniques, how the phenomena related or observed in the present study might be correlated to brain mapping, rewiring or plasticity. Such information can enhance our understanding of the relationships between brain, language, and behavior, and ultimately help in the diagnosis and treatment of language, speech, and hearing disorders.

Acknowledgements The research reported here was funded by the journal *Language Learning*. We thank Aliza Cohen and Marina Rogachov for help in running the experiments and data analysis.

Appendix A

Translation of the Sentence Stimuli

1. My wife and I drove to town and decided to buy a
   (a) school-bag (one word in hebrew)
   (b) bicycle
   (c) cooking pots (one word in Hebrew)
   (d) iron
2. When we took our family holiday abroad, we did not have time to see
   (a) the circus
   (b) friends
   (c) the theater
   (d) competitions
3. The role of the inquiry committee that was convened after the disaster was to check
   (a) the rules
   (b) the evidence
   (c) the claims
   (d) the instruments
4. The hardest thing to do in the army was to dismantle
   (a) tents
   (b) tank tower (one word in Hebrew)
   (c) cannons
   (d) antennas
5. When I was a high school student my dream was to be
   (a) popular
   (b) handsome
   (c) rich
   (d) a judge

6. When the school-children were wild during recess they started to throw

   (a) shoes
   (b) books
   (c) food
   (d) gravel

7. As a result of the children's low achievements, the principal cancelled the distribution of

   (a) shirts
   (b) pens
   (c) school-bags
   (d) pictures

8. When we left for summer camp, mother asked the maid to clean the

   (a) carpets
   (b) dishes
   (c) shelves
   (d) closets

9. My neighbor has a 5-year-old son who likes to light/turn on

   (a) torches
   (b) ovens
   (c) cigarette lighters (one word in Hebrew)
   (d) computers

10. Usually, adolescent children like to make/have

    (a) an impression
    (b) noise
    (c) parties
    (d) shows/acting-out

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