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Naeimeh Afshar – Vincent J. van Heuven: Does consistency in perceptual assimilation reflect language dominance in early bilinguals?
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Does consistency in perceptual assimilation reflect language dominance in early bilinguals?

Using the Language Experience and Proficiency Questionnaire (Marian *et al*., 2007), we collected measures of language dominance for 23 early bilingual Azerbaijani-Persian (AZ-PE) adolescents and 21 monolingual PE peers. In a perceptual assimilation (PA) task, these participants had identified each of the 11 pure vowels of American English (AE) as one of the six monophthongs of PE, and the bilinguals also as one of the nine monophthongs of AZ. Vowel tokens were presented twice in different random orders, yielding consistent (same choice twice) and inconsistent (different choices) response pairs. We test the hypothesis that PA consistency, defined as the percentage of consistent pairs, should reflect language dominance. Results show that an optimal combination of LEAP-Q parameters explains 35% of the variance in PA consistency. The correlation is significant but not strong enough to advocate PA consistency as a useful and reliable correlate of language dominance.

Keywords: Perceptual assimilation, (Correlates of) Language dominance, LEAP-Q, L3, Early bilingualism, English, Azerbaijani, Persian

1. Introduction

1.1. Background

Iran is a multi-ethnic and multilingual society with about 85 million inhabitants. A recent census shows that 61% of the population is Persian and speaks Modern Persian (PE) as its first language. PE, an Indo-European language, is the national language that has been positioned as the official language of government and education throughout Iran. The second-most frequently spoken mother tongue in Iran is Azerbaijani (also called Azeri or Azari, henceforth AZ). AZ belongs to the Turkic language family. Although it differs markedly from Standard Turkish, it is often considered a Turkish dialect.[1] AZ is the native language of 16% of the Iranian population, i.e., about 13.5 million people.[2] It is spoken in the north of Iran, in the area bordering Azerbaijan. Children speak AZ as their home language in the first four years of their life. At the age of 4, children go to primary school, where PE is the language of instruction. In some cases, the children spend a pre-school year preparing for the all-Persian immersion one year later. As a result of this diglossic language situation, Azerbaijani in Iran are early bilinguals who have learned to speak two languages from childhood onwards, with roughly equal command of the two languages, and whose linguistic performance as adolescents or adults should be on a par with that of monolingual speakers of either PE or AZ.

In our project, we are interested in the potential advantage of knowing two different (and unrelated) languages from childhood onwards for learning a foreign language; specifically English, later in life. We investigate the advantage of early bilingualism in the field of phonetics, i.e., the acquisition of the sound system of the foreign language. As a first step in our project, we targeted two groups of adolescent EFL learners in Iran. At the time of testing, they were roughly 16 years of age and had taken English lessons in secondary school for some four years. We recorded these learners when they produced the vowels, consonants, and a range of consonant clusters (in onset and coda position in syllables) in English target words in fixed carrier phrases and read aloud a short piece of connected speech. We also tested the learners' perceptual representation of the vowels of English and – as a preliminary step – asked them to map the vowels of (American) English to the vowel inventories of their native languages (using a perceptual assimilation task, see § 2.2). The materials used in the perceptual assimilation task were presented twice to each participant to estimate the participants' consistency in performing the assimilation task.

1.2. Language dominance

It is well known in the literature on language acquisition that 'balanced' bilinguals, i.e., bilinguals who are equally proficient in their two languages, are rare (e.g., Grosjean, 1982, 2010; Luk & Bialystok, 2013). This is true not only for the end-state bilinguals reach, but also for the developmental stages they pass through. Typically, bilingual children, even if exposed to both languages from birth, are more proficient, or dominant, in one of their two languages (e.g., Paradis, 2007). Children's relative proficiency in their two languages will, in some sense, be a function of the amount of language to which they are exposed in those languages. In the context of bilingualism, dominance refers to observed asymmetries of skill in, or use of, one language over the other. Thus, a Spanish-English bilingual who is Spanish-dominant may process Spanish speech more easily than English speech, access lexical items faster in Spanish than in English, and use Spanish more often daily than English (Birdsong, 2014).

The concept of language dominance captures disparities in the rate and complexity of a bilingual's development of two languages in that the language developing faster and with greater complexity is usually denoted as one's dominant language, whereas its counterpart is referred to as their weaker language (Yip & Matthews, 2013). Correlated with the degree of language use and found to be influential in language choice, language dominance is expected to impact both the frequency and complexity of bilinguals' code-mixing (Genesee, Paradis & Crago, 2004; Montrul, 2013). Unsworth (2015) explores the extent to which children's language experience and their absolute and relative language proficiency are related to determine whether measures of language experience can be used as indicators of language dominance in studies of bilingual language acquisition.

Language dominance is understood here as bilingual children's relative proficiency in their two languages. In addition, language dominance can also be conceived of as a broader concept involving "a linguistic proficiency component, an external component (input), and a functional component (context and use)." Unsworth reviews factors affecting bilingual children's language environments, e.g., parental language strategy, the status of the language(s) (minority/majority, high/low prestige), type of education (monolingual/ bilingual/immersion, etc.), siblings and birth order, literacy and literacy-related activities, amongst others. These factors can affect the amount and type of language exposure available, leading to considerable variability in bilingual children's language experiences. Like monolingual children, and probably even more so, bilingual children also vary in the rate at which they acquire their two languages. In any accurate assessment of bilingual children's linguistic abilities, such differential capabilities must be considered, whether this is for assessing bilingual children in comparison with their monolingual peers, comparing and contrasting the linguistic development of different groups of bilingual children, or examining possible bilingual language outcomes. The current study will also compare bilingual adolescents' performance with their monolingual peers to consider whether bilingualism affects learning and improving a foreign language.

Another critical aspect of bilingual children's language experience related to their acquisition rate is language use or output, i.e., the extent to which children actively speak the language in question. Bilingual children's (rate of) acquisition has been linked to quantitative and qualitative properties of their language experience, including the amount of exposure, children's language output, and whether the input is from native or non-native speakers. These factors have been related to absolute proficiency measures such as mean length of utterance and vocabulary size (Unsworth, 2015). Their relation to children's relative proficiency, i.e., to their patterns of language dominance, has remained largely unexplored.

In the present study, we compare the possible advantage of bilingual learners of English as a foreign language (EFL) relative to a matched group of monolingual EFL learners. As explained in §1.1, the bilinguals speak Azerbaijani as their home language and have been exposed to Persian as the language of instruction and education from age three onwards. Given the age difference at which the two languages were acquired, we do not expect perfect or balanced bilinguals. Instead, we expect to find the students on a cline between Azerbaijani dominant to Azerbaijani and Persian balanced. Given the language situation in the northwest of Iran, it would be unusual to find bilingual adolescents with a dominance of Persian over Azerbaijani.

We have quantified the language dominance in our Azerbaijani/Persian EFL learners by conducting the Language Experience and Proficiency Questionnaire (LEAP-Q, Marian *et al*., 2007). This questionnaire asks the respondents to self-

estimate the length and intensity of exposure to the languages they command, how often they use the languages in a range of communicative domains, and how they self-rate their proficiency in each of the languages in terms of listening, speaking reading and writing skills (see §2 for details). At the same time, we have detailed experimental data on how our participants carried out a perceptual assimilation task in which they identified each of the 11 monophthongs of American English as one (and only one) of the six vowels of Persian or one of the nine vowels of Azerbaijani. To complement the self- rating, we will examine the consistency with which the students performed the assimilation task as a validation measure of the language dominance indicated by the questionnaire. If the task consistency is positively and strongly correlated with one or more of the questionnaire-based dominance measures, the self-rating of the respondents would be (much) more credible, and we would have yet another objective proxy of language dominance.

1.3. Hypotheses

Even when performing tasks in one language, multilinguals have several languages activated in their minds (e.g., Grosjean, 1989; Rodriguez-Fornells *et al*., 2005). Multilinguals, therefore, have to constantly control interfering information from their multiple active and competing language systems to select the appropriate language and inhibit the others that are not in use at that moment (e.g., Costa *et al.*, 2009; Festman & Münte, 2012). Evenly balanced bilinguals have to reduce the interference from their other language more than bilinguals with a strong dominance in one language. Suppressing the interfering language is more difficult as their languages are more evenly balanced. Consequently, we hypothesize that it will be increasingly more difficult for our bilingual participants to execute the perceptual assimilation task quickly and consistently as their responses to the LEAP-Q indicate they are more equally balanced between AZ and PE.

This hypothesis breaks down into several sub-hypotheses. First, when the EFL learner is an early monolingual in just a single language, i.e., PE, the perceptual representation of the six native vowels of PE will be excellent, and the assimilation task will be done with a high level of consistency. Second, when the learner is an early bilingual speaker of AZ and PE, the mental representation of each of the two vowel systems may be less sharply defined than in the case of a monolingual speaker, so we expect an overall slower and less consistent task performance for the bilinguals. If it is true that suppression of the non-attended language is more difficult as the language dominance is more evenly balanced, we expect slower and less consistent task performance as language dominance is more balanced.

Depending on the amount of language input and age of acquisition in each of the two languages, one language may be more fully acquired and, therefore, better

represented in the learner's mind than the other. It is reasonable, therefore, to expect our early bilinguals to differ in the relative strength of the two languages they command. AZ will be strongly dominant for some, while the two languages will be more equally balanced for others. In the present study, we will test the hypothesis that language dominance in our AZ-PE early bilinguals will be reflected by the difference in consistency with which they perform the perceptual assimilation task in each of their two languages. Moreover, we test the second hypothesis that the bilinguals will be slower and less consistent overall in the perceptual assimilation task than their monolingual Persian peers, and more so as the two competing languages are more evenly balanced.

The present article is not a report of an experiment. Rather, we attempt to use the by-product of an earlier experiment, the main results of which have recently been published (Afshar & Van Heuven, 2022), as a new correlate of language dominance in early bilinguals. The data was collected through an elaborate questionnaire to establish the relative strength of the Azerbaijani and Persian languages acquired by our early bilinguals in the first six years of their lives. In §2, Methods, we will first describe the set-up of the questionnaire (§2.1) and then (§2.2) summarize the method of the perceptual assimilation experiment reported in Afshar & Van Heuven (2022). Next, we will describe the results of this study in three subsections. In the first part of the results (§3.1), we will present an overview of the responses collected in the questionnaire to see how the two languages, AZ and PE, compare in the self-reports of the bilingual respondents and to what extent their responses differ from similar data we collected from the monolingual Persian control group. Part 2 of the results (§3.2) presents the consistency measures we derive from the responses from the same participants in our earlier perceptual assimilation experiment. Finally, in part 3 of the results (§3.3), we analyze the relationship between the consistency found in the perceptual assimilation task and differences in language dominance that can be derived from the questionnaire data.

2. Methods

2.1. Collecting data on Language Experience and Proficiency

The *Language Experience And Proficiency Questionnaire* (LEAP-Q) was developed by Marian *et al*. (2007). The LEAP-Q is a validated questionnaire tool for collecting self-reported proficiency and experience data from bilingual and multilingual speakers aged 14 to 80. It is available in over 20 languages and can be administered in a digital, paper-and-pencil, and oral interview format (Kaushanskaya 2020: 954). We used the paper-and-pencil version of the LEAP-Q that is available for use in Iran.[3] Our participants filled in the questionnaire on sheets of paper. We obtained responses from 23 AZ-PE bilinguals (12 female) and 21 monolingual Persian participants (11 female). All participants filled in the same questionnaire using the Persian-Arabic script. The first author then copied

the responses into digital LEAP-Q forms (in English) and collected them automatically in an SPSS-readable Excel sheet.

In the LEAP-Q, respondents are asked nine general questions (Q1.1-9), which have to be answered by providing free-format information such as the name of one or more languages, percentages of the time devoted to specific language activities, etc. These questions (in English) are listed in Appendix 1 of Marian *et al*. (2007: 966). In the second part of the LEAP-Q, questions Q2.1-7 are fixed, requiring the respondent to tick a number on a scale from 0 to 10, and answer these questions for each of the maximum five languages listed in response to Q1.1. In the results section (§3.1), we will first discuss the free- format answers given to Q1.1 through 1.9, and then examine the numerical responses to the questions in part 2 of the LEAP-Q.

2.2. Perceptual assimilation experiment

In a perceptual assimilation task, listeners are asked to decide with which of the sounds in their native language they identify each of several unfamiliar target sounds and then rate the goodness of the target sound as a token of the native category chosen. In the experiment, we asked our monolingual and bilingual participants to identify tokens of the monophthongal vowels of American English (AE) as instances of the six vowel categories of PE, /i, e, æ, ɑ, o, u/, and (in the case of the bilinguals) also as instances of the nine vowels of AZ, which has roughly the same six vowels as are used in PE plus three central vowels /y, ɯ, œ/ (for more details on the vowel systems of AE, PE, and AZ, see Van Heuven *et al*., 2020 and references therein). Following established practice, e.g., Peterson and Barney (1952) and Hillenbrand *et al*. (1995), stimuli were the words ***heed*** /hid/, ***hid*** /hɪd/, ***hayed*** /hed/, ***head*** /hɛd/, ***had*** /hæd/, ***hud*** /hʌd/, ***hod*** /hɑd/, ***hawed*** /hɔd/, ***hoed*** /hod/, ***hood*** /hʊd/, and ***who'd*** /hud/. These words had been spoken by two male native speakers of AE in a fixed carrier phrase ***Now say … again***. The 2 × 11 target words had been digitally excised from their spoken context and were presented to each listener over headphones twice in different random orders per listener, who heard 44 target words in all. Listeners were instructed to categorize the vowel in the target word as a token in either PE (with a forced choice from a set of six alternatives) or AZ (with a forced choice from nine alternatives). The alternatives were shown as six or nine response buttons on a computer screen, one of which the listener had to click on using a mouse pointer.

Immediately after clicking a response button, the listener had to click one of five activated buttons at the bottom of the screen to indicate the goodness of the token as an exemplar of the category just chosen. Response latency was measured in milliseconds from the moment the onset of the target word was made audible until the goodness button was pressed. The listeners in the experiment were the same 44 adolescents we asked to fill in the LEAP-Q in §2.1. The monolingual Persians performed the perceptual assimilation task only once, assimilating the

AE vowels to the PE response set. The bilinguals performed the task twice, once in PE and the second in AZ. We refer to Afshar and Van Heuven (2022) for details of the procedure,.

In the present paper, we will not be concerned with the distribution of the choices the two groups of listeners made for the target vowels (for which we refer to Afshar and Van Heuven (2022) and Afshar (2022: Chapter 4). Here we will only analyze the consistency with which the respondents performed their perceptual assimilation task. Earlier research has shown that listeners are more consistent in their perceptual labeling choices as they are more familiar with the phonological system of the language they respond in (Van Zanten & Van Heuven, 1984; Van Heuven & Van Houten, 1989; Van Heuven, 2017). When hearing a target sound that is a good or excellent representative of a sound category in the listener's native language, the choice is easy: the listener will make the same decision quickly on both occasions, with high typicality ratings. However, when hearing a sound that is a poor token of one native category (or even several adjacent native categories), the decision is difficult: the typicality rating will be low, different choices may be made on the first and second presentation, and the response will only be given after some delay.

2.3. Statistical analysis

The data we collected in this study are of several different kinds. The consistency measure derived from the two vowel choices made by the same participant on the same stimulus is expressed as a coefficient between 0 and 1, which can be treated as a continuous variable on a ratio scale. The goodness rating accompanying each choice (on a scale from 1 to 5) is a discrete sampling of an underlying continuum. The difference between the two goodness ratings given to the same stimulus by the same participants should have a mean of 0 and is normally distributed. The third dependent variable is the speed (reaction time, RT) with which the assimilation responses were given. RT is a continuous variable at the interval level of measurement. Although RTs tend to be positively skewed, they are routinely analysed by conventional parametric statistics that assume a normal distribution. The responses to the LEAP-Q, in so far as we analyze them in this article, are either time intervals (measured in years; months), estimated percentages, or ratings on continuous scales between either 0 and 5 or between 0 and 10, which conventional parametric statistical techniques can analyse.

In what follows, we will present descriptive statistics for the various measures collected from our participants and express their interrelationships by Pearson's product-moment correlation coefficient *r*. Preliminary analyses showed that the scores for the variables were close enough to normalcy and that the relationships among them were compatible with the assumption of linearity so that the application of conventional parametrical statistics is legitimate for both descriptive and inferential purposes. Our data analysis accordingly employs the t-

test for independent groups to test differences between the monolingual and bilingual participants and the repeated measures analyses of variance (RM-ANOVA) to simultaneously test the effects of task repetition (within participants) and group (between participants) on selected dependent variables. Correlation and multiple linear regression analysis is then used to select the best (combination of) predictors of language dominance.

3. Results

3.1. Analysis of the questionnaire data

A descriptive statistical overview of the LEAP-Q responses collected from our two groups of participants, i.e., 21 monolingual speakers of PE, and 23 bilingual speakers of AZ and PE, is given in Table 1. The table presents the mean, standard deviation, and range of the responses given to each of the 27 questions, grouped in eight rubrics, i.e., two for part 1 of the LEAP-Q (free format responses) and six more for part 2 (numerical responses). In the remainder of this sub-section, we will explain the questions asked in the questionnaire and comment on the responses.

In **Q1.1**, students were asked to list maximally five languages in order of dominance (as they perceived it). All monolinguals listed PE as their most dominant language and English as their second-most dominant language. All bilinguals listed AZ as their most dominant language, with PE in second place, with just one exception who mentioned English as his second-most dominant language (and PE fourth). All other bilinguals mentioned English as their third-most dominant language.

Q1.2 asked students to specify the order in which they had acquired the languages they mentioned in Q1.1. All monolinguals acquired PE as their first language. All bilinguals indicated that they acquired AZ before PE. More in general, the order of acquisition of the spoken language perfectly reflects the self-estimated dominance.

In response to **Q1.3**, the students listed what percentage of the time they were *currently and on average* exposed to each language (percentages should add up to 100). It is not clear over what period of time the "current average" has to be taken. Be this as it may, the answer could be useful to assess the dominance- ratio between AZ and PE for bilinguals. For the monolinguals, the current exposure should be high. The results (Table 1, Q1.3) show that the monolinguals think they have exposure to PE about 72% of the time and some 19% to English (the remaining 9% is not specified in the table; it is divided over a range of other languages mentioned, e.g., Arabic, Chinese, German, Hungarian, Turkish, Urdu).

Only one monolingual mentioned exposure to AZ (10% of the total exposure time). The bilinguals, even as adolescents, stated that they had exposure to AZ 60% of the time against only 20% in PE (and 14% in English).[4]

Table 1. Selected LEAP-Q results for bilingual Azerbaijani-Persian and monolingual Persian learners of EFL. For each question the mean (Mn), standard deviation (SD) and range (Rg) of the responses is given.[a]

	Bilingual Azerbaijani/Persian (*N* = 23)									**Monolingual Persian (*N* = 21)**					
	Azerbaijani			Persian			English			Persian			English		
	Mn	SD	Rg	Mn	SD	Rg	Mn	SD	Rg	Mn	SD	Rg	Mn	SD	Rg
Q1.3. Estimated current average exposure to language (adds up to 100%)															
Exposure	60.00	21.9	5-90	19.52	12.2	5-50	13.61	8.5	4-30	71.57	17.8	40-98	18.76	12.0	2-48
Q1.4-5. Relative preference per language for … (adds up to 100%)															
Reading	24.78	24.2	0-90	38.57	26.9	7-80	27.65	19.5	2-80	55.05	25.1	0-98	35.57	25.1	2-90
Speaking	55.22	29.2	5-90	20.78	16.0	3-50	20.61	19.8	2-85	67.38	26.5	10-100	26.90	22.1	0-80
Q2.1. Age milestones (years)															
Started talking	1.30	.47	1- 2	4.04	2.08	1- 7	11.30	1.78	7-15	1.05	.22	1- 2	9.33	2.27	4-12
Fluent talker	4.57	2.59	2-12	7.83	2.89	4-15	14.50	1.50	12-17	4.48	1.29	3- 8	14.14	2.43	10-18
Started reading	7.67	2.09	5-13	6.65	.88	5- 8	11.40	3.03	1-15	6.62	.59	5- 7	10.24	2.12	6-13
Fluent reader	10.38	2.36	7-16	9.17	1.30	7-12	14.05	3.53	1-17	8.65	.59	7- 9	14.14	2.29	10-18
Q2.2. Immersion duration (years)															
Country	16.78	.74	15-18	16.78	.74	15-18	.00	.00	0- 0	16.43	1.50	14-18	.05	.22	0- 1
Family	16.65	1.07	13-18	7.17	8.24	0-18	.10	.45	0- 2	16.43	1.50	14-18	.00	.00	0- 0
School	10.70	.88	8-11	10.74	.92	8-12	6.50	1.40	3- 9	10.76	2.07	8-17	6.57	2.13	3-10
Q2.3. Self-reported proficiency in…[b]															
Speaking	9.61	.94	7-10	8.39	2.08	2-10	5.80	2.46	2-10	9.52	.75	8-10	6.90	2.28	3-10
Understanding	9.26	1.25	5-10	9.48	.85	7-10	6.00	2.03	1-10	9.67	.66	8-10	6.62	2.40	3-10
Reading	6.43	2.97	0-10	9.57	1.08	5-10	7.10	1.92	4-10	9.48	.93	7-10	7.67	1.74	5-10
Q2.4. Contribution to language learning from…[c]															
Family	8.74	2.56	1-10	4.48	3.82	0-10	2.35	2.80	0-10	6.76	3.10	1-10	4.29	2.69	0-10
Friends	.57	1.44	0- 5	2.22	3.29	0-10	4.30	3.60	0-10	3.19	3.96	0-10	2.52	2.73	0-10
Reading	10.00	.00	10-10	3.83	3.94	0-10	2.35	3.63	0-10	10.00	.00	10-10	.38	1.12	0- 5
TV	2.52	2.25	0- 5	7.35	3.92	0-10	2.00	2.81	0-10	4.81	3.50	0-10	5.67	4.21	0-10
Radio	3.30	3.05	0-10	8.30	2.74	1-10	6.35	3.00	1-10	6.76	3.10	1-10	7.71	3.18	1-10
Self-learning	.96	1.66	0- 5	2.61	3.53	0-10	.75	2.45	0-10	.52	1.50	0- 5	1.57	3.17	0-10
Q2.5. Extent of current language Exposure to…[d]															
Family	9.17	2.29	1-10	4.43	3.87	0-10	.95	1.47	0- 5	7.86	2.54	5-10	4.10	3.19	0-10
Friends	2.22	2.11	0- 5	6.26	3.71	0-10	4.05	3.27	0-10	7.24	3.55	0-10	5.67	3.90	0-10
Reading	9.78	1.04	5-10	3.35	3.50	0-10	.35	1.14	0- 5	10.00	.00	10-10	.24	.44	0- 1
TV	3.52	3.34	0-10	8.91	2.11	5-10	3.80	2.69	0-10	7.14	2.54	5-10	7.10	2.49	5-10
Radio	1.83	1.97	0- 5	7.87	3.55	0-10	1.85	2.16	0- 5	6.90	2.49	5-10	5.19	3.63	0-10
Self-learning	.09	.29	0- 1	1.04	2.42	0-10	5.00	4.59	0-10	2.62	3.94	0-10	5.29	3.64	0-10
Q2.6-7. Self-reported foreign accent as perceived by…[e]															
Self	2.78	2.11	0- 6	4.17	2.13	0- 9	5.70	1.95	0- 9	2.52	3.54	0-10	5.62	2.44	1-10
Others	4.43	2.86	1-10	4.39	1.62	0- 5	5.55	3.52	0-10	1.43	2.09	0- 5	6.05	2.82	1-10

Notes:

a. Question numbers refer to their listing in Marian, *et al*. (2007: 966-67).
b. 0 'none' to 10 'perfect'.
c. 0 'not a contributor' to 10 'most important contributor'.
d. 0 'never' to 10 'always'.
e. 0 'none' to 10 'pervasive'.

Q1.4 asks the respondents what percentage of the cases they would prefer to *read*, in each of the languages they command, a translation of a text originally written in a language they would be unable to understand. **Q1.5** asks the respondents what percentage of the time they would prefer to *speak* in each of the languages they listed (assuming the interactant is equally fluent in each language chosen). The percentages should add up to 100. The results indicate that the bilinguals preferred to read the translations in PE rather than in AZ (39% vs. 25%, and 28% for English), which probably means that the Western- style AZ orthography was a problem for the participants (since AZ is not part of the school curriculum). The monolinguals preferred translations into PE (55%, against 36% into English). This result contrasts rather sharply with the responses to Q1.5, which revealed a clear preference on the part of the bilinguals to speak in AZ rather than in PE (55% vs. 21%), while the monolinguals preferred to speak PE (67% of the time) rather than English (27%). Generally, students preferred to use the language they listed as first acquired and most dominant.

In **Q1.6**, the students were asked to name the cultures with which they identified and to express the strength of their identification on a scale from 0 to 10. With just one exception, all respondents identified with Iranian culture first (one calls it 'Persian culture'). The exception mentioned Azerbaijanian culture first and Iranian second. All bilinguals mention Turkish (or sometimes Azerbaijanian) as their second-most favorite culture. Only three monolinguals list Turkish/ Azerbaijanian as their second choice; they tend to list American culture as the second. Cultural identification is at odds with linguistic preferences. We will not use the responses to Q1.6 in our attempts to quantify PE-AZ language dominance.

Q1.7 inquired about the length of the respondent's education and the highest level attained. Since all our respondents went through the same curriculum, the responses are predictable from the student's age, which is the topic of one of the latter questions. **Q1.8-9** are either not applicable to our respondents (when did you emigrate to the USA?) or were uniformly filled in with negative answers (vision/hearing impairment, language or learning disability).

In the second part of the LEAP-Q, **Q2.1** asks the respondents to specify, for each of the languages they listed in Q1.1, their age (in years) when (a) they were first exposed to them, (b) when they considered themselves fluent speakers, (c) when they started reading, and (d) when they considered themselves fluent readers. The responses indicate that the monolinguals started learning their mother tongue (PE) at the age of 1.05 years, while the bilinguals said they started learning AZ at age 1.30; their acquisition of PE started at age 4.04. Participants considered themselves fluent in their first language about three years later (age 4.48 for monolinguals, 4.57 for bilinguals). The bilinguals stated they were fluent in the second language (PE) at 7.83. Reading is a different matter altogether. All respondents started reading in PE at the same age, i.e., 6.62 and 6.54 for monolinguals and bilinguals, respectively. Reading in AZ, for the bilinguals only,

started a year later, at age 7.67. Monolinguals considered themselves fluent readers in PE at age 8.65, followed slightly later by the bilinguals at age 9.17. Learning a second writing system (Western instead of Arabic script) possibly caused some delay here.

In **Q2.2,** the respondents had to specify, for each of their languages, how many years and months they had spent in (a) a country, (b) a family, and (c) a school where the language was spoken as the primary vehicle of communication. In the large majority of the responses, our respondents specified years only. In our data analysis, the occasional specification of months was converted to an extra year if the number of months was greater than six. Since all respondents hailed from Iran, the answer to question (a) was roughly the same for monolinguals and bilinguals (16.43 vs. 16.78 years, with no difference between PE and AZ). These numbers also correspond to the respondents' age. The bilinguals indicate that the time they spent in the homes of PE-speaking families was considerably shorter (7.17 years) than the monolinguals.[5] The length of (self-reported) immersion in the school context in PE (and AZ for the bilinguals) was the same for all respondents, i.e., roughly 10.7 years.

Q2.3 in the LEAP-Q is probably the most relevant question for our purpose. Students specified how proficient they considered themselves in each of the languages they command in terms of (a) speaking, (b) listening, and (c) reading. The latter two questions relate to receptive language skills (the questionnaire does not ask the respondents to say anything about writing proficiency). On a scale from 0 to 10, the students considered themselves equally proficient in speaking their first language, i.e., 9.52 and 9.61 for the monolinguals and bilinguals, respectively. The bilinguals consider themselves slightly less proficient in PE, 8.39, than in AZ. This difference is significant, $t(22) = 2.4$ (p =.024). We take this as an indication that the bilinguals have a realistic view of their language proficiency and that AZ is indeed the stronger of the two languages they acquired at a young age. No significant differences in the self-rated proficiency between monolinguals and bilinguals regarding listening skills can be observed. As for reading PE, there is no significant difference between monolinguals (9.48) and bilinguals (9.57). However, the bilinguals rate their reading proficiency in AZ (6.43) significantly lower than in PE, $t(22) = 4.9$ ($p < .001$). In our research, we are primarily concerned with the proficiency and dominance in the spoken language modality, so we will ignore the reading proficiency score in our attempts to find a measure of relative language dominance of AZ over PE.

Questions **Q2.4-5** concern the settings in which the participants acquired and currently use their various languages. The self-estimations are included in Table 1 under Q2.4 and 2.5, respectively. We will not comment on the results here, as these background data are not of immediate use in our attempts to define a quantitative measure of language dominance.

Finally, we need to consider **Q2.6-7**. Here the respondents had to specify, for each of their languages, the strength of a non-native accents (a) as perceived by themselves and (b) as indicated to them by others. The self-perception of non-native accent in their respective first language is low for monolinguals (2.52) and bilinguals (2.78) alike, $t(42) = .3$ ($p = .768$, n.s.). The bilinguals, however, rate their non-native accent in PE as significantly stronger (4.22), $t(22) = 2.2$ ($p = .040$, 2-tailed). Moreover, the monolinguals report virtually no comments by others (1.43 on a scale from 0 to 10) on their non-nativeness in PE – which means that they speak PE without any accent. However, the bilinguals report more comments on their non-native accent, both when they speak AZ (4.43) and PE (4.39). The difference between monolinguals and bilinguals in PE is significant, $t(42) = 3.0$ ($p < .001$); the difference between speaking AZ and PE by the bilinguals is not, $t(22) = .1$ ($p = .955$, n.s.). This might indicate that the bilinguals' pronunciation of the two languages they learned at a young age is somewhat compromised in both languages, i.e., that bilingualism comes at a price. Probably, some (weighted) mean of these non-nativeness ratings could be a robust index of relative language dominance of AZ over PE.

It would seem reasonable to hypothesize that bilingual students who are (or consider themselves to be) highly native and proficient in AZ, will be less native and proficient in PE, and *vice versa*. The more dominant one language, the less dominant the other language will be. This would predict a negative correlation between the two languages. In Table 2, we show a non-redundant correlation matrix (i.e., lower triangle) for the relevant variables.

Table 2. Correlation matrix of eight self-rated performance measures (scales from 0 to 10) for 23 bilingual Iranian participants with Azerbaijani (AZ) as L1 and Persian (PE) as L2. Pearson's *r* in upper part of cells, *p*-value in bottom part.

	SpeakAZ	ListenAZ	SpeakPE	ListenPE	AccentAZ	IdentifAZ	AccentPE
Proficiency Listening in AZ	**.863**** < .001						
Proficiency Speaking in PE	−.150 .247	−.058 .396					
Proficiency Listening in PE	−.097 .330	−.037 .433	**.585**** .002				
Non-native accent in AZ	**−.388*** .034	**−.408*** .027	**.455*** .015	.265 .111			
Identified as non-native in AZ	**−.509**** .007	**−.440*** .018	.268 .108	.230 .146	**.620**** .001		
Non-native accent in PE	**.392*** .032	**.389*** .033	−.335 .059	−.276 .101	−.233 .143	−.210 .169	
Identified as non-native in PE	**.454*** .015	**.502**** .007	**−.430*** .020	**−.356*** .048	**−.487**** .009	**−.513**** .006	**.781**** < .001

* Correlation significant at the 0.05 level (1-tailed).
** Correlation significant at the 0.01 level (1-tailed).

Some correlations stand out immediately. Speaking and listening proficiency in AZ are strongly correlated (r = .863); the same correlation is still significant but weaker (r = .585) in PE (so apparently, the skills diverge more in the less dominant language). Also, a self-assessed non-native accent correlates strongly with reported identification as a non-native for AZ and PE. These four positive correlations are highlighted in green cells in the matrix. Crucially, there is a (moderate but significant) negative correlation between the student's identifiability as a non-native speaker of PE and his/her identifiability as a non-native of AZ – as predicted. Note that proficiency in AZ (whether speaking or listening) correlates negatively with the proficiency measures in PE and with the self-rated strength and identifiability of a non-native accent in AZ – but positively with the same accent ratings for PE.

3.2. Consistency in perceptual assimilation

We define our listeners' response consistency as the percentage of repeated target pairs with identical choices divided by the total set of pairs presented (N = 22). Table 3 presents the overall results we obtained.

Table 3. Overall Response consistency, Goodness rating (on a scale from 1 to 5 = best) and Response latency (ms) on first and second presentation for monolingual Persian (PE) and bilingual Azerbaijani (AZ)-PE listeners, when assimilating American English vowels to the vowels of PE or AZ.

	Monolinguals		Bilinguals				Comparison			
	(a) PE		(b) PE		(c) AZ		(a) vs. (b)		(b) vs. (c)	
	Mean	SD	Mean	SD	Mean	SD	t(42)	p	t(22)	p
Consistency (%)	78.35	13.63	77.67	11.38	58.30	16.65	.18	.856	6.13	< .001**
Goodness1 (1..5)	4.06	.59	3.77	.50	3.61	.69	1.76	.086	1.37	.184
Goodness2 (1..5)	4.05	.62	3.83	.56	3.60	.71	1.23	.227	1.82	.083
Latency1 (s)	3.04	.75	3.18	.77	3.67	.77	.61	.546	5.61	< .001**
Latency2 (s)	2.68	.69	2.94	.62	3.36	.74	1.30	.201	3.27	.004*

Notes: *very significant ($p \leq .01$); **(7.17 years) ($p \leq .001$)

When responding in the PE mode, the bilinguals are only marginally less consistent than the monolinguals; the difference of (less than) 1 percent is non-significant by a t-test for independent groups. Goodness ratings are somewhat more favorable when given by the monolinguals than by the bilinguals, both on the first and second presentation of the stimuli, but again the differences between the two groups are not significant.

Before analyzing the response latencies, we first applied data trimming to exclude excessively long responses. The trimming was done to remove the 10 percent longest responses from the data. The cutoff for the 90th percentile was found at 7.02 seconds. The results then show that reaction times were shorter in the second half of the experiment than in the first, with a mean difference for the monolinguals of 359 ms and the bilinguals of 242 ms. A repeated measures ANOVA with Repetition as a within-subjects factor and Language background

(monolingual, bilingual) as a between-subjects factor bears out that the main effect of Repetition is highly significant, $F(1, 42) = 21.20$ ($p < .001$, $p\eta^2 = .335$) but that the interaction between Repetition and Language background is not, $F(1, 42) = .81$ ($p = .374$, $p\eta^2 = .019$). The most likely reason participants are faster in the second half of the experiment is that they got more familiar with the location of the response buttons on the computer screen. The more relevant factor of Language background turns out to have no effect. To be valid, the monolinguals are faster than the bilinguals overall, but the mean difference of 140 ms after the first presentation and even of 257 ms after the second presentation is not significant, $F(1, 42) = .944$, $p = .337$, $p\eta^2 = .022$).

The results are rather different when we compare the responses given in the PE mode with those in the AZ mode. Since these differences occur within participants, the t-test for correlated samples can be used. When responses are given in terms of the AZ vowel system, consistency is about 20 points poorer than when the bilinguals respond in the PE mode. The difference is highly significant (rightmost column in Table 3). This indicates that the AZ response mode (the dominant L1 for all bilinguals) is more difficult than the PE mode, even though Persian is the less dominant language for these participants. Similarly, the response latency is longer in the AZ mode than in the PE mode, both on the first and second presentation of the stimuli. The difference is (highly) significant on both occasions. There are no significant differences in goodness ratings, neither on the first nor second presentation, although there is a slight tendency for the ratings to be lower when the response mode is AZ. Typically, we would expect higher consistency and faster responses in the dominant language mode. In the present case, however, the vowel system of the dominant language, i.e., AZ, is more complex than that of the less dominant language, PE. For AZ, the participants must choose from nine possibilities against only six for PE. This would seem to be the primary reason why the choice in the AZ response mode is intrinsically more complex and therefore yields more inconsistencies and longer latencies. The problem may have been aggravated further by the relative unfamiliarity of the bilinguals with the writing system of AZ, which we used to identify the response alternatives on the computer screen.

3.3. Language dominance and PAM consistency

In order to test the hypothesis that the difference in consistency with which our bilinguals perceptually assimilate the vowels of AE to AZ vs. PE reflects a difference in language dominance at the level of the individual participant, we computed a number of simple difference measures by subtracting the scores found for PE (consistency and LEAP-Q measures) from the scores found for AZ. Since AZ is the dominant language (given the LEAP-Q measures), we expect positive differences; negative differences would indicate that PE is the more dominant language. A caveat is in order here where it concerns the difference in consistency. We have seen that consistency is poorer overall for AZ than PE due

to the smaller number of response categories and greater familiarity with the writing system for PE. For this reason, most of the consistency difference scores will be negative. Nevertheless, as the dominance of AZ over PE is stronger, smaller negative differences will be obtained, and in some extreme cases of AZ dominance, we may even find a positive difference. In all cases, we expect to find positive correlations between the LEAP-Q-based dominance measures and the difference in consistency as defined here.

Table 4 summarizes the difference scores we examined. Here the difference in consistency is the dependent variable (criterion), which we want to predict from one or more independent variables based on differences in LEAP-Q scores (predictors).

Table 4. Difference scores defined for Azerbaijani (AZ) - Persian (PE) early bilinguals (*N* = 23).

	Name	**Definition**
1.	Δ Consist	Consistency in AZ minus Consistency in PE (= dependent variable)
2.	Δ Exposure	Current exposure (% of time) to AZ minus PE
3.	Δ Speak	Proficiency (0..10) speaking in AZ minus PE
4.	Δ Listen	Proficiency (0..10) understanding spoken AZ minus PE
5.	Δ Accent Self	Strength of self-perceived nonnative accent (0..10) in AZ minus PE
6.	Δ Accent Others	Frequency of comments by others on nonnative accent (0..10) in in AZ minus PE

Table 5 is a correlation matrix of these six variables (non-redundant lower triangle only).

Table 5. Non-redundant lower half of correlation matrix for difference measures defined in Table 4. Significant r-values in bold face ($p < .010$).

		Δ Consist	Δ Expo	Δ Speak	Δ Listen	Δ Acc. S.
Δ Exposure	*r*	−.195				
	p	.372				
Δ Speak	*r*	.205	.283			
	p	.347	.191			
Δ Listen	*r*	.042	.398	**.615**		
	p	.850	.060	.002		
Δ Accent Self	*r*	−.115	−.330	**−.626**	**−.603**	
	p	.602	.124	.001	.002	
Δ Accent Others	*r*	−.305	**−.547**	**−.563**	**−.627**	**.768**
	p	.157	.007	.005	.001	< .001

The two self-ratings for non-native accentedness are positively correlated. A stronger non-native accent in AZ than in PE (as judged by the participants themselves) corresponds rather well with the frequency of comments received on their way of speaking. The strength of a non-native accent (i.e., sounding PE when speaking AZ and *vice versa*) is inversely correlated with the difference in self-reported exposure to, and preference for speaking and listening to AZ versus PE. It should be feasible to derive an index of language dominance of AZ over PE

from these LEAP-Q-based measures that make at least a reasonable prediction of the consistency index we computed for the participant's PAM decisions. In order to find such an index, we performed a multiple linear regression analysis with the five LEAP-Q dominance measures as predictors and the difference in PAM consistency as the criterion. The full model yields an *R* of .623 (which accounts for 39% of the variance in Δ Consistency). An optimal model, obtained by backward elimination of predictors, yields *R* = .592, with Current exposure and the two Accentedness ratings as remaining predictors. The index derived from this analysis, i.e.,

$$.417 \times Z(\Delta \text{ Accent Self}) - .938 \times Z(\Delta \text{ Accent Others}) - .571 \times Z(\Delta \text{ Exposure})$$

explains 35% of the variance in the z-normalized difference in consistency between AZ and PE PAM performance.

4. Discussion and conclusions

In this study, we tested the hypothesis that a difference in language dominance in early bilinguals would be reflected by the relative consistency with which such bilingual respondents perform a perceptual assimilation task in the two languages they learned during childhood. The experience and proficiency in Azerbaijani (AZ, a Turkic language, acquired from birth onwards) and Persian (PE, acquired from age three onwards) was established by administering the LEAP-Q questionnaire to 23 AZ-PE early bilingual adolescents, as well as by a matched group of PE monolinguals.

The questionnaire results reveal that the early bilinguals acquired AZ before they acquired PE and considered themselves more proficient in AZ than in PE. Their current exposure to AZ generally exceeded that of PE, and the large majority of the early bilinguals considered their AZ accent in PE stronger than their PE accent in AZ, which corresponded quite well with the frequency of comments received on their pronunciation of the two languages.

Both groups of adolescents performed a perceptual assimilation task in which they had to identify tokens of American English (AE) monophthongs as instances of the vowels in their native language(s), i.e., to one of the six vowels of PE and, for the bilinguals, also as one of the nine vowels of AZ. No significant differences were found in the consistency and speed with which the monolinguals and early bilinguals performed the perceptual assimilation task for PE. For the bilinguals, assimilation of the AE vowels to the nine vowels of AZ was more difficult, in terms of consistency and speed, than to the six vowels of PE, which effect is most likely caused by the greater uncertainty yielded by nine response alternatives for AZ versus six in PE.

Although no single dominance measure derived directly from the LEAP-Q questionnaire correlated significantly with the difference in consistency with

which the bilinguals assimilated the AE monophthongs to the nine vowels of AZ or the six vowels of PE, a combination of three LEAP-Q dominance measures accounted for 35% of the variance in the consistency differences observed in our group of 23 early bilinguals. This result does support our hypothesis that language dominance is reflected in the consistency with which a perceptual assimilation task can be performed in the two languages acquired by an early bilingual. However, we consider the correlation insufficiently robust and too complicated to advance it as a straightforward, reliable, and valid indicator of language dominance.

Notes

1. The cross-lingual intelligibility of Standard Turkish for Azerbaijani listeners has been estimated at 56% (Salehi & Neysani, 2017). Cross-lingual intelligibility of AZ for Turkish listeners (using a different method) was estimated at 42% (Sağın-Şimşek & König, 2012).
2. These are conservative estimates. According to Lazerte (2021), the official demographic statistics in Iran do not generally include self-declared ethnic identity. For this reason, estimates of Iran's Azerbaijani Turk population range from 18 million to 40 million, depending on the sources consulted. A more realistic estimate would be that Azerbaijani constitute well around 23 percent of the entire population of Iran, concentrated in the six northwestern provinces (Shaffer, 2021).
3. https://bilingualism.soc.northwestern.edu/wp-content/uploads/2013/06/LEAPQ-Farsi.doc
4. We may define a PE/AZ dominance ratio for current exposure by dividing the percentage of the time spent on exposure to PE by the total percentage of the time the participant claims to be exposed to either PE or AZ, %P / (%P + %A). The mean ratio then turns out to be .99 for the monolinguals against .27 for the bilinguals, $t(42) = 16.0$ ($p << .001$).
5. Many bilinguals made friends with monolingual PE classmates and started visiting them in their own PE-speaking homes. Respondents specified the year this first happened.

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