TWO LANGUAGES, TWO PITCH RANGES: THE CASE OF JAPANESE-ENGLISH SEQUENTIAL BILINGUALS

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ABSTRACT

We designed an experiment aiming to investigate variation in the pitch range of the two languages of Japanese-English sequential bilinguals. Data were collected from eight Japanese-English bilinguals and eight English monolinguals in London (UK). Preliminary results from a reading task show significant differences across the pitch profiles in the English of the bilinguals and the English of the monolinguals, as well as significant cross-linguistic differences across the pitch profiles of the two languages of the bilinguals. The observed between-group differences are consistent with previous findings on pitch profiles of languages spoken as an L1 and an L2. The within-group differences show an unexpected pattern: the bilinguals' mean F0s in English are higher than their mean F0s in Japanese, irrespective of whether female or male. This could be attributed to increased stress due to L2 anxiety or to a potential change in the language norms of Japanese.

Keywords: Pitch range, prosody, bilingualism, L2 acquisition, sex

1. INTRODUCTION

There is a substantial body of research on pitch which has compared languages [4, 22, 27], dialects [15] and social groups [6] showing that differences in pitch can be due to (1) different phonological and intonational structures, and/or (2) extra-linguistic factors, including culture and emotional state. A few studies have also compared F0 profiles in first (L1) and second (L2) language speech [10, 33] showing that pitch varies across the two languages of bilinguals and this has been attributed to L1 prosodic transfer.

Following Ladd [16], pitch is considered a manifestation of Fundamental Frequency Range (FFR). There is a general consensus that pitch range varies across two quasi-independent dimensions: (1) *level*, which refers to the overall height of an individual's F0 and (2) *span*, which refers to the range of F0s in a speech sample. However, as noted in [21], there is no general consensus on the best approach for quantifying these two dimensions. Here, we follow methods operationalized in [27] for level and [17] for span (see section 2.4 for details).

Previous research has reported that Japanese females use a much higher pitch level than Euro-American females [6, 19, 24, 25], due to the socio-cultural constraints linked to 'being female' in Japan [19, 24, 25]. In contrast, Japanese males have been reported to use a low pitch level to maintain a "cool" profile [19]. Using a reading task, Graham [12] investigated cross-linguistic variation in the pitch of simultaneous balanced Japanese-English bilinguals and found that both females and males used a higher pitch level and a wider pitch span in Japanese compared to English. It was considered of interest to investigate sequential bilinguals as they might be more subject to linguistic and cultural transfer from their L1 to their L2 [10], which could be modulated by differences in Age of Acquisition (AoA), Length of Residency (LoR) in the L2 country and L2 proficiency (as shown in [33]). The term *bilingual* is used to describe people who use two or more languages in their daily lives [13], in line with similar research examining differences in individuals who speak more than one language [18].

The present study is an initial stage investigation on the pitch range of the two languages of Japanese-English sequential bilinguals. To this end, we compared the pitch range of the bilinguals in English to the pitch range of native monolingual speakers of English [as in 10, 22], as well as the pitch range of the two languages of the bilinguals [as in 12, 19, 24, 25]. Our corpus was also balanced by sex, i.e. "the individual biological status as female, male or intersex" [3, p.2], allowing us to look into the effect of this variable in the speech of the two groups of participants. We expected to find differences in pitch profiles between English as an L1 and an L2, as well as a difference in the pitch range of the two languages of the bilinguals. We also expected Japanese females to show greater differences in their pitch profiles both across sex groups and across languages, due to Japanese language socio-cultural norms.

2. METHODS

This study was part of a larger study carried out both in London (UK) and in Tokyo (JP).

2.1. Participants

Sixteen participants, all residents of London, UK, took part in the study, divided into two groups: (1) 8 Japanese-English sequential bilinguals – JEB (4 females and 4 males) and (2) 8 SSBE functional monolinguals – EM (4 females and 4 males).

Prior to data collection, participants were asked to complete a language background questionnaire adapted from LEAPQ [20] and MSI-Goldsmiths [23]. All bilingual participants considered Standard Japanese to be their L1, followed by English, which they all acquired from childhood through formal education. Overall, the bilingual participants of this study were consecutive bilinguals, varying in degrees of AoA and LoR and self-reported L2 proficiency on a scale from 0 (*none*) to 10 (*perfect*) (see Table 1 below). In contrast, the SSBE native speakers reported English as their L1 and to have studied some languages mainly at secondary school but not to be proficient nor to use them on a daily basis. The 8 EMs only ever resided in England and had only been abroad for holidays.

Table 1: Language background information of participants of both groups (SD in brackets).

Group	Age (yrs)	AoA (yrs)	LoR (yrs)	L2 proficiency
JEB	30 (7.1)	11 (3.1)	6 (4.4)	7.5 (1.2)
EM	25 (6.4)	n/a	n/a	n/a

2.2. Stimuli

The stimuli which the participant read out consisted of 16 English sentences and their translations in Japanese taken from [12]. They comprised four types of sentences: Alternative questions (Alt_QS), Declarative questions (Dec_QS), Declarative statements (Dec_ST) and Wh-questions (Wh_QS). Four sentences for each type were used. These sentences were chosen because they are favourable for pitch analysis, i.e. they contained a high amount of fully voiced segments, whilst being short enough to typically correspond to a single intonational phrase (IP) and so control for declination effects [28].

2.3. Experimental Procedure

Data collection took place in a soundproof IAC booth in the QMUL Phonetics Lab. The recording chain was a Røde NT1-A condenser microphone (cardioid polar pattern) and a Steinberg UR22 audio interface (microphone preamp and analogue to digital converter). All audio was recorded on a MacBook Pro at a sample rate of 44.1 kHz, 16-bit.

The reading task was the second task of a longer study comprising 3 tasks and 3 questionnaires. Participants were comfortably seated at a computer and presented with an interface created in PsychoPy 1.85.2 [29]. Participants were instructed to read each sentence naturally without changing the words in any way. To minimize interference from the investigator [11] and avoid influences in terms of phonetic imitation [1] or gender interactions [7] on the speech of the participants, instructions were given by a gender-neutral animated character created in Adobe Character Animator [2], who 'spoke' to the participants via speech bubbles. The study was first created in English and then translated into Japanese by a professional translator. The translation was subsequently blindly back-translated into English by another translator, as recommended for cross-cultural research [9].

Each stimulus was presented only once, in a randomised order. Bilinguals did the study in both of their languages separately with a 30-min break between halves to account for language modes [14]; languages were counterbalanced across participants.

2.4. Phonetic analysis

FFR measurements were made for the two aspects of pitch range described previously: level and span.

Recordings were first segmented and then visually and auditorily inspected in Praat [8] before running a customized script to extract pitch variables across each sentence. Waveforms and spectrograms were examined in 5-10 second intervals to check for octave jumps and/or doubling, as well as for sections of creaky voice which were removed from the analysis.

For females, the pitch floor was set at 100 Hz and pitch ceiling at 500 Hz. For males, pitch floor was set at 75 Hz and ceiling at 300 Hz. Following [27], for pitch level, mean, min and max F0 were extracted; for pitch span, the 80% range was obtained as in [17].

3. BETWEEN GROUP DIFFERENCES

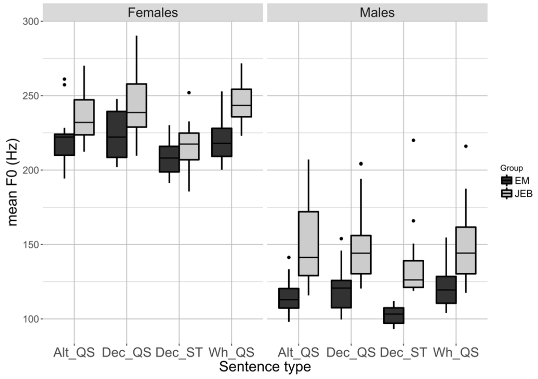
We first aimed to expand upon prior work on L2 acquisition of prosody by asking whether JEB and EM differed in the use of pitch range in English.

3.1. Statistical model

Linear mixed-effects models for measures of both pitch level and span were built in R [30] using the lme4 package [5]. *Speaker* and *sentence* were included as random intercepts. Predictor variables included *Group* (JEB vs EM), *Sex* (Female vs Male), *Sentence type* (Alt_QS, Dec_QS, Dec_ST, Wh_QS), and interactions between *Group:Sex* and *Group*:*Sentence type*.

3.2. Results: Pitch level

Figure 1: Boxplot of mean F0 (Hz) by Sentence type, divided by Group.



There was a significant effect of Group (*ß*=25, 3.610, *p*=.002), i.e. Japanese-English bilinguals showed an overall higher mean F0 in their English compared to the SSBE monolinguals. There was also a significant effect of Sentence type (*ß*=-16, -6.652, p<.0001), i.e. Declarative statements elicited an overall lower mean F0; as well as a significant effect of Sex (*ß*=-96, -13.924, *p*< .0001), i.e. males showed an overall lower mean F0 compared to females. There were no significant interactions.

Due to clear differences in mean F0 across male participants visible in Figure 1, data were further partitioned by sex and two separate mixed effect models were run for female and male participants separately. Model parameters were the same as for the previous analysis. Bonferroni-corrected results show that Japanese males' mean F0 was significantly higher than the SBBE males (*ß*=32, 2.766, corrected *p* =.024). Difference in mean F0 between Japanese females' and SBBE females did not reach significance (*ß*=18, 2.751, *p*=.051).

Pearson product-moment correlations were run to investigate the potential relationship between mean F0 of the bilinguals and AoA, LoR and L2 Proficiency. No significant relationships were found.

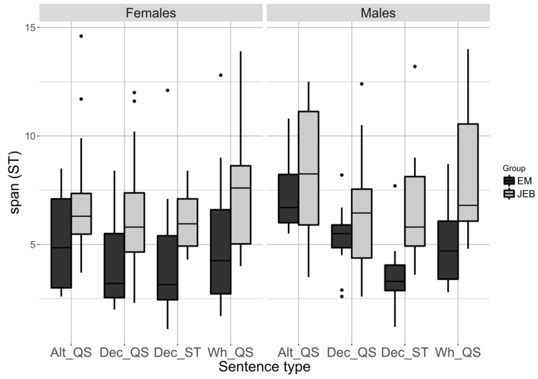
3.3. Results: Pitch span

There was a significant effect of Group (*ß*=3.3, 3.121, *p*=.011), i.e. Japanese-English bilinguals showed a wider span in their English compared to the SSBE monolinguals. There was also a significant effect of Sentence type (*ß*=-1.9, -2.493, *p*<.0001), i.e. Declarative questions elicited a narrower span. Declarative statements also elicited an overall significantly narrower span (*ß*=-2.1, -2.680, *p*<.0001).

As for pitch level, separate models were run for female and male participants. Male bilinguals showed a significant wider span than male monolinguals (*ß*=3.9, 3.249, corrected *p*=.011), whereas differences in the female bilinguals did not reach significance (*ß*=3.9, 2.481, *p*=.028).

Pearson product-moment correlations were run to investigate the potential relationship between span of the bilinguals and AoA, LoR and L2 Proficiency. No significant relationships were found.

Figure 2: Boxplots of span (ST) by Sentence type, divided by Group.



4. WITHIN GROUP DIFFERENCES

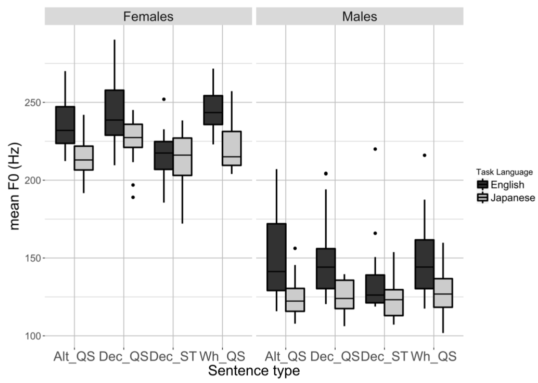
Having observed between-group differences, we next investigated whether there was variation within the bilinguals.

3.1. Statistical model

Linear mixed-effects models of both pitch level and span were created as before. *Speaker* and *sentence* were again included as random effects. Predictor variables included *Task language* (English vs Japanese), *Sex*, *Type of sentence*, and interactions between *Task language*:*Sex* and *Task language*:*Sentence type*.

3.2. Results: Pitch level

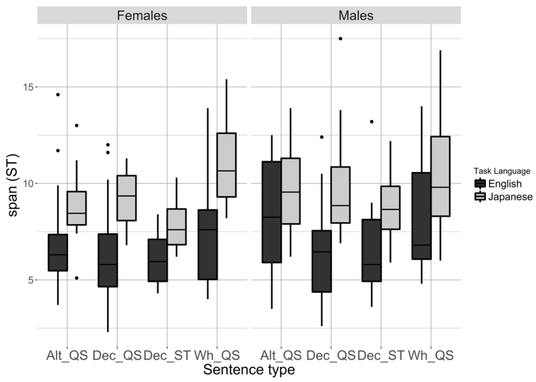
Figure 4: Boxplots of mean F0 (Hz) by Sentence type, divided by Task language for bilinguals.



There was a highly significant effect of Task language (β=-23, -5.613, p<.0001), i.e. Japanese evidenced an overall lower mean F0 compared to English in the speech of the bilingual participants. There was also a highly significant effect of Sex (β=-88, - 9.977, p<.0001), i.e. overall males' mean F0 were significantly lower than the females', but no significant interaction between Task language and Sex. Again, Declarative statements elicited a highly significant lower mean F0 in both languages (β=-19, -4.172, p<.0001). There was also a highly significant interaction between Task language and Sentence type (β=18, 3.409, p<.0001); i.e. in Japanese, Declarative questions elicited a mean F0 higher than in English.

3.2. Results: Pitch span

Figure 5: Boxplots of span (ST) by Sentence type, divided by Task language for bilinguals.



There was a highly significant main effect of Task language (β=2.3, 9.773, p<.0001), i.e. Japanese evidenced an overall wider span compared to English in the speech of the bilingual participants. No main effect of Sex was found, nor interactions between Task language and Sex. Declarative sentences elicited an overall narrower span (β=-1.1, -3.001, p=.009) and Wh-questions an overall wider span (β=0.8, 0.542, p=.039).

4. DISCUSSION

Though preliminary, the results yielded some noteworthy observations regarding the pitch profiles of the bilinguals.

First, the study confirms and extends findings about differences in pitch range between languages spoken as an L1 and L2. We found that the bilinguals' pitch range in English differed from the pitch range of the monolinguals: specifically, the model estimate for the bilinguals' mean F0 in English was 25Hz higher than the monolinguals' mean F0. Moreover, the model estimate for the bilinguals' span was 3.3ST wider than the monolinguals' span. This is consistent with previous research on the pitch range of L2 speakers [10, 33] and could be attributed to a transfer from the L1 to the L2.

To investigate the possibility of such transfer, a separate analysis compared the pitch ranges of the bilinguals across their two languages. As expected, we found a difference between the pitch profiles of the bilinguals in their two languages; but unexpectedly our results showed that the mean F0 of the Japanese-English bilinguals in English was significantly higher than their mean F0 in Japanese for both women and men. This is not consistent with mean F0 patterns previously reported for Japanese-English bilinguals [12, 19, 24, 25]. Research on SLA has shown that reading tasks correlate with increased anxiety in students [32], and previous work on pitch range and emotions has shown that stress and fear/panic lead to higher mean F0 values [31]. This may account for why our bilinguals had not only a higher mean F0 in English than the monolinguals, but also a higher mean F0 in their English than in their Japanese. However, it may also be that language norms in Japanese have changed since the aforementioned studies were undertaken. Span results are consistent with [12].

We were also interested in the effect of sex of speaker on pitch range. Our results did not show sex related differences, i.e. all bilinguals' English mean F0s were higher than the mean F0s of SBBE speakers and all bilinguals' mean F0s in English were higher than their mean F0s in Japanese. Interestingly, if anything, our results suggested that Japanese-English males are the ones driving the difference in mean F0 across bilingual and monolingual groups. Previous literature has reported an effect of gender on the mean F0 of Japanese monolinguals and bilinguals, whereby Japanese females' high mean F0s were explained as a consequence of gender-roles in the Japanese culture [19, 24, 25, 26]. Why did Japanese-English males, and not females, have a significantly higher mean F0 in English compared to monolinguals of the same sex in this study? At present, it is difficult to draw any definite conclusion due to the small sample size of the current study, but since Japanese males have been reported to use a low mean F0, which in English implies 'being cool…even unpleasant' [19, p.83], it might be argued that these speakers increased their mean F0 in English, potentially subconsciously, to ensure they portrayed themselves as pleasant.

In sum, our results showed an unexpected pattern in the mean F0 of the two languages of Japanese-English bilinguals in that the bilinguals' pitch level in English was significantly higher than their pitch level in Japanese, irrespective of sex. Further investigation using a larger data set, natural speech and/or different methods is needed to deepen our understanding of the potentially changing pitch patterns in this population.

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