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Pitch Range in the Production of Saudi and English Women

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ABSTRACT

In the present small-scale preliminary study, we sampled four groups of younger and older female Arabic and English speakers to examine if speaking fundamental frequency (SFF) could show any systematic variations across languages and different age groups performing different tasks. All groups of speakers were recorded reading the North Wind and the Sun twice in their native language, and speaking spontaneously about themselves for around two minutes. Mean SFF values for each speaker and speaking task were obtained using Praat's autocorrelation algorithm with a pitch range of 100-500Hz, with manual correction to remove spurious F0 values caused by doubling or halving the first harmonic. As well as presenting SFF results for all groups, mean values will be given for each group and speaking task.

Keywords: Fundamental Frequency, Mean Values, Pitch Behaviour.

1.0 Introduction

Acoustic studies of speaking fundamental frequency (SFF) have shown that it can vary systematically across languages in ways which cannot be accounted for by speaker-specific physiology. For example, Mennen, Schaeffler & Docherty (2012) reported higher SFF for English females compared to German females by as much as 25Hz or more on certain kinds of phrase accents. They controlled for body height and concluded it had no effect. It has also been shown that female SFF declines with age. Nishio & Nimi (2006) found that the SFF of their sample of Japanese-speaking females was lower in women in their fifties compared to women in their twenties by an average of 36Hz (190.1Hz compared to 126.1Hz). Regarding the speaking task, Abu-Al-Makarem & Petrosino (2007) obtained results showing that the mean SFF of a group of fifteen Arabic-speaking males was on average 1.1Hz higher when reading aloud compared to spontaneous speech. They report this as a significant difference.

In the present study, speech samples from two speech styles of female speakers have been collected. The aim was to find general characteristics in pitch behaviour and if these characteristics are language-specific or not. Knowledge about fundamental frequency phenomena in Saudi and English female speakers could be of interest for speech recognition and speaker identification. Also, aspects of

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fundamental frequency characteristics could be helpful in improving the quality of synthetic speech. More or less related studies on the topic of fundamental frequency characteristics are quoted in the following paragraph. The measurements of fundamental frequency characteristics on Arabic and English female speakers are presented and discussed. The results include mean values and measures of variability.

A number of experiments have been performed to show the importance of the fundamental frequency in age identification tasks. Schwartz and Rine (1968) showed that the age of speakers are distinguishable without information on the pitch by means of an experiment in which voiceless fricatives were presented to listeners. The listeners were able to identify the age of the speakers. Colman (1971), on the other hand, performed some experiments in which speakers and listeners were asked to identify the age of the speakers. Sachs (1975) reports of experiments in which listeners identified the sex of young children in several speech samples. In his study, spoken sentences were presented to the listeners in a natural way as well as played backwardly. It was found that the listeners responded less accurately when they heard the sentences backwardly. According to Sachs (1975), this means that is normal speech not only fundamental frequency level and resonance characteristics give information about the sex of the speaker, but prosodic cues like intonation and rhythm may also be important. Fichtelius et al. (1980) found that rhythm and intonation would be sufficient to identify the child's age as speech become more prosodically differentiated. As far as language is concerned, Loveday (1981) found different fundamental frequencies in politeness formulae for Japanese as opposed to English speakers. Therefore, he concludes that the function of pitch is different in these two cultures. It also seems to be the case that voice quality is an important marker for one's personality (Henley, 1977). In addition, it could be assumed that people adjust their voices within certain limits according to the target they want to achieve whether fully conscious or not (Linke, 1973).

2.0 Fundamental frequency measurements

2.1 Procedure

In the present study, four groups of female speakers are sampled: six younger speakers of Saudi Arabian Arabic (22yrs), six younger speakers of British English (20-22yrs), six older Saudi Arabian Arabic speakers (55yrs), and six older British English speakers (54-58yrs). All were recorded reading the North Wind and the Sun twice in their native language, and speaking spontaneously about themselves for around two minutes. Mean SFF values for each speaker and speaking task were obtained using Praat's autocorrelation algorithm with a pitch range of 100-500Hz, with manual correction to remove spurious F0 values caused by doubling or halving the first harmonic. The Arabic speakers are form Jeddah, Saudi Arabia and the English speakers are from Yorkshire and Lancashire, United Kingdom. dB values can only be compared within speakers because mouth-to-mic distances were only approximately controlled for, and different recording devices were used in Jeddah and Leeds.

3.0 Results of mean fundamental frequency

3.1 Younger and older Arabic and English speakers

It is clear from figure 1 that there are distinctly different fundamental frequency regions for the Arabic younger speaker when they read aloud compared to spontaneous speech. Younger Arabic females tend to have higher SFF and intensity when reading aloud compared to unscripted speech. However, Older Arabic females tend to have lower SFF than age-matched English females for reading aloud and unscripted speech. On the other hand, English females tend to have higher SFF for unscripted speech than age-matched

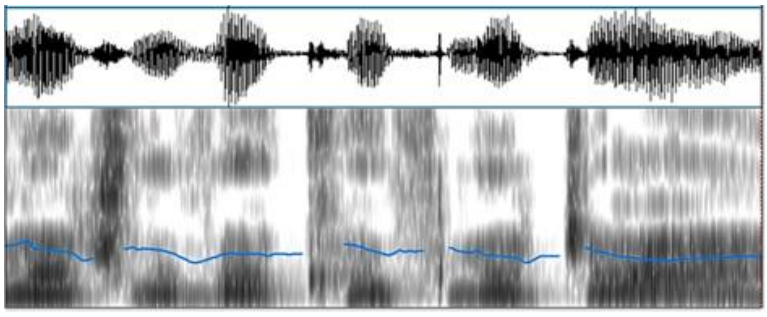
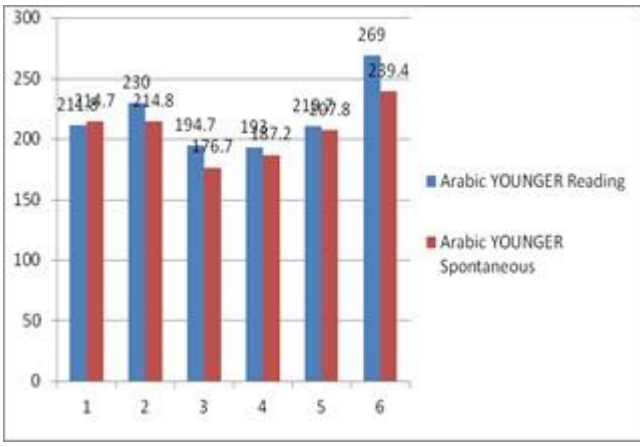


Figure 1: Speakers' mean F0 values were obtained using Praat's 'Get pitch' function (autocorrelation) with pitch settings of 100-500Hz

Arabic females. Older English females tend to read aloud with a higher SFF compared to unscripted speech.



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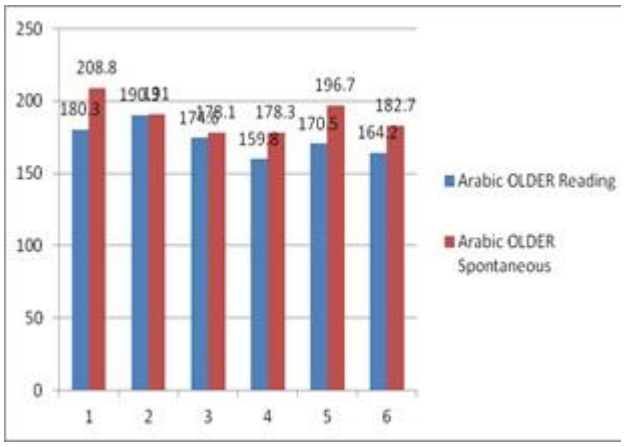
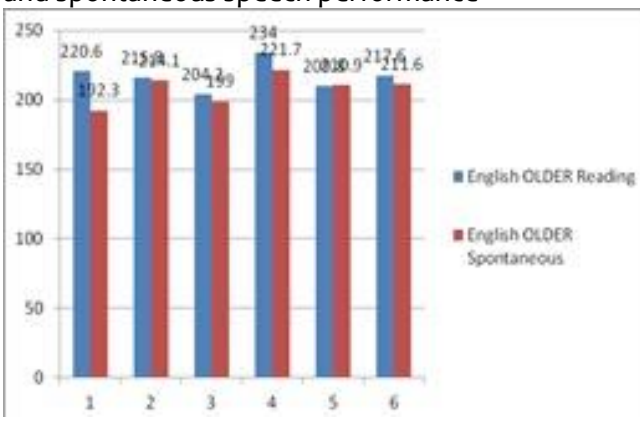


B

Figure 2: Fundamental frequency distribution of younger (A) and older (B) Arabic speakers in read and spontaneous speech performance



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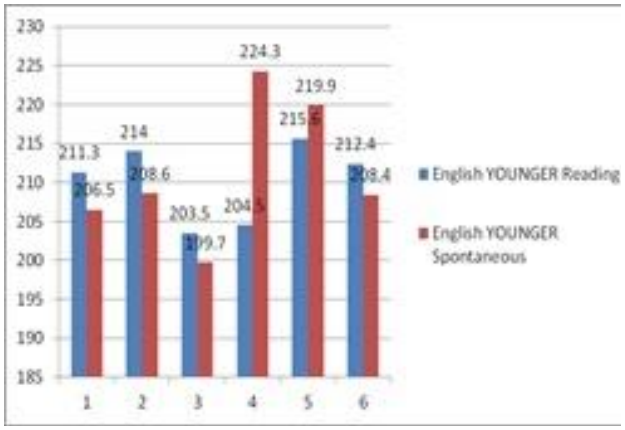


B

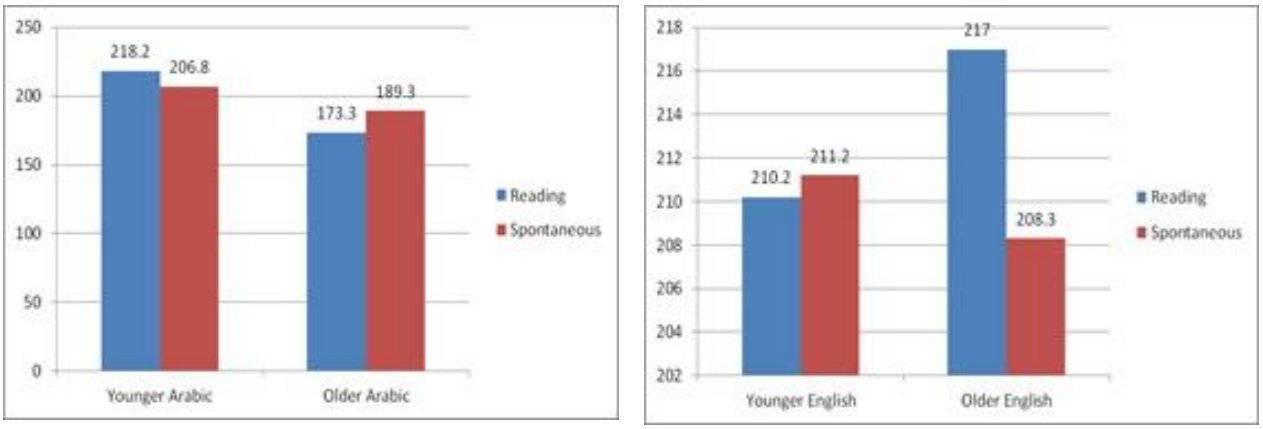
Figure 3: Fundamental frequency distribution of younger (A) and older (B) English speakers in read and spontaneous speech performance

4.0 Discussion and conclusion

Results show that the older Saudi Arabian women's spontaneous speech averages 15.5Hz higher than their read speech (190.6Hz compared to 175.1Hz), while the opposite trend is evident with the younger women: their spontaneous speech averaged 206.8Hz, with their read speech averaging 218.2Hz, a difference of 13.4Hz. The overall lower SFF for both tasks in the older group is to be expected in light of what is known about age-related changes in SFF in females (Nishio & Nimi 2006).

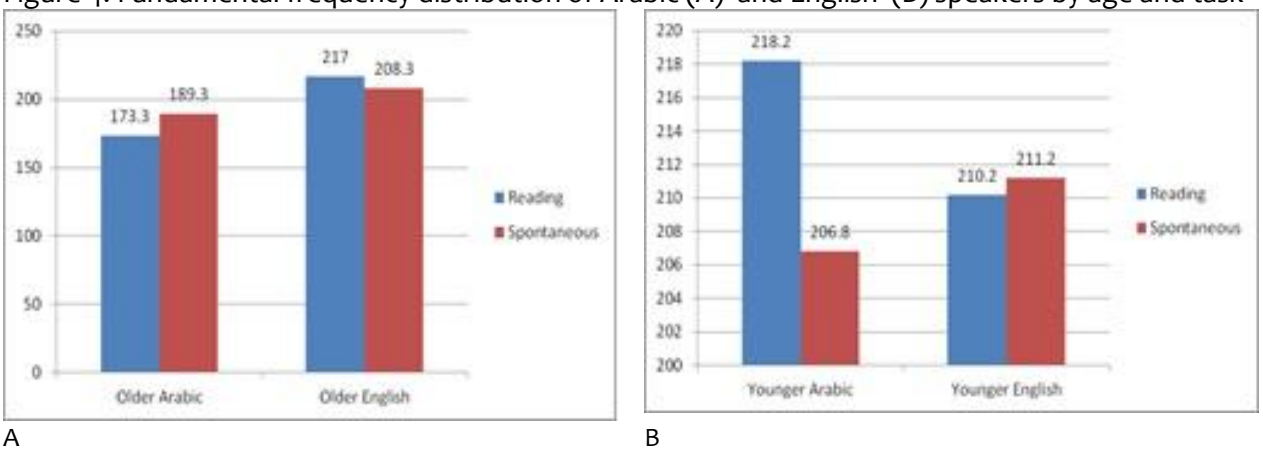
However, the magnitudes of the differences - 16.2Hz for spontaneous speech, 43.1Hz for read speech – suggest language-specific effects, and the reversed trends in the speaking tasks across the two groups is an unexpected finding. The lowering of the voice of the older Arabic speakers in sentence reading is in agreement with the suggestion of Linke (1973) that people are pushed to speak on a low level in order to achieve an effective reading performance.

However, this result is different with the two English-speaking groups as older English females tend to read aloud with a higher SFF compared to spontaneous speech. Nevertheless, in presenting or comparing frequency data, it has to be kept in mind that there are a lot of variables that can have affected the results. Even though several variable like age, task and language have been taken in to account, other variables like personality structure, mental and physical condition could have affected the results.



A B

Figure 4. Fundamental frequency distribution of Arabic (A) and English (B) speakers by age and task



A B

Figure 5: Speakers' mean F0 values were obtained using Praat's 'Get pitch' function (autocorrelation) with pitch settings of 100-500Hz

Although more measurements on more speakers have to be performed, some conclusions could be drawn from the present study:

- Younger Arabic females tend to have higher SFF and intensity when reading aloud compared to unscripted speech
- Older Arabic females tend to have lower SFF than age-matched English females for reading aloud and unscripted speech
- English females tend to have higher SFF for unscripted speech than age-matched Arabic females
- Older English females tend to read aloud with a higher SFF compared to unscripted speech
- Results are consistent with the view that language, speaker age and speech task influence SFF and, to a lesser extent, intensity.

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