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Abstract

This study examines the impact of changes in two speaking styles –story reading vs. storytelling– on the spectral and temporal properties of long and short vowels in Jordanian Arabic. The transition from one register to another may generate temporal spectral modifications. This is why a particular interest has been paid to the behavior of long and short vowels in the context of these two types of variations. Ten speakers of Jordanian Arabic read and then narrated the same short story. Contrary to what was expected, spectral and temporal vowel properties were not influenced by the change in speaking style. These results indicate that in Jordanian Arabic, the transition from one register to the other had little impact on vowel quality and quantity. However, the conditions under scrutiny in this study may be too close to one another to enable such expected differences to emerge. Additional components of the currently collected corpus may be more appropriate to let differences between controlled and more spontaneous speech styles be revealed.

Keywords: speaking style, vowel length, Jordanian Arabic, spectral variation

1. Introduction

In continuous speech, the speaking style usually changes systematically depending on the situation that we experience. For example, in a classroom, we can read a text ("reading" style), talk to our teacher ("formal" style), and discuss with our classmates ("informal" style). This changing in speaking style can provoke temporal and spectral variations of the produced segments (Lindblom and Lindgren 1985). These variations take place due to the change in strategies of speech production. Some speech situations must be realized with a high degree of perceptual contrast; others require less and allow more variability. Consequently, the acoustic properties of the same sound show a wide range of variations reflected along a continuum varying from hypo- to hyper-articulation (Lindblom 1990; Farnetani and Recasens 2010). The present study aims to examine the impact of speaking style on vowel spectral and temporal information in a context where phonologically long and short vowels are opposed.

Many studies investigated the influence of changing the speaking style on vowel quality and quantity in many languages (among others, DiCanio et al. (2015) in Arapaho, DiCanio et al. (2015) in Mixtec, Blaauw (1992) in Dutch, Bolotova (2003) in Russian, and Meunier and Espesser (2011) in French). The common point of these studies is that in spontaneous/casual speech, segment duration and vowel space are reduced compared with read/clear speech. Few studies examined the relationship between long and short vowels when speaking style changes. For example, DiCanio and Whalen (2015) found an asymmetrical influence of speaking style on long and short vowels in Arapaho[1]. Long vowel duration is more influenced by changing speaking style, while its vowel space is less impacted by this factor in comparison with short vowels. Similar results were found in English tense-lax opposition where the duration of tense vowels is more impacted than the duration of lax vowels due to speaking style variation. In addition, the latter has fewer consequences on vowel space of lax than tense vowels.

Asymmetric influences were also noted between long and short vowels in speaking rate variation studies in several languages (Svastikula (1986) in Thai, Pind (1995) in Icelandic, and Hirata (2004) and Hirata and Tsukada (2009) in Japanese). According to these researches, the duration of long vowels is more lengthened than their short counterparts when the speaking rate slows down. The vocalic duration of long vowels is also more shortened than the duration of short vowels when the speaking rate accelerates. However, the impact of variation in rate on the vowel space seems to depend on the language. In Thai, spectral information of long and short vowels remains relatively stable (Svastikula 1986), unlike Japanese, the frequencies of short vowels are more influenced by the change of speaking rate than their corresponding short ones (Hirata and Tsukada 2009). In summary, the vowels, respectively long and short, react differently when the speaking rate or the speaking style is changed.

2. Research Question

The purpose of this research is to examine to which extent variations from story reading to storytelling would influence the durational and spectral information for long and short vowels in Jordanian Arabic. Jordanian Arabic contains 3 short vowels and their long counterparts /i, iː, a, aː, u, uː/ in addition to 2 other long vowels /eː, oː/. The importance of vowel duration in Jordanian Arabic depends on the vowel timbre; /a, aː/ are mainly differentiated by duration, /u, uː/ are distinguished by both duration and spectral information, and /i, iː/ are mainly distinguished by spectral information (Al-Tamimi 2007; Abuoudeh 2018). According to the studies mentioned above, it is expected that reading a story can lead to longer vowel durations and larger spectral spaces than storytelling since the task of reading would correspond to hyper-articulated speech while the task of storytelling would be closer to a more hypo-articulated speech style. Furthermore, this influence could be asymmetrical between short and long vowels.

[1] An endangered Algonquian language spoken in the State of Wyoming in the United States of America. This language have phonological length opposition and contains 4 long and 4 short vowels.

3. Methods

3.1. Speakers

To answer the problem of this study, 10 Jordanian speakers (5 females and 5 males) participated voluntarily in a speech production experiment. The participants were all undergraduate students at Al-Hussein bin Talal University in Ma'an, in the south of Jordan and were aged between 18 and 22 at the time of the recording. They are from Amman and Zarqa, cities located in the Central region of Jordan. The speakers have declared that they do not have any speech disorder.

3.2. Stimulus

The stimulus for this experience consists of the story of "Little Red Riding Hood" written in the Arabic alphabet in a version of Jordanian Arabic written by the first author. It should be noted that this story is popular in Jordan, and all of the registered participants declared that they knew it. The choice of a well-known and popular story is intended to facilitate the task of storytelling[2].

3.3. Procedure

First, speakers were asked to read the story of 'Little Red Riding Hood' from a text that was displayed on a computer screen. Subsequently, they were asked to tell the same story, without reading it. Before recording the storytelling task, the speakers could – if they felt it necessary – reread the story silently to prepare their narration. Before the experiment began, participants were instructed to read and retell the story in their dialect and not in Classical Arabic.

The experiment took place in a quiet room at the Faculty of Letters of Al-Hussein bin Talal University. The equipment used for the recordings is a Sennheiser e835 microphone connected to a Tascam DR-100. The sound files were sampled at 44100 Hz on 32 bits in monophonic mode. The recordings of the two tasks (reading and storytelling) were first transcribed and transliterated with the new Arabic transliteration system (ATR convention) and then segmented by forced alignment using the 'Arabic WebMAUS Basic' service (Kisler, Reichel, and Schiel 2017; Al-Tamimi et al. 2022).

The results of the forced alignment were subsequently corrected by hand using the Praat software (Boersma and Weenink 2022). The duration of the segments, the frequency of the formants (F1, F2, F3), and the f0 were automatically extracted by a Praat script. The *Burg* extraction algorithm (LPC analysis by autocorrelation) was used with an analysis window of 0.025 s and a step of 0.01 s. The formant extraction thresholds were adapted to the sex of the speaker (5000 Hz maximum for men and 5500 Hz maximum for women). The extracted data was then saved in a *.csv* file. For this study, the duration and frequencies of the F1 and F2 formants of vowels were analyzed. The frequencies of F1 and F2 of all speakers were normalized using the Lobanov method in order to limit inter-speaker variation (Lobanov 1971)[3]. Data analyses were performed using the R program (R Core Team 2021).

[2]The data from this study are part of a larger database that is currently under construction on Jordanian Arabic ("Speech Database Jordanian Arabic Dialects - SDJAD" project), which will consist of over 100 participants from different regions of Jordan.

[3]Normalization was carried out using the function 'normLobanov' from the library 'phonR' (McCloy 2016).

3.4. Statistical analysis

The relationships between each of the studied dependent variables ("Vowel duration", "F1", and "F2") and the fixed effects ("Vowel" and "Task") were evaluated by linear mixed models with the function 'lmer' from the library 'lme4' (Bates et al. 2015). The intercept for speakers was also included in the models as a random effect. Additionally, per-speaker random slopes were included for each fixed effect, corresponding to the inter-speaker variability in the effect of each fixed factor on the dependent variables to avoid a high rate of Type I error. The *p-values* were obtained by Satterthwaite approximations using the 'anova' function from the 'lmerTest' library (Alexandra Kuznetsova 2017). These analyses were followed by *post hoc* Tukey tests using the 'glht' function of the 'multcomp' library (Hothorn, Bretz, and Westfall 2008).

4. Results

All speakers produced 0 vowels in reading task and 0 vowels in telling task as detailed in Table 1. It was expected to have less realization in the telling task than in the reading task because the reader would omit some events or phrases while he or she was telling the story. Furthermore, it should be noted that

Vowel	Task	
	reading	telling
i	1120	942
iː	393	360
a	1664	1211
aː	1185	871
u	81	155
uː	188	182
eː	278	180
oː	63	91

Table 1: Number of realisations of each vowel in each speaking style.

short vowels – except /u/ – are overall more frequent than long vowels in the present data, regardless of the speaking style, with a total of 5173 short vowels compared to a total of 3791 long vowels.

4.1. Duration

Descriptive analyses indicate that the two studied speaking styles have a low impact on vowel durations (Figure 1). Mean durations of short vowels remain relatively stable in both speaking styles. As for those of long vowels, the /iː, oː/ are slightly longer in reading than in storytelling. The vowels /aː, uː/, on the contrary, are longer in narration than in reading, particularly the duration of /uː/. The duration of /eː/ remains relatively unchanged in both styles. The observations from the descriptive analyses were confirmed by linear mixed analyses that show no significant difference between the task of reading and the task of storytelling for the duration ($F_{(1,7)} = 0.30, p = .587$). In addition, *post hoc* analyses (Tukey) point out that the duration of vowels is not significantly different depending on the speaking style except for /iː, uː/. These results also reveal that the temporal relationship between long and short vowels in Jordanian Arabic is not influenced by changing speaking style from reading to storytelling.

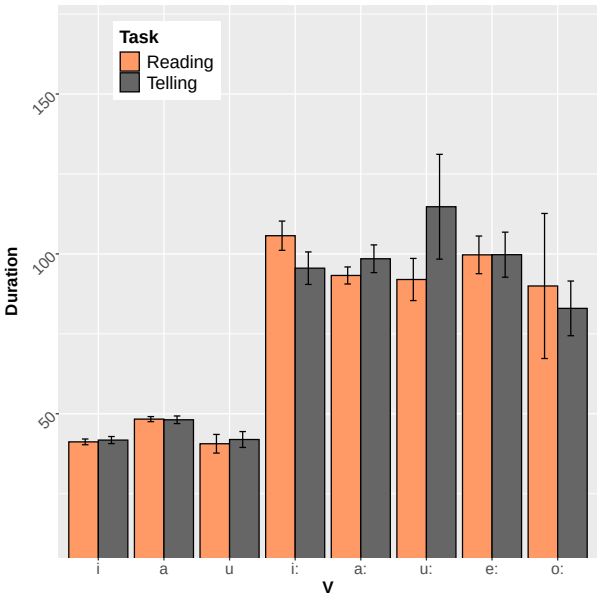

Figure 1: Means of vowel durations in the two speaking style conditions (in ms, the error bars represent the Confidence Interval at 95%).

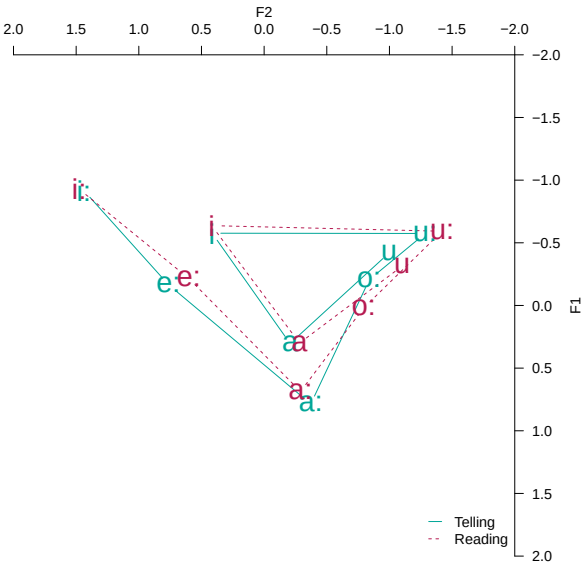

Figure 2: Vocalic space of the eight vowels (in Lobanov) in both speaking style conditions.

4.2. Spectral space

The examination of the vowel space highlights also that the two speaking styles have little influence on spectral information (Figure 2). Indeed, long and short vowels occupy very close positions in both speaking styles on the F1-F2 space. These observations were confirmed by linear mixed analyses, which showed no significant difference between the reading task and the storytelling task for the frequencies of F1 ($F_{(1,7)} = 0.48, p = .494$), and of F2 ($F_{(1,7)} = 0.0001, p = .99$). The *post hoc* analyses (Tukey) confirm also that the frequencies of F1 and F2 observed for all vowels do not significantly change when speaking style changes. Furthermore, these results reveal that the spectral relationship between long and short vowels in Jordanian Arabic is not influenced by the change in speaking style from reading to storytelling.

5. Discussion and conclusion

This study aimed at evaluating the impact of changing speaking style on vowel opposition in Jordanian Arabic. According to the results of this study, this change has very little influence on the spectral and temporal information of long and short vowels. The vowel quality showed no significant difference between the two speaking styles for all vowels. As for the quantity, only two vowels out of eight revealed a significant difference depending on the style (/uː/ and /iː/), including one in an unexpected direction. Indeed, the vowel /uː/ – but also slightly the /aː/ with no significant effect – attests to a lengthening of its duration in storytelling rather than reading. This observation could be due to more hesitation or reflection in the storytelling task than in the reading task.

These findings are not in agreement with previous studies mentioned above. As a reminder, these studies described that the transition from formal to spontaneous speech leads to spectral and temporal variations that can be asymmetric between long and short vowels. The findings of this research could be explained by the fact that these two speaking styles have potentially limited effects on temporal differences in a language that contains a phonemic length opposition. In other words, the absence of the reading *vs.* storytelling distinction – in the case of this study – could be due to the proximity of the two styles compared to the styles investigated in the studies mentioned above. For example, DiCanio et al. (2015) – but also DiCanio and Whalen (2015) – describe that their condition "elicitation" is a repeated pronunciation of isolated words and that the "spontaneous" speech is taken from telling a personal story. It is potentially significantly more discriminating in speaking style terms than reading *vs.* storytelling of the same story, such as that which we compare in the present study.

In addition, the importance of duration separation between long and short vowels in Jordanian Arabic could reduce the temporal impact and, therefore, the variations associated with spectral space in these two types of speaking styles. Another factor for this absence of style effect is that Jordanian Arabic speakers are not used to reading stories in the Jordanian Arabic dialect since they mainly read stories in classical Arabic. This may explain why their reading style resembles closely to their storytelling style. During the recordings, a hesitation, even a reflection, was observed with some speakers in both speaking styles. Finally, studying other tasks of the SDJAD project (such as words produced in isolation, conversational speech, and image description) that are in progress could be enriching to evaluate these different assumptions.

6. Acknowledgements

This research was funded by Al-Hussein Bin Talal University, grant number (85/2022).

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