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Speaking Rate among Professional Radio Newscasters: Hebrew Speakers

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Abstract

This is a preliminary and exploratory study aimed to examine and quantify speaking and articulation rate among professional Hebrew speaking radio newscasters. Nineteen radio newscasters (ten men and nine women) were digitally recorded during live public broadcasts. The newscasters were assigned to two age-groups: "younger" (under 30 years) and "older" (over 58 years). All recordings were first transcribed and then analyzed acoustically to measure overall speaking rate, speaking rate within-item, articulation rate, pause duration and percentage of disfluency. The average speaking rate obtained for the entire group was 5.90 Syllable-per-Second, and average articulation rate was 6.42. No differences were found between men and women for any of the observed measures, and no age-group differences were found. This study provides preliminary rate data for a reading task, performed by Hebrew speaking professional newscasters. It also suggests that within this professional population of adult speakers, rate and fluency measures are not affected by gender or age.

Keywords: speaking rate, articulation rate, reading, newscasters, radio, fluency, Hebrew

1. Introduction

Speaking rate is a supra-segmental feature of speech (Walker & Archibald, 2006). As such, it directly affects fluency, intelligibility and overall communication. Various speech impediments are associated with speaking rate characteristics. Such impediments include dysarthria, dyspraxia, cluttering and stuttering (Furquim, 2003; Van Zaalen-op't Hot, Wijnen & De Jonckere, 2009; Ziegler, 2002). From a language development perspective, speaking rate and pause duration at a younger age are associated with future development of reading disorders (Smith, Roberts, Lambrecht Smith, Locke & Bennett, 2006). From a social perspective, speaking rate was shown to influence listeners' perception of the speaker's personality and social skills (Stewart & Ryan, 1982). Furthermore, speaking rate provides perceivable cues to the listeners, for encoding the speaker's emotional state (e.g., Scherer, Banse, Wallbott, & Goldbeck, 1991).

In addition to its communicational impacts, speaking rate was shown to associate with specific physiological changes. For example, it has been reported that faster speaking rate increases blood pressure, more than speaking at the regular (habitual) rate (Friedmann, Thomas, Kulick-Ciuffo, Lynch, & Suginohora, 1982). As a result of acknowledging these effects and the importance of speaking rate to communication and intelligibility, various current speech-therapy approaches focus on identifying and modifying speaking rate.

Obtaining normative data on speaking rate for various groups of speakers is required, prior to diagnosing speech disorders, evaluating professional speakers and enabling a comparison between disordered speech and acceptable norms (Amir & Grinfeld, 2011; Furquim, 2003). Yet, presently there are no published studies that have directly examined speaking rate among adult Hebrew speakers. Therefore, the present study is a preliminary attempt to provide such data, by quantifying speaking rate within a specific subgroup of speakers – radio newscasters. This group was selected as they are expected to exhibit fluent speech and perceived as a model for "normal" speech and voice (Warhurst, McCabe, & Madill, 2013). Historically, radio news announcements have been presented using a strictly formal language register. Nonetheless, this has gradually changed, and contemporary news announcements have become less formal, to maintain its appeal and accessibility to the contemporary audience (Mann, 2008; Lavie, 2002). Noteworthy is the fact that speaking rate, by itself, is not affected by the level of speech formality

(Laver, 1994). Moreover, it was shown that similar speaking rate values were observed among newscasters and the people they interview (Castro, Serridge, Moraes & Freitas, 2010).

1.1 Quantifying Speaking Rate

Speaking rate is quantified as the number of spoken units (typically referring to words or syllables) over a given time. This measure includes all forms of pauses, disfluencies and interruptions. Accordingly, it is expressed in Syllables-per-Seconds (SPS), or in Words-per-Minutes (WPM) (Howell, Au-Yeung, & Pilgrim, 1999). Another related speech rate measure is *articulation rate*, which is based on fluent speech alone, excluding disfluent utterances, long pauses, breaks or other speech disturbances (Hall, Amir & Yairi, 1999; Laver, 1994).

Measuring speaking rate, as well as articulation rate, requires identifying instances of speech as well as the pauses within a continuous sample of speech. In that respect, pauses within continuous speech may be either *silent* or *filled*. Silent pauses are defined as *not* including perceivable speech sounds. Filled pauses in Hebrew, on the other hand, may contain either the neutral vowel /□/, the nasalized consonant /m/ or the syllable /□m/, which is a fusion of the two (Lauper, 1996). Filled pauses are typically indicative of time in which the speaker searches for the following word or phrase (Schachter, Christenfeld, Ravina, & Bilous, 1991).

1.2 Hebrew Syllable and Word Structure

Although normative speaking rate measurements were performed in different languages, universal norms cannot be defined. The primary reason for the need for specific norms for each language or dialect is related to the differences in syllable and word structure (Laver, 1994). Different languages use different combinations of consonants and vowels for constructing syllables and words, as well as different syntactic rules, for constructing sentences. Such differences directly affect speaking rate.

The two most common syllable structures in Hebrew are CVC (Consonant-Vowel-Consonant) and CV (Consonant-Vowel). The nucleus of the syllable is obligatory while the other components (coda and onset) are optional. Consonant clusters are rare in Hebrew, especially in the coda. Diphthongs are also infrequent, to the extent that most native speakers produce them as a single vowel (Ben- David, 2001). Mono-syllabic words are most frequent in spoken Hebrew. Studies have shown that natural speech comprises of 45% mono-syllabic words, 41% bi-syllabic words and 14% tri-syllabic words (Segal, Nir-Sagiv, Kishon-Rabin & Ravid, 2008; Nir-Sagiv, 2005). Because these features are language dependent and they directly affect rate, there is an obvious need for defining speaking rate norms for each language.

1.3 Effect of Task on Speaking Rate

Previous studies have examined speech rate in different conditions, such as a monolog, a dialog, reading a passage or picture naming. It is beyond the scope of the present study to describe and discuss the differences between these tasks. Suffice to note that such tasks require different levels of memory span, attention, executive functions, reading skills and overall language skills. Consequently, speaking and articulation rate differ between tasks. For example, it was suggested that articulation rate in English is slower during reading, in comparison to conversation (3.40 and 5.12 SPS, respectively) (Jacewicz, Fox, O'Neill, & Salmons, 2009). In contrast, other studies have reported an opposite trend among adult English speakers, suggesting that reading is produced at a faster rate (e.g., Duchin & Mysak, 1987; Johnson, 1961).

The only study that directly assessed speech rate among Hebrew speakers was performed on children and adolescents (Amir & Grinfeld, 2011). In that study, articulation rate measurements were found to be faster during a conversation compared to a picture description task.

In addition to the effect of task on speaking rate, it was also suggested that speech rate is affected by the communicational setup. Specifically, the number of conversation partners was shown to influence rate, such that talking to a single partner is typically performed at a relatively slower rate (Hirose & Kawanami, 2002; Jacewicz et al., 2009).

1.4 Effect of Gender and Age on Speaking Rate

The possibility of a gender effect on speaking rate was examined in previous studies, yielding inconclusive findings. In a review of the literature, that evaluated a large and diverse group of published studies (Van Borsel & De Maesschalk, 2008), it was reported that approximately half of the reviewed studies demonstrated faster speaking rate in men, while the other half indicated no gender difference. In a study that specifically evaluated articulation rate among professional newscasters and weather reporters, no gender differences were found (Shevchenko & Uglova, 2006). In Hebrew, no gender difference was found (Amir & Grinfeld, 2011). It should be

noted, though, that in this single study conducted in Hebrew, only children and adolescents were included, a reading task was not performed and it examined only articulation rate, but not speaking rate.

Various studies have shown that speech rate increases with age, from childhood to early adulthood. This was documented in various languages including Hebrew (Folha & de Felicio, 2009; Martins, Vieira, Loureiro & Santos, 2007; Walsh & Smith, 2002; Amir & Grinfeld, 2011). This increase in rate is attributed to the gradual maturation of speech oral-motor neuro-muscular mechanism, as well as the well-documented development in language skills and capacities (Kent, 1976; Amir & Grinfeld, 2011; Walsh & Smith, 2002).

In adults, contradicting results have been reported with respect to the effect of age on speaking rate. Some studies have suggested that older adults exhibit slower speaking rate (e.g., Verhoeven, De Pauw, Kloots, 2004). Other studies have reached inconsistent results and presented large individual differences (e.g., Jacewicz et al., 2009). Yet others have reported no age effect on speaking rate (Bruckl & Sendlmeier, 2003).

In contrast to the inconclusive findings on the effect of aging on speaking rate, researchers agree that speaking rate during a reading task appears to slow with age (Bruckl & Sendlmeier, 2003; Jacewicz et al., 2009). This result was explained by a combination of a reduction in various related capacities with age. These capacities include abdominal and general muscular tone, decreased lungs elasticity, atrophy of the vocal folds and vocal tract mucosa, ossification of laryngeal cartilages (Sataloff, 1991), as well as a reduction in visual acuity, language and cognitive processing time (Ramig, 1983; Jacewiz et al., 2009), and neuro-muscular control over the speech mechanism (Verhoeven et al., 2004).

1.5 Pauses during Speech

As noted above, pauses are integral to continuous speech. Pauses during speech can be the result of a combination between the physiological need for inhaling and syntactic constraints (Laufer, 1996). On the one hand, speakers can phonate continuously for fifteen seconds or more. On the other hand, a typical utterance lasts up to two seconds approximately. Therefore, it is conceivable that the frequent pauses evident in continuous speech are not mainly driven by physiological limitations. Instead, these pauses are evidently related to linguistic rules and requirements. In support of this view, it was shown that Hebrew speakers use only a small proportion of the pauses to inhale, and use most of them for controlling rhythm and conforming to syntax rules and communication requirements. It was also suggested that pauses are used to allow the listener time to decode the message, and time for the speaker to arrange the following utterance (Laufer, 1996). Therefore, utterances that are contextually related are separated by shorter pauses than utterances that are more loosely related.

Professional newscasters use fewer and shorter pauses in their speech, in comparison with other professional and non-professional speakers (Castro & de Moraes, 2008; Castro et al., 2010). It was also suggested that professional newscasters perform pauses in accordance with semantic and linguistic rules, in addition to using pauses for enhancement and emphasis, whereas non-professional speakers use pauses mainly in accordance with syntactic rules (Strangert, 1991).

1.6 Normal Disfluency

Normal Disfluency is a term used for describing common disruptions in the flow of speech (e.g., repetitions, hesitations, pauses) which are typical of normal speakers (unlike stuttering, for example), and occur at a frequency lower than 10% (Yairi & Ambrose, 2005). Normal disfluencies are less common in planned or arranged speaking conditions, like reading, compared to spontaneous conditions (i.e., conversation, interview or picture description). Normal disfluency occurs similarly in both men and women (Lutz & Mallard, 1986) and across a wide age-range (Duchin & Mysak, 1987). During reading, normal disfluency was reported to occur at a low frequency of 0.8% and below (Lutz & Mallard, 1986; Duchin & Mysak, 1987).

Filled pauses are the most frequent characteristic of normal disfluency in spontaneous speech, and may occur up to hundreds of times in an hour (Schachter et al., 1991). In contrast, speech samples of professional speakers do not include many filled pauses (Castro & de Moraes, 2008). No published data is available, however, on the frequency of normal disfluency among professional newscasters. Therefore, the present study is an exploratory and preliminary attempt to quantify speech rate and fluency measures in professional Hebrew speaking newscasters.

2. Method

2.1 Participants

After obtaining the approval of our institutional ethical review committee, 21 professional newscasters (11 men and 10 women) were recorded during public news announcements broadcasted on the radio. Information on the newscasters' age was obtained through public domain sources. Participants' age range was between 19 to 67 years.

Nine of them were under the age of 30, and ten were older than 58 years. Accordingly, two age groups were defined: "younger" and "older". The remaining two newscasters (age 39 and 49 years) could not be fitted into these two age categories. Therefore, they were not included in the final sample, which consisted of 19 newscasters. Table 1 presents the two groups of newscasters.

Table 1. Age and gender of the participants in the two groups

	Younger	Older
N	9	10
Age		
Mean	25.1±3.07	62.5±3.04
Range	19-29	58-67
Gender (Men/Women)	3/6	7/3

2.2 Speech Sample

Recordings of public news announcements were performed from four major Israeli radio channels, broadcasting in Hebrew. Such news announcements are regularly broadcasted every hour, and all recordings were obtained between June and September 2012. Due to the preliminary nature of this study, it was decided to examine only recordings of readings of public news announcements, as representing correct and accurate professional speech pattern. Speech samples of approximately 600 syllables were recorded for each newscaster. The opening and closing two sentences of each recording were omitted from the analyses, to minimize the effect of possible interfering factors.

Recordings were performed directly to a computer, using an audio capturing and editing software (GoldWave V. 5.58; GoldWave Inc., Newfoundland, Canada) with a sampling rate of 24 kHz (16 bit) on a single (mono) channel.

2.3 Data Analysis

Prior to analysis, recordings were transcribed and annotated manually. All markings were performed, first, by an experienced transcriber. Following, an expert speech-language pathologist re-examined the transcription. This procedure was carried out, until complete agreement between the two judges was achieved. Transcriptions, annotations and measurements were performed using Praat 5.3 speech/voice analysis software (Boersma & Weenink, 2013).

Each recording of news announcement was first segmented into items. For this purpose, an item was defined as a sequence of sentences discussing or describing a cohesive subject. Typically, items were also naturally separated from each other by longer pauses. Items were then segmented into utterances. An utterance was defined as a string of words that (i) communicated an idea, (ii) was bound by a simple intonation contour, and (iii) was grammatically accepted (Amir & Grinfeld, 2011). Utterance duration as well as inter-utterance pause duration was determined, using a simultaneous display of the waveform and a wide-band spectrogram. The beginning and ending of each utterance were identified as the corresponding burst of spectral energy evidenced on both displays. Utterance duration was measured by subtracting the onset time from the offset time (in ms). The number of syllables within each utterance was obtained from the transcription, and speaking rate was calculated in syllable-per-seconds (SPS). Consequently, five measures were obtained:

1) Overall Speaking Rate – a global measure of speech rate in an entire news announcement;
2) Speaking Rate Within-Item – a rate measure, obtained from utterances within a single item;
3) Articulation Rate – a rate measure, limited to a single item, based only on fluent utterances, excluding utterances containing disfluencies or pauses longer than 250ms;
4) Pause Duration – a measure of inter-utterance pauses, calculated within a single item;
5) %Disfluency – percentage of disfluent syllables (e.g., revisions, repetitions, prolongations and interjections) out of the total number of syllables, in an entire news announcement.

2.4 Statistical Analysis

Mean values for each measure were first obtained for each individual newscaster, and then group means were calculated. Separate analyses-of-variance were conducted for each measure, in which Age-group (younger/older) and Gender (male/female) were defined as the between subject factors. In addition, Pearson correlation

coefficients between all measures were calculated. Significance level was set at $p<0.05$. All statistical analyses were performed using SPSS 17.0 (IBM, Armonk, NY).

3. Results

Table 2 presents a summary of the measures' values for all participants. All rate measurements are presented in syllable-per-second (SPS), and pause duration is presented in ms.

Table 2. Mean speech rate and fluency measures' values for both genders and age-groups (standard deviations are presented in parentheses).

Measure	Men		Women		Overall
	Younger	Older	Younger	Older	
Overall Speaking rate	5.69	5.31	5.57	5.59	5.50
	(0.05)	(0.27)	(0.32)	(0.54)	(0.33)
Within Item Speaking Rate	6.06	5.69	5.94	6.13	5.90
	(0.18)	(0.20)	(0.33)	(0.43)	(0.31)
Articulation Rate	6.64	6.20	6.45	6.65	6.42
	(0.12)	(0.37)	(0.32)	(0.29)	(0.35)
Pause Duration	0.40	0.43	0.40	0.38	0.41
	(0.12)	(0.05)	(0.04)	(0.08)	(0.06)
%Disfluency	0.0003	0.0013	0.0005	0.0010	0.0023
	(0.0006)	(0.0026)	(0.0079)	(0.0017)	(0.0049)

Initial inspection of the data presented in Table 2 demonstrated similar numerical results for all four groups. As shown, rate measurements among younger male speakers were faster than among older male speakers. An opposite tendency was observed in women, such that older women exhibited slightly faster rate values than younger women. Nonetheless, in both cases, these numerical differences were small. Similarly, no consistent group differences were observed for pause duration and %Disfluency. Statistical analyses revealed no significant main effect for Gender or Age-group ($p>0.05$), and no significant Gender X Age-group interaction for any of the measures ($p>0.05$).

Examination of the individual rate data revealed that the newscaster with the fastest overall speaking rate was 17.8% faster than the slowest one (6.19 versus 5.09 SPS, respectively). Similarly, the newscaster with the fastest Within-Item Speaking-Rate was 16.6% faster than the slowest one (6.58 versus 5.48 SPS, respectively). These differences were 18.9% for articulation rate (6.97 versus 5.66, respectively) and 44% for pause duration (0.54 versus 0.30, respectively).

Statistically significant strong correlations ($0.79<r<0.88$) were found between the three rate measures ($p<0.01$). In addition, significant medium negative correlation was found between speaking rate within-item and pause duration. The latter correlation indicates that speaking rate within an item is affected by the duration of the pauses between utterances. Table 3 presents all correlation coefficients.

Table 3. Pearson correlation coefficients between the five measures

	Overall Speaking Rate	Speaking Rate within-Item	Articulation Rate	Pause Duration
Speaking Rate within-Item	r=0.82* p<0.010			
Articulation Rate	r=0.88* p<0.010	r=0.79* p<0.010		
Pause Duration	r=-0.29 p=0.230	r=-0.46* p=0.048	r= -0.25 p= 0.308	
%Disfluency	r=-0.28 p=0.250	r=-0.23 p=0.355	r=-0.26 p=0.280	r=-0.59 p=0.810

* $p<0.010$

4. Discussion

The four radio channels scanned for this study are the most popular in Israel; therefore, it is safe to conclude that the newscasters in our study are currently the most widely heard in Israel and represent the contemporary newscaster population in Israel. Our data show that overall speaking rate among Hebrew speaking radio newscasters was 5.50 SPS. It was not possible to compare our findings with previous findings in Hebrew, since this is the first study to present such empirical data. The only two studies that examined speaking rate among television newscasters were performed in Portuguese and reported on a speaking rate of 5.86-6.00 SPS (Castro & de Moraes, 2008; Castro et al., 2010). It should be noted, though, that one of these studies was based on only two male speakers and the other was based on five.

Our data demonstrated that overall speaking rate (5.50 SPS) was slower than speaking rate within-item (5.90 SPS), and that the latter was slower than articulation rate (6.42 SPS). This finding was consistent for both genders and age-groups. Evidently, this illustrates the impact of inter-utterance pauses on rate measurements. Specifically, articulation rate was fastest, since it is based exclusively on fluent utterances, and excludes any form of disfluency, speech disruption or pauses. On the other hand, overall speaking rate was slowest since it includes pauses between utterances and between items. Our recordings were taken from live public radio broadcasts, and some radio stations add background music to the news announcements. Therefore, transitions between items are sometimes marked by slightly longer pauses. This leads to an artificially slower overall speaking rate, since these pauses are incorporated into the overall time. Therefore, it appears that the measure of speaking rate within-item provides a more reliable and valid representation of the newscasters' speaking rate. Interestingly, this value highly resembles the values reported in Portuguese. This could be interpreted as suggesting that newscasters aim for an "optimal" speaking rate, which could be similar in different languages, despite possible inter-language differences in speaking rate. Clearly, such assumption should be verified first, on a larger sample of languages.

As noted above, the literature does not provide definitive answer to the question of whether gender affects speaking rate. While some studies have suggested that men speak faster than women, other studies have contradicted it and did not reveal such differences (Van Borsel & De Maesschalk, 2008). The single published study that directly examined articulation rate in Hebrew, has examined children and adolescents (age 3-17 years) during conversation and a picture description task (Amir & Grinfled, 2011), and found no gender differences. Our current results support these findings and demonstrate that the lack of gender differences in articulation rate (and speaking rate) shown in children and adolescents is also evident in adults. This result is consistent despite methodological differences between the two studies, thus it lends support to the conception that speaking rate is not affected by gender.

In contrast to the inconsistent reports on the possible effect of gender on speaking rate; the literature is more consistent in showing that speaking rate among adults becomes slower with aging (Bruckl & Sendlmeier, 2003; Jacewicz et al., 2009). Our results, however, did not reveal age differences in any of the examined measures. The explanation for this could be two fold. First, our participants were professional and highly trained newscasters. Therefore, it can be assumed that they demonstrate the capability of controlling their speech characteristics, including speech rate, such that age differences that would have been evident in "natural" speaking conditions does not appear in their "professional" speech. Further evaluation of this possibility requires the examination of speaking rate among non-professional speakers at different ages, and comparison of their values with those of our speakers. The second possible explanation could be related to methodological constraints of our study. We included only two age-groups in our study design. The "younger" age-group consisted of speakers under the age of 30, and the "older" group consisted of speakers above the age of 58. It could be readily argued that this age-group definition is insufficient for revealing age differences in adults. Accordingly, a wider range of age groups should be included to demonstrate this effect, especially a group of speakers who would fit unequivocally into the category of "aging speakers".

Disfluent utterances were very rare in our speech corpus, as shown by the extremely low %Disfluency values presented in Table 2. This is attributed to the fact that professional newscasters are highly trained and therefore their speech is very fluent. This is supported by previous findings on fluency differences between professional and non-professional speakers (Castro et al., 2010; Duchin & Mysak, 1987). In addition, speech disfluencies are more common in spontaneous speech and less frequent in reading (Lutz & Mallard, 1986). Therefore, because our data are based on reading performed by professional speakers, the exceptionally rare occurrence of disfluency is not surprising. The strong and highly significant correlations between the three rate measures support this, beyond providing added reliability to the measurements. Nonetheless, despite the fact that our speakers were extremely fluent, results show a noticeable numerical difference between the values obtained for speaking rate within-item and articulation rate. This difference highlights the need to examine various rate measures, while observing both

speaking rate and articulation rate, because they are not necessarily equivalent, even when observing highly fluent speakers.

In the analysis of our speech corpus, it was noted that not even a single case of filled pause was found. This is worth noting, in light of the known high incidence of filled pauses in spontaneous speech of non-professional speakers (Schachter et al., 1991). Filled pauses were shown to occur more often when speakers experience anxiety (Jurich & Polson, 1985). Filled pauses were also shown to be indicative of demanding cognitive processes, which interfere with the execution of the speech process (Goto, Itou & Hayamizu, 1999). Since our speech corpus is based on a reading task, performed by experienced and trained professionals, this task is not assumed to pose exceeding demands on their reading/language capacities or create anxiety. Therefore, the lack of filled pauses in our sample could be expected.

5. Conclusion

This study was a preliminary attempt to quantify speaking rate and articulation rate during a reading task within a specific group of Hebrew speakers – professional newscasters. Data provided no gender or age effects on the rate and fluency measures. Because this study examined professional newscasters, it provides a reference point for much needed future studies on speech rate among adult Hebrew speakers. Future studies should also examine inter- and intra-speaker variability. Such empirical data is essential for setting therapeutic goals in clinical settings and for training professional speakers, such as newscasters, radio hosts and actors.

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