Speaking rate: The Differences between Adult-directed and Infant-directed Speech

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Abstract

In this study the Infant-directed and Adult-directed Speech (IDS and ADS) of 27 Dutch mothers of 18-month-old children was analyzed. They were instructed to tell a story to an adult and to their child according to a picture book containing seven target words that were unfamiliar to the child. Overall measurements on the whole story and measurements on the target utterances were performed. It was found that both speech rate (including pauses) and articulation rate (excluding pauses) were slower in IDS compared to ADS. Mothers paused more in IDS but they did not pause longer. Finally, it was found that mothers slowed down full utterances when introducing novel words.

Keywords: infant-directed speech, speech rate, articulation rate, pausing, Dutch

Speaking rate: The Differences between Adult-Directed and Infant-Directed Speech

Infant-directed speech is the speaking style adults take on when talking to a child whose language development has not been fully completed yet (it is also called motherese, babytalk, or child-directed speech, hereafter in this report called: IDS). IDS seems to facilitate language learning for children (Thiessen, Hill, & Saffran, 2005), draws more attention and communicates affect (Soderstrom, 2007). It was found that children tend to prefer IDS over adult-directed speech (hereafter in this report called: ADS), which shows in attention paid to the different speech registers (Cooper & Aslin, 1990). This is a very robust effect and found in numerous studies (Soderstrom, 2007). IDS seems to be a universal speech register used by adults from many typologically different backgrounds (Grieser & Kuhl, 1988). The unique speaking style of IDS, compared to ADS, is usually characterized by shorter and simpler utterances (Snow, 1972; Cameron-Faulkner, Lieven & Tomasello, 2003), more and longer pauses (Fernald & Simon, 1984), a wider range of pitch (Biersack, Kempe, & Knapton, 2005), higher mean pitch (Kitamura, Thanavishuth, Burnham, & Luksaneeyanawin, 2001), and a slower speaking rate (Fernald & Simon, 1984). Adults seem to adjust their speech in a way that makes word learning easier for children (Ma, Golinkoff, Houston, & Hirsh-Pasek, 2011). Few studies looked at the particular changes that adults make in IDS when introducing novel words to children. There might be specific changes adults make in their speaking style when introducing new novel words to children. Fernald and Mazzie (1991) found that mothers speaking to 14-month-old infants tended to put novel words in so called ‘focus’. Novel words were consistently positioned at the point with most ‘perceptual prominence’ in sentences, meaning they usually occurred at F0 peaks and in utterance-final positions. Other studies found that words that are placed at these focus positions are easier to

recognize and to segment for children (Fernald, Pinto, Swingley, Weinberg, & McRoberts, 1998; Aslin, 2000; both cited in Thiessen, Hill, & Saffran, 2005).

Speaking rate in IDS, compared to ADS, will be the main focus of this study. When measuring speaking rate, several methods can be used. In this report, the term speaking rate is used as an umbrella term for the pace of speech and can be measured by calculating speech rate or articulation rate. The measure of speech rate takes the number of syllables expressed and divides it by the total speaking time including silent pauses. Measuring pace of speech by calculating speech rate might not be the most accurate way as it groups speech and silent pauses together under one measurement. To avoid this and just measure speech, articulation rate can be calculated. To do so, the number of syllables is divided by total speaking time, from which all silent pauses are cut out. Few previous studies made this distinction which makes comparing results difficult. In this study, speaking rate is examined closely and compared between IDS and ADS.

Earlier studies on speaking rate

A first study examining speaking rate in IDS was carried out by Fernald and Simon (1984). The prosody of 24 German mothers' speech to newborns (three to five days old) was closely examined. They separated three conditions: when the mother was speaking directly to the infant, when the mother was talking to an infant but the infant was not present, and finally when the mother spoke to the experimenter. For all of these conversations mean utterance duration, mean pause duration and mean rate of articulation was measured. They found that in infant-directed speech utterances were shorter, pauses were longer and articulation rate was slower than in ADS. This was the case for when the baby was present and absent. Articulation rate was, when addressing adults, 5.8 syllables per second, and when addressing babies, 4.8 syllables per second.

Another study was done by Bernstein-Ratner (1985). She examined whether formant frequency characteristics are affected by the rate of speech and segmental duration. A longitudinal investigation of the spontaneous speech of five American-English mothers of female 17-month-old children was carried out. Vowel duration and several formant frequency characteristics were measured. The results showed that there is no simple relationship between vowel duration and their formant frequency characteristics. They found an overall slower speaking rate for IDS compared to ADS: respectively 184 words per minute and 138 words per minute, which means a difference of almost 25%.

A study done by Tang and Maidment (1996) also found a large difference in speaking rate between IDS and ADS. They investigated the semi-spontaneous speech of seven Cantonese-speaking mothers of children aged one to two years old. Speech was recorded when the mother was talking to the experimenter about several set topics and when she was telling the child a story from a picture book. To measure speaking rate Tang and Maidment chose to measure speech rate by determining the number of syllables uttered per minute (without excluding pauses). They found a highly significant difference between IDS and ADS, where IDS was approximately 40% slower.

Recently, Narayan and McDermott (2016) carried out an extensive longitudinal and cross-linguistic study. They looked at the way in which a mother's IDS changes as the child addressed grows older, and focused on three prosodic features: speaking rate, mean pitch and pitch range. To do so, they used the natural interactions at home between sixteen mothers (Sri Lankan Tamil, Talagog and Korean) and their children over the course of 12 months (once every month, beginning at the age of four months). Each IDS session was followed by an ADS session where the mother and experimenter talked about the infant. The researchers manually selected single phrase utterances of five seconds long without silences longer than 300 milliseconds to calculate speaking

rate. Syllables were both manually and automatically counted (using a speech rate script for Praat by de Jong and Wempe, 2009, as cited in Narayan & McDermott 2016). Articulation rate, mean pitch and pitch range were measured for all utterances. The results showed that overall articulation rate was faster for all languages in ADS compared to IDS. They also found that this difference became smaller as the children grew older; the mothers increased their articulation rate over time in IDS. Consistent with previous studies, the mean pitch of mothers talking to children was higher and their pitch range was expanded. The pitch modifications did not show the typical pattern of becoming closer to ADS as the addressed child grows older. They then stated that a slower speech rate can raise intelligibility and improves word learning for children (Song, Demuth, & Morgan, 2010, as cited in Narayan & McDermott 2016). Narayan and McDermott speculate whether other, previously reported characteristics of IDS are made deliberately and specifically enhance word learning or if these characteristics are just concomitant effects of slower speaking rate.

McMurray, Kovack-Lesh, Goodwin and McEchron (2013) carried out a study to answer that particular question. They investigated whether changes in segmental properties of infant-directed speech are caused by changes in speaking rate. To investigate this, they examined the measure of voice onset time (hereafter: VOT). For stop consonants (like /p/ and /b/) the VOT is the relationship between the moment of the opening of the mouth and the onset of voicing by the vocal chords. This relationship can be negative (voicing starts before opening, voiced stop, e.g. /b/) or positive (voicing starts after opening, voiceless stop, e.g. /p/). McMurray and colleagues state that when deliberately changing phonetic cues in speech, the VOT of the voiceless category should get shorter and the VOT of the voiced category longer. By making this contrast, children would be better at hearing the difference between the categories. However, if these changes are not made deliberately, VOT's should get longer in both categories as a result of the slower

speaking rate in IDS. They say this makes VOT a good measure to differentiate between making deliberate changes or changes that occur due to change in speaking rate. They tested this by comparing the speech of 18 English speaking parents. 16 females and two males read simple picture books to either their infant or to the experimenter. The two picture books both included 12 target words which were all part of a minimal pair, starting voiceless or voiced (e.g. bugs – pugs). In this way they could compare voice onset times. On each page a picture and three sentences were printed corresponding to the target word. In a second session the other book was read so that all target words were spoken in both IDS and ADS. IDS and ADS were compared on the target words. They found that for both voiced and voiceless categories the VOT's lengthened in IDS. Also, vowel quality in IDS was similar to that in slow speaking rate. They state that this confirms that the changes in VOT are due to speaking rate and not by intentional enhancement.

In previous studies speaking rate was measured in a variety of ways which makes comparing results difficult. Fernald and Simon (1984) measured speaking rate in an accurate and defined manner by calculating articulation rate. Narayan and McDermott (2016) were also accurate by measuring articulation rate manually and automatically using a Praat script. On the other hand, Bernstein-Ratner (1985) measured speaking rate by determining the amount of words per minute, which is a very coarse and confounding measure as it does not take word length into account. Tang and Maidment (1996) only measured speech rate and did not investigate pause length. Mcmurray et al. (2013) merely estimated speaking rate by measuring syllable length of the target words in the picture books. By doing so, they only looked at speaking rate of words and not the global speaking rate. It might not be accurate to state that the duration of target words is representative for the global speaking rate. For example, one of the sentences in the book was '*there are three*

pears'. As pears is the subject of this sentence it would usually be spoken with a slower speaking rate.

Notable was that Fernald and Simon (1984), Bernstein-Ratner (1985), Tang and Maidment (1996) and Narayan and McDermott (2016) all chose to compare spontaneous speech or story telling in the IDS condition with interview-style speech in the ADS condition. Mcmurray chose to avoid this by letting the mothers read picture books to both the child and experimenter. In that way, speaking styles were the same in the IDS and ADS condition. However, by choosing for a reading style spontaneity of the speech is lost which might influence speaking rate.

Current study

The current study will take a closer look at speaking rate by measuring both speech rate and articulation rate. In that way it will be possible to precisely decide whether previously reported segmental properties of IDS (for example change in VOT in McMurray et al., 2013) are just caused by slower speaking rate or that they are in fact special properties of the IDS register. The two measurements will be compared in IDS and ADS. If articulation rate turns out to be on the same level for IDS and ADS, it is suggested that the previously reported differences in speaking rate are caused by elongated and more frequent pauses in IDS. This means that segmental properties are in fact different in IDS and cannot be ascribed to slower speaking rate.

To examine this, the main research question in this study will be: *What is the difference in speech and articulation rate between adult-directed and infant-directed speech in Dutch?* It is expected that speech rate will be slower in infant-directed speech compared to adult-directed speech. This difference in speech rate is predicted to be largely caused by more and longer pauses and this will show in small to zero difference in articulation rate between the two registers. The

difference in outcome between these measurements will mainly show that, in infant-directed speech, pauses turn out to be more frequent and of longer duration.

To examine the effect of introducing novel words on the IDS register, the sub-question in this study will be: *To what extent does speaking rate of infant-directed speech change within utterances when introducing novel words to children?* It is expected that mothers will tend to slow the utterance down when introducing novel words. This to emphasize the novelty of the word and make sure the child captures it. Fernald and Mazzie (1991) found that adults tend to put novel words 'in focus' by placing them at pitch peaks at the end of the sentence. In this study the speaking rate of utterances containing novel words will be examined.

To avoid the same problems other studies had with comparability of the conditions, in this research design a picture book is used like McMurray and colleagues (2013) did. However, unlike McMurray, there are no full sentences written on the pages, just single words and pictures. By letting the mother use a picture book, the same semi-spontaneous speech is used for both conditions and can therefore be compared. A target word is written on each page to make sure the mother uses that word to describe the picture next to it. The target words are chosen to be novel to the children. In this way speaking rate of utterances containing novel words can be studied. Mothers of 18-Month-old children were chosen because of the vocabulary spurt at this age of children (Bloom, 1973). By doing so, the effects of expressing novel words on the speaking rate of mothers' IDS can be examined.

Method

Participants

Participants were 27 mothers of 18-month-old (M = 18;13, SD = 0.469), typically developing, monolingual Dutch-learning children (15 female and 12 male). They were recruited by telephone from the database of the Babylab, Utrecht.

Materials

The mothers were instructed to read a picture book called *'Konijntje heeft geluk'* ('Little rabbit is lucky') to their child and to the experimenter. The book was designed for this experiment. On each page, a word appeared on the left and on the right a picture illustrated this word. The book contained twelve words with corresponding pictures. Seven words were target words and five were fillers. The words are listed in table 1.

Table 1: *Words in the picture book*

Word	Translation	Target/filler	Familiarity
Zon	Sun	Filler	Familiar
Markt	Market	Filler	Familiar
Appel	Apple	Target 1	Familiar
Walnoot	Walnut	Target 2	Novel
Bos	Forest	Filler	Familiar
Eland	Elk	Target 3	Novel
Bever	Beaver	Target 4	Novel
Kasteel	Castle	Target 5	Novel
Naar huis	To home	Filler	Familiar
Opa	Grandpa	Target 6	Familiar
Pompoen	Pumpkin	Target 7	Novel
Slapen	Sleep	Filler	Familiar

The target words were chosen to be disyllabic nouns; five of them were novel to the children and two were familiar. Because data for this study was also used to answer questions about stress patterns in Dutch IDS and to compare them to Chinese IDS, disyllabic words were chosen. Sample pages of the picture book can be found in appendix I. To check the familiarity of the seven target words to the child, mothers were asked to fill in a checklist in which they could mark whether the child could already understand and/or say them. This form can be found in appendix II. The sessions were recorded by an audio recorder (ZOOM H1, with a 16-bit resolution and a sampling rate of 44.1 kHz) in .WAV format. All sessions were videotaped by a Canon HD-camcorder model HF11 in .MTS format.

Procedure

Mothers were instructed to read the book twice, to their child (IDS condition) and to the experimenter (ADS condition). To prevent any effects of familiarity with the book, the order of these conditions was counterbalanced, meaning half of the mothers did ADS first and the other half did IDS first. The mother was told to tell a story according to the pictures. She was instructed to make sure she included the written words next to the pictures in her stories but was further free to use any other utterances. In the ADS condition, the child was playing with some toys in the corner of the room while the mother told the story to the experimenter. In the IDS condition, the child was sitting on the mothers' lap while she told the story to him or her. After both conditions were completed, the children received a small book as a gift, any made travel expenses were reimbursed and the mothers filled in the word checklist and a consent form.

Measurements

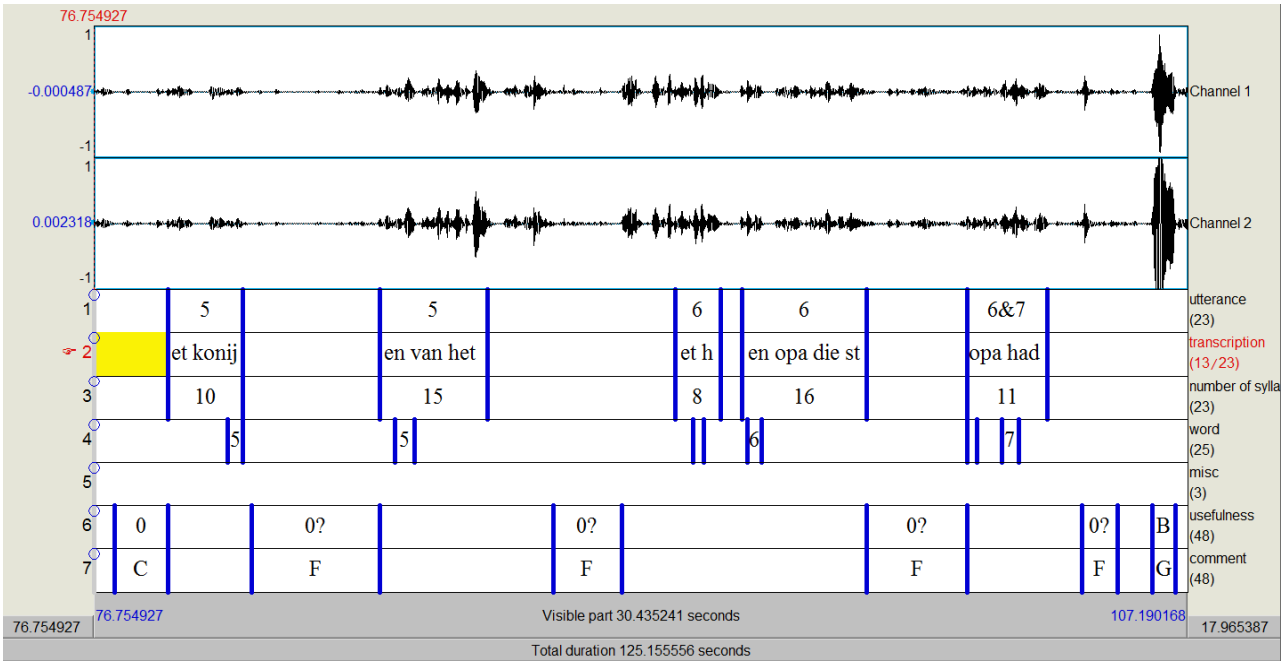
For each mother the audio recordings were analyzed, in total 127.5 minutes of speech. The mean duration of the recordings was 113.4 seconds in the ADS condition (SD = 42.978) and 180.9

seconds in the IDS condition (SD = 52.465). Before analysing, all recordings had to be cleared of any disturbing noise. For each recording, a textgrid in Praat (Boersma & Weenink, 2014) was created (example shown in figure 1). In table 2 the names of the created interval tiers are listed.

Table 2: *Tiers in textgrid*

Tier	Name
1	Utterance
2	Transcription
3	Number of syllables
4	Word
5	Misc
6	Usefulness
7	Comment

Figure 1: *Screenshot Praat textgrid*



In tier one, the numbers of used target words were written. In the second tier these utterances were transcribed. The number of syllables was manually counted for each utterance and written in tier three. In the fourth tier intervals were created for when the target words were

uttered. In the fifth tier various comments were made, for example it was marked when the child uttered a target word or the mother was whispering. In the sixth tier noise was marked with different codes. In the seventh tier, the type of noise was identified. Codes and explanations can be found in table 3.

Table 3: *Transcription coding*

Tier	Code	Explanation
6	0	Part that needs to be cut out, reason notified in tier seven
	0?	Noise due to turning pages
	B	Mother and child talking at the same time
7	A	Experimenter's voice
	B	Mother conversing with the experimenter
	C	Background noise
	D	Non-relevant conversation between mother and child, e.g. comforting
	E	Child's voice
	F	Noise due to page turning
	G	Mother and child talking at the same time
	H	Mother laughs/yawns/etc.

Two kinds of measurements were performed: the overall measurements and the measurements of the target utterances. For the overall measurements, a Praat script (de Jong & Wempe, 2009) was used to calculate the total duration, the number of syllables, the number of pauses, mean pause duration, the number of pauses per syllable, phonation time, speech rate and articulation rate. Based on intensity and voicing of the acoustic signal, this script automatically detects syllable nuclei using a validated algorithm. For the measurements of the target utterances, information from tiers one, three and four was used. Using a Praat script (Lennes, 2002[a]) utterance and word durations were extracted from the textgrids. Using another Praat script (Lennes, 2002[b])

the numbers of syllables from the target utterances were extracted from the textgrids. Articulation rates including and excluding target words were then calculated. All necessary formulas for the above measures are listed in table 4.

Table 4: *Formulas*

Overall measurements	
Speech rate (syllables/second)	$\frac{\text{Total number of syllables}}{\text{Total duration}}$
Articulation rate (syllables/second)	$\frac{\text{Total number of syllables}}{\text{(Total duration - total pause duration)}}$
Mean pause duration (seconds)	$\frac{\text{Total pause duration}}{\text{Number of pauses}}$
Number of pauses per syllable	$\frac{\text{Number of pauses}}{\text{Number of syllables}}$
Number of pauses per second	$\frac{\text{Number of pauses}}{\text{Speaking time}}$
Measurements of the target utterances	
Utterance articulation rate (including target the words)	$\frac{\text{Number of syllables}}{\text{Utterance duration}}$
Utterance articulation rate (excluding the target words)	$\frac{\text{(Number of syllables - 2)}^{a}}{\text{(utterance duration - word duration)}}$

[a] as all target words exist of two syllables

A problem was found regarding the noise of turning pages. Mothers handled turning pages differently, some turned the pages during their speech pauses, and others added extra pauses to turn the pages. To examine whether this made a difference in the measurements, page turning was specifically marked in the textgrid. When cutting out noise, first page turning was left in, and next page turning was cut out. By doing so, for each mother four audio files were created to be analyzed by the script: ADS and IDS with page turning and ADS and IDS without page turning. Paired t-

tests were performed to compare overall speaking rate in IDS and ADS, and to examine the speaking rate of utterances in IDS containing novel words.

Results

Overall measurements

After pilot analyses it was found that including or excluding page turning made no difference for the results. All the following results are based on the exclusion of page turning. For the overall measurements a Praat script (de Jong & Wempe, 2009) automatically extracted the results displayed in table 5. To compare the ADS and IDS conditions on all measurements, one-tailed paired sample t-tests were performed. *p*-values are also listed in table 5.

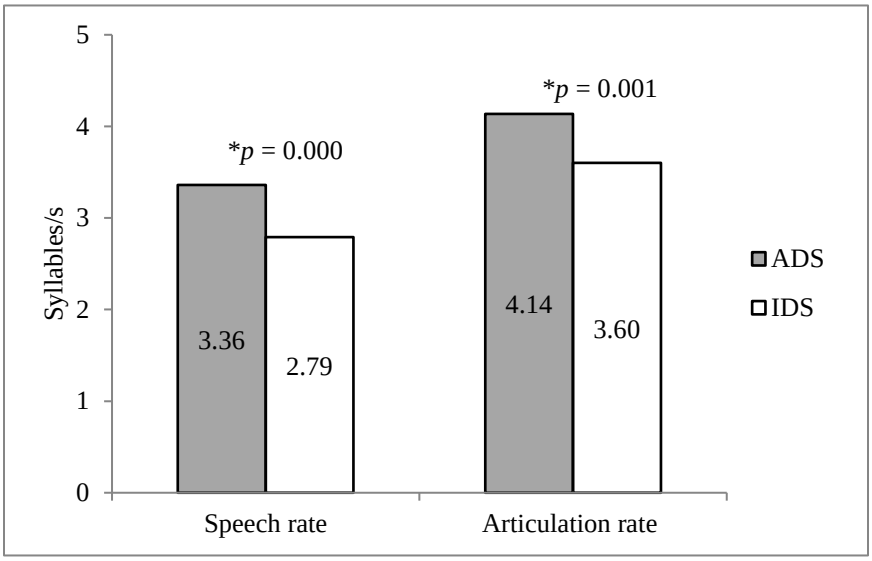
Table 5: *Results overall measurements*

Measurements	ADS		IDS		*p*
	Mean	SD	Mean	SD	
Total duration (s)	84.80	37.78	138.71	43.70	0.000*‡
Speech rate (syllables/s)	3.36	0.44	2.79	0.61	0.000*†
Articulation rate (syllables/s)	4.14	0.40	3.60	0.83	0.001*†
Mean pause duration (s)	0.76	0.19	0.75	0.15	0.612‡
No. of pauses/syllable	0.07	0.39	0.12	0.09	0.016*‡

*$p < 0.05$. † right tail. ‡ left tail.

The total duration of IDS (M = 138.71 SD = 43.70) was longer than in ADS (M = 84.80 SD = 43 .70), $t(26) = -7.762$, $p = 0.000$. Speech rate was significantly slower in the IDS condition (M = 2.79 SD = 0.61) compared to the ADS condition (M = 3.36 SD = 0.44), $t(26) = 4.445$, $p = 0.000$. Also articulation rate showed a significant difference, IDS (M = 3.60 SD = 0.83) was slower than ADS (M = 4.14 SD = 0.40), $t(26) = 3.351$, $p = 0.001$. These results are displayed in figure 2.

Figure 2: *Speech rate and articulation rate in ADS and IDS*



Looking at pausing, in IDS (M = 0.11 SD = 0.09) the number of pauses per syllable is significantly higher than ADS (M = 0.07 SD = 0.39), $t(26) = -2.275$, $p = 0.016$ (shown in figure 3). However, the mean pause duration does not significantly differ between IDS (M = 0.75 SD = 0.14) and ADS (M = 0.76 SD = 0.19), $t(25) = 0.288$, $p = 0.612$ (shown in figure 4).

Figure 3: *Number of pauses per syllable in ADS and IDS*

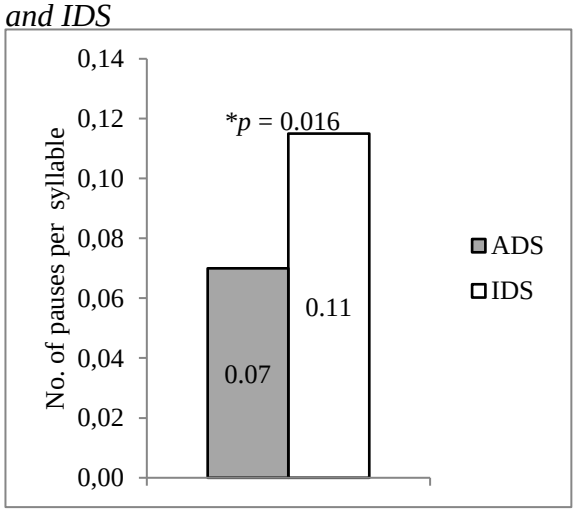
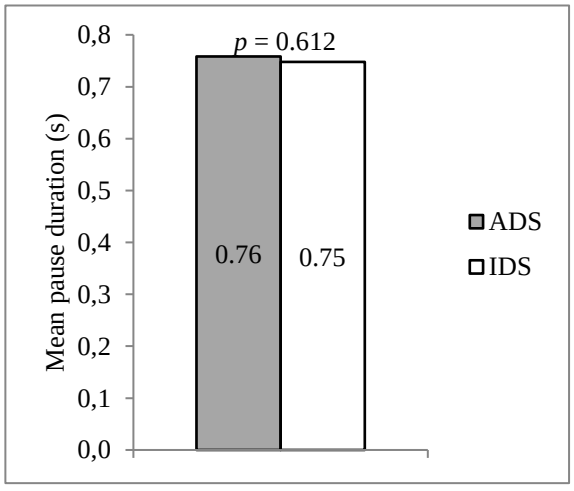


Figure 4*: Mean pause duration in ADS and IDS*



Measurements of the target utterances

For the measurements of the target utterances, syllables were manually counted and target words and utterances marked in a textgrid in Praat. The results of these measurements are displayed in table 6.

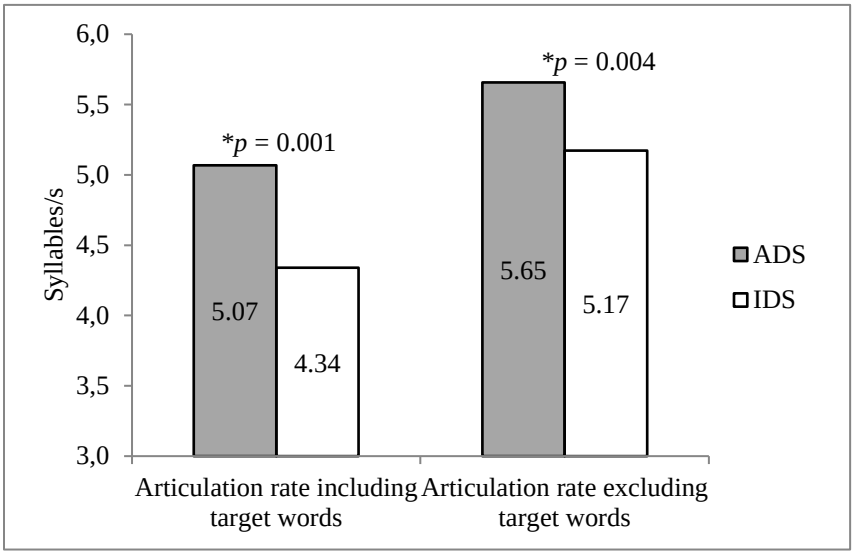
Table 6: *Results measurements of the target utterances*

Measurements	ADS		IDS		*p*
	Mean	SD	Mean	SD	
Utterance duration (s)	2.17	0.50	1.87	0.39	0.007*†
No. of syllables	10.80	2.27	8.41	1.77	0.000*†
Articulation rate (including target words) (syllable/s)	5.07	0.61	4.34	1.07	0.001*†
Articulation rate (excluding target words) (syllable/s)	5.66	0.72	5.17	0.84	0.004*†
Target word duration (s)	0.51	0.10	0.56	0.08	0.002*‡

*$p < 0.05$. † right tail. ‡ left tail.

Articulation rate in the target utterances was significantly slower in the IDS condition (M = 4.34 SD = 1.07) compared to the ADS condition (M = 5.07 SD = 0.61), $t(24) = 3.315$, $p = 0.003$. However, target word duration was significantly longer in IDS (M = 0.56 SD = 0.08) than in ADS (M = 0.51 SD = 0.10), $t(24) = -3.181$, $p = 0.002$. When looking at articulation rate excluding the target words, again a significant difference was found between IDS (M = 5.17 SD = 0.84) and ADS (M = 5.65 SD = 0.72), $t(23) = 2.854$, $p = 0.004$. These results are displayed in figure 5.

Figure 5: *Articulation rate of the target utterances*



Utterance duration was significantly longer in ADS (M = 2.17 SD = 0.50) compared to IDS (M = 1.87 SD = 0.39), $t(24) = 2.669$, $p = 0.007$. Also, the number of syllables was higher in the ADS condition (M = 10.80 SD = 2.27), than in the IDS condition (M = 8.41 SD = 1.77), $t(23) = 4.490$, $p = 0.000$. (Shown in figures 7 and 8)

Figure 7: *Duration utterances containing target words*

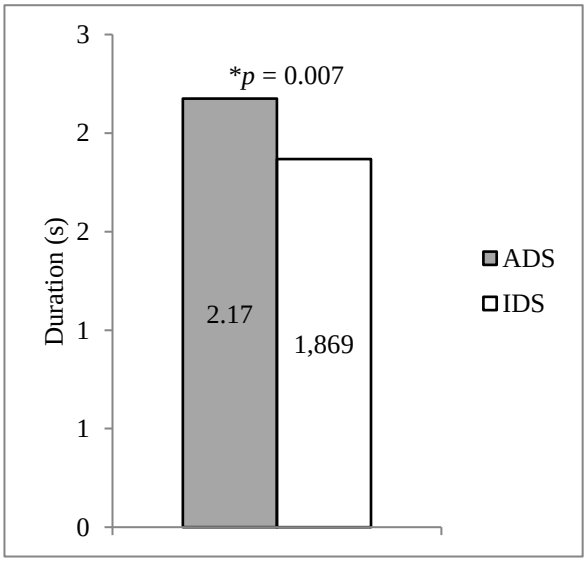
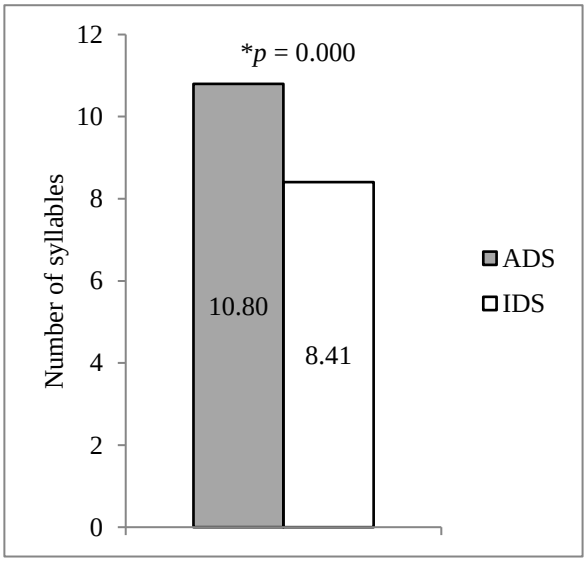


Figure 8: *Number of syllables utterances containing targetwords*



Discussion

To answer the research questions in this study, the infant-directed and adult-directed speech of 27 Dutch mothers of 18-month-old children was analyzed. They were instructed to tell a story to an adult and to their child according to a picture book containing seven target words that were unfamiliar to the child. Measurements were performed on both the overall speech and on the utterances containing target words.

The main research question was: *What is the difference in speech and articulation rate between adult-directed and infant-directed speech in Dutch*? It was expected that speech rate would be slower in IDS compared to ADS based on previous studies (e.g. Fernald, & Simon, 1984; Narayan, & McDermott, 2016). These findings were replicated in this study as automatic measures showed a significantly slower speech rate in the IDS condition compared to the ADS condition. Mothers talked faster to the experimenter than to their child. However, this method of measuring speaking rate has proven not to be the most accurate measurement, as it groups speech and pausing together. This is why articulation rate was also measured. In this method of measuring speaking rate, silent pauses are cut out. Hypothesized for this study was that if articulation rate turned out to be at the same level for IDS and ADS, previously reported differences in speaking rate (e.g. Bernstein-Ratner, 1985; Tang, & Maidment, 1996) would have been caused by more and longer pauses in IDS. McMurray et al. (2013) stated that changes (e.g. changes in voice onset time) adults make in speech directed to children are not made deliberately to facilitate word learning but are concomitant effects of slower speaking rate. Hypothesized here is that changes might be, in contract to what McMurray et al. (2013) stated, made deliberately to enhance word learning because adults talk at the same rate and only pause more frequent and longer. However, this hypothesis could not be proves by this dataset. Articulation rate was, like speech rate, also

significantly slower in IDS compared to ADS. This means mothers did talk in a slower manner to children, even when pauses were excluded from the measurement.

Besides measuring speech and articulation rate, other analyses have been conducted on the overall measurements. The way in which mothers pause when talking to either a child or an adult has been investigated. Overall, mothers made significantly more pauses in IDS compared to ADS. However, no significant difference was found in mean pause duration between ADS and IDS. The mean pause duration was almost exactly at the same level for IDS and ADS. This means mothers paused more in IDS but they did not pause longer.

With regard to the utterances containing the novel target words, the research question was: *To what extent does speaking rate of infant-directed speech change within utterances when introducing novel words to children?* It was expected that mothers would slow down the utterances when introducing the novel words. Consistent with the results of the overall measurements, articulation rate in utterances containing novel words was significantly slower in IDS compared to ADS. This significant difference can be ascribed to the fact that words are novel to the child but already familiar to the adult. Mothers slow down when introducing these words to emphasize its novelty and make sure the child captures it. The question is whether mothers slow down the full utterance or just the novel word. Looking at the measure of target word duration, there is a significant difference between IDS and ADS. Mothers significantly lengthen the target words in IDS compared to ADS. To examine whether the full utterances were slowed down or just the target words, articulation rate of the remaining speech in the utterances (excluding target words) was measured. The significant difference between IDS and ADS in articulation rate remained present, meaning mothers slowed down the full utterance and not just the novel word. By slowing down these utterances, mothers are possibly giving cues to the child that a novel word is going to be

introduced. This act may facilitate the child's word learning. This finding is consistent with a study done by Ko and Sodertrom (2013) which studied the way in which utterances are lengthened in IDS. They found that the elongation effect is a general effect across the sentence and is not just applied to the final syllable, like other studies claimed (Bernstein-Ratner, 1986; as cited by Ko &, Soderstrom, 2013).

However, to fully investigate to what extent global speaking rate differs from speaking rate in utterances introducing novel words, changes in speaking rate should be examined in more detail. To do that for this dataset, all utterance boundaries should be manually marked. In that way utterances containing novel words and familiar words can be compared on speaking rate to observe any changes between them. In newly designed future research to investigate change of speaking rate between utterances, leveling the amount and length of target words should be taken into consideration.

Another finding in the data is the dissimilarity in some measurements between overall speech and the target utterances. Overall, mothers used significantly more syllables and talked longer in IDS compared to ADS. However, when zooming in on the target utterances, in ADS mothers used significantly more syllables, and utterances were significantly longer. Overall, mothers elaborated more when talking to their child, but when introducing a novel word they used more words when talking to the adult. This difference may be caused by mothers using simpler sentences to their child. Sentence structure may have been kept simple because the child did not know the target words yet. However, because the adult was already familiar with the target words, sentences could be made longer. It should be noted that making comparisons between outcomes of the automatic and manual measures is not completely trustworthy. Automatic measured global speaking rate cannot be compared to the manual measured speaking rate from the target utterances.

Manual transcription usually ends up with more syllables than automatic transcription, which is caused by the fact that people typically hear more syllables then there really are in the data. To make comparisons on amount of words between utterances containing novel and familiar words, as mentioned before, all utterances should be manually marked.

Large standard deviations were found for the measures of pausing. For example, the measure of the number of pauses in IDS and ADS had large standard deviations, meaning there was a large variation in the amount of pauses mothers made. Listening to the speech of different mothers while transcribing made it clear that pausing was done in many different ways which may impact the outcome of the measurements used. Some mothers tended to use the time of page turning as a moment to pause. As loud page turning had to be cut out because of the script, the speech of these mothers ended up with very little pauses. Other mothers paused more in between sentences and turned the pages quicker to continue the story. Their speech ended up with more pauses. This difference in pausing might have been the cause for the large standard deviations in the measures of pausing.

During transcribing some personal observations were made which might be subject to new research. When introducing novel words, mothers tended to express them twice: First time merely uttering the word, combined with filled pause disfluencies like *uhh* and *umm* etc. The second time, more of a full sentence was constructed. This phenomenon has been studied before by Orena and White (2015). By using filled-pause disfluencies people (both children and adults) present the listener with a marker that a novel word or difficult structure will be presented. Differences between first and second mention of target words in this dataset could be subject to future research.

Also personally observed during transcribing were large individual differences in the amount of IDS mothers used. Some mothers made major differences between the ways in which

they spoke to their child compared to the adult. Large pitch changes, particular word usage and extremely elongated vowels and pauses. Other mothers spoke in nearly the same manner to their child as to the experimenter. Also, some mothers tended to change the structure of their sentences when talking to their children. For example, one mother told the entire story according to questions she asked her child, and another mother only used passive sentences. In further research, it might be interesting to look at these individual differences to study the variety of ways mothers talk to children and whether these differences have an impact on the child's word learning.

To further investigate the effects of novelty of words on speaking style in IDS, it could be compared with the effect of novel words on ADS speaking style. To do so, the familiarity of the words should be novel to both children and adults. A good method for this could be the use of non-words. Interesting differences might be found in the way in which adults change their way of expressing words that are novel between children and adults. When investigating the length of novel words, the position of the target words within the utterances should be taken into account. Even though this study showed that the full utterance containing a novel word was lengthened, in other studies utterance-final lengthening in IDS was found (Bernstein-Ratner, 1986)). The position of the target word within the sentence might have an effect on its length. Uttering a novel word at the beginning of a sentence, e.g. The beaver said hi!' or at the end of a sentence, e.g. 'Bunny saw the beaver', might make a difference in speaking rate of this target word as utterance-final lengthening has an influence.

In summary, this study found that both speech rate and articulation rate were slower in IDS compared to ADS for mothers talking to 18-month-olds. Mothers paused more in IDS but did not pause longer and they slowed down full utterances when introducing novel words. To fully

investigate the changes in speech that mothers make when introducing novel word to children and the effects this might have on children's word learning, further research is needed.

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APPENDIX I

Pages of the picture book.

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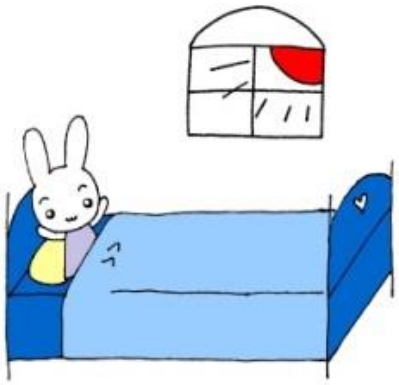
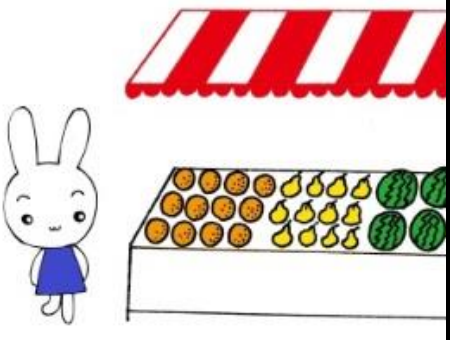
<tr><td>zon</td><td>  </td></tr>
<tr><td>markt</td><td>  </td></tr>
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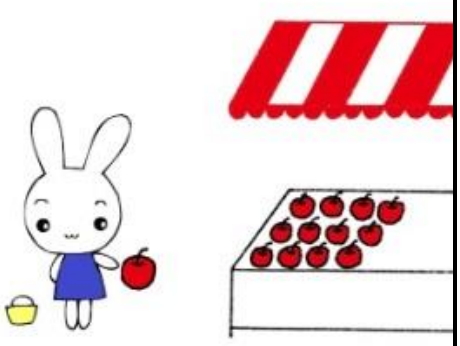
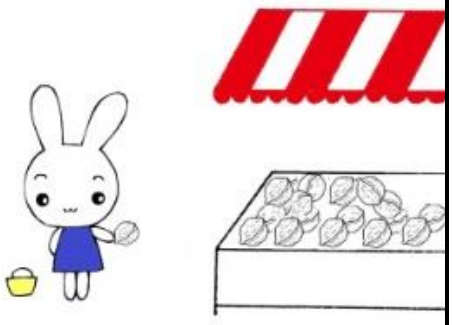
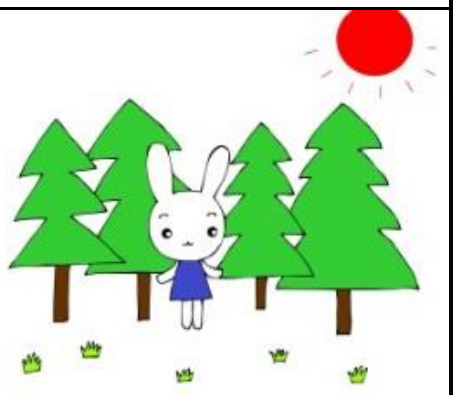
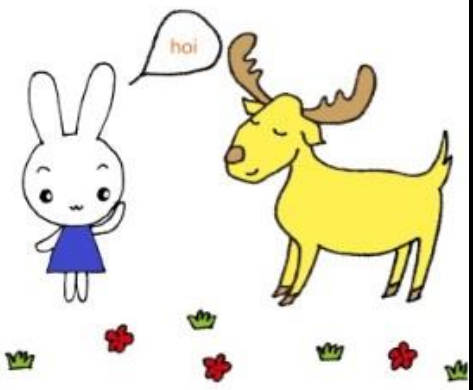
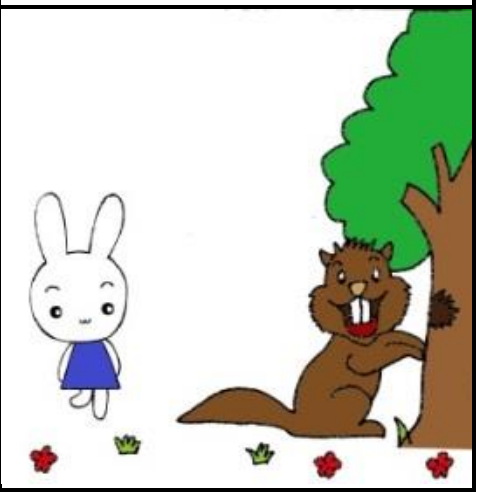
appel	
walnoot	
bos	

eland	
bever	
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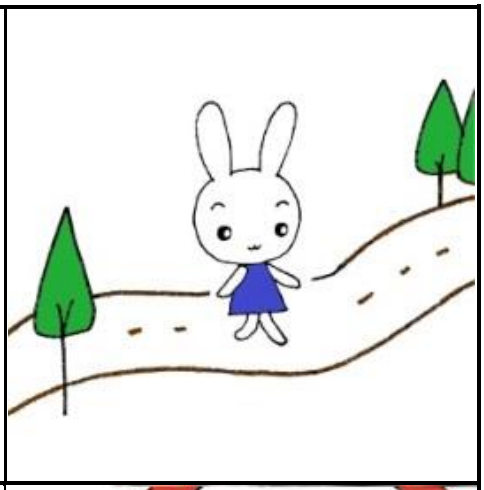
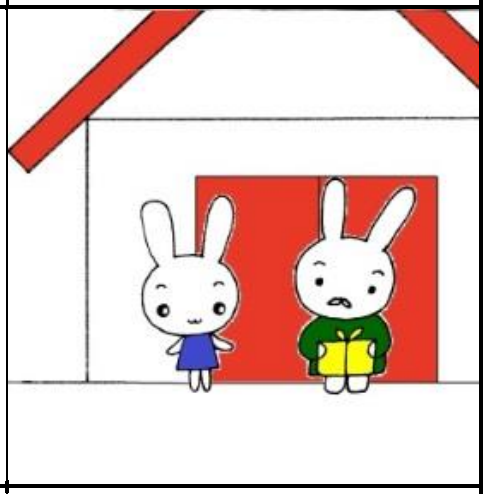
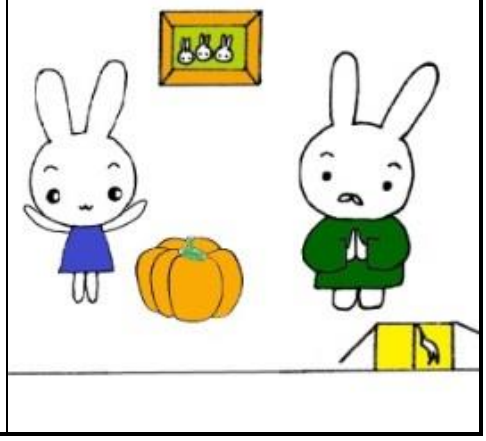
naar huis	
opa	
pompoen	

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APPENDIX II

Word checklist

Word Checklist Dutch 18 Months

Filled in by parents:

Name: Date:

Birthday:

Please mark the list below: did your child know these words before the story-reading game:

	begrijpen	begrijpen en zeggen
appel		
opa		
walnoot		
pompoen		
bever		
kasteel		
eland		

Filled in by Experimenter:

Participant ID:

Order: