MÁRIA GÓSY
Linguistics Institute, Eötvös Loránd Research Network and ELTE University, Budapest

Temporal and disfluency patterns of narratives in old age

Introduction

Narrative is an important interactional speech communication form that each generation uses (e.g., Colletta et al. 2010, Ferreira Netto 2017, Schegloff 2007). Narrative production involves organizing and expressing a series of events and facts that were experienced by the speaker (Bruner 1991) in order to provide social knowledge (Linde 2001). Narrative as specific verbal behavior shares similarities with various styles of spontaneous speech; however, there are marked differences in several important ways (Levelt 1989). The twofold aim of a narrative is to provide the listener(s) with information and to make personal comments to inform the listener about the speaker's opinion concerning the topic (Labov 1981). Narratives can be parts of any kind of discourse, so they can occur in any conversation. In a specific type of narrative, the speaker is asked to summarize an orally presented text immediately. The input is not related to the speaker's own intention: it is based on speech comprehension followed by the usual speech planning processes. Immediate recall of a heard text involves specific schemes based on holistic thinking (Bruner 1986). The most characteristic difference between usual spontaneous utterances and immediate recall narratives arises at the level of message (or concept) generation, since in the latter type of communication it is not the speaker who decides the information content of the utterance. In addition, the speaker fulfills a task under relatively artificial circumstances. However, syntactic, semantic, phonological and phonetic planning as well as the routes of lexical access are very similar to the operations characteristic of usual spontaneous speech. Recall narratives provide a possibility to analyze the speakers' cognitive performance and the functional, phonetic, psycholinguistic, and pragmatic characteristics of narratives. In this study we focus on two aspects of these possibilities (phonetics and psycholinguistics) when analyzing the temporal patterns in immediate recall narratives and the disfluency phenomena produced by the speakers.

Production of narratives starts at the preschool age and shows a continuous development depending on the children's developing (language) skills and strategies that are needed to establish this speech style (Hickmann 2003, Lucero 2015). Teenagers' verbal utterances follow the patterns found in adults' speech. However, there are various differences, resulting in a specific mixture of standard, sub-standard and also some slang forms in their language use (e.g., Coulmas 2013). The production of a coherent narrative requires a large structural brain network (Troiani et al. 2008); therefore, the speaker's age is a decisive factor in narrative production (Hickmann 2003, Rodríguez-Aranda and Jakobsen 2011).

Changes in speaking behavior depending on age reflect various anatomical, physiological and psychic factors, as well as the speakers' cognitive workload (Rodríguez-Aranda and Jakobsen 2011, Xue and Hao 2003, Zraick et al. 2006). Typical ageing influences breathing, musculature, articulation gestures and control over all patterns of speaking, including memory and attention, but has only a slight influence on semantic knowledge (e.g., Burke et al. 2000). Findings showed that adults between the ages of 40 and 91 years produced longer narratives as they were getting older; on the other hand, information content decreased with age, along with a parallel increase in irrelevant information (Juncos-Rabadán et al. 2005). Age-specific changes concern primarily the speed of articulation gestures, durations of sound segments, words, phrases, speech tempi and fluency on the one hand (e.g., Fletcher and McAuliffe 2015, Jaczewitz et al. 2010), while on the other hand the coincidence of various disfluency phenomena interrupting the flow of speech but not adding propositional content to an utterance also have an effect on the utterances (e.g., Levelt 1989). Disfluency phenomena are either simple errors (e.g., morphological and other grammatical errors, false words, slips of the tongue) or represent phenomena expressing uncertainty (hesitation), such as repetitions, re-starts, prolongations and filled pauses (Beke et al. 2014, Bortfeld et al. 2001, Shriberg 2001, etc.). Findings are controversial as to the frequency of disfluencies depending on age, particularly concerning the data for old people (Bóna 2011, Menyhárt 2003). Immediate recall narratives might show age-specific patterns in timing and disfluencies from teenagers to old-old speakers (around 80 years of age). Our research question is whether the temporal and disfluency patterns of such narratives show variation across age ranges that can be confirmed by objective measurements. The goal of this study is to make a systematic analysis concerning the

durations of phrases and pauses in narratives, as well as the occurrences of disfluencies to explore the age-specific features of narrative. Four hypotheses were proposed. (i) Temporal characteristics of the narratives would show large overlaps depending on age. (ii) The decisive temporal differences would be experienced between 'young' and 'old' speakers but hardly between neighboring age groups. (iii) Younger people would produce more disfluencies than older people. (iv) Filled pauses would be less frequent in older speakers' narratives than with younger speakers.

Methodology

58 speakers (aged between 20 and 80 years) were selected randomly (except for age and gender) from the BEA Spontaneous Speech Database of Hungarian (Gósy 2012). They were divided into six age groups (mean ages: 16-, 25-, 35-, 50-, 65-, and 80 years). Five groups contained 10 speakers (half of them females) while in one group (speakers with a mean age of 80 years) there were 8 speakers (5 females and 3 males). The 16-year-olds were high-school students. All speakers had normal hearing (corresponding to their age), and none of them had any speech defects. All of them had similar socio-economic status.

Immediate recall narratives were used in this study in which speakers were asked to summarize the content of a heard text in their own words in the form of a narrative. The text was a popular scientific story (270 words, with a duration of 2 minutes and 5 seconds, recorded by a female speaker). The mean speech tempi of the speakers varied slightly across ages (from teenagers to old-old speakers: 91.2 words/min, 108.9 words/min, 100.8 words/min, 102.4 words/min, 95.3 words/min, and 105.6 words/min, respectively). No significant differences could be found in speech tempi across ages.

Recordings were made of the narratives produced by all the speakers in the same room and under identical technical conditions, using the same microphone (type AT4040), the same high-quality computer and GoldWave sound editing software with sampling at 44.1 kHz. A total of 78.3 minutes (more than an hour) of spontaneous speech material was analyzed.

Phrases (speech flow between two pauses) and both filled and unfilled pauses were annotated manually in the waveform and spectrogram displays via continuous listening to the words in Praat (Boersma and Weenink 2014). The word boundaries

were identified using common acoustic-phonetic criteria. All disfluency phenomena (Gósy 2007) occurring in the narratives were identified and annotated for further analysis.

Durations of phrases and pauses were obtained automatically using a specific script. In addition, the number of words in the narratives were also counted. The occurrences of various disfluency phenomena were categorized and calculated both in terms of the 100 words and duration. For statistical analysis, the GLMM method, non-parametric tests and correlations were used within SPSS software (No. 21.). A total of 10,000 measured pieces of data were subjected to analysis.

Results

The data will be shown and discussed according to occurrences and temporal patterns (narrative lengths, phrase and pause durations) as well as according to occurrences and types of disfluency phenomena.

Narratives: words and durations

The total number of words in all the narratives was 7,819. 25-year-old and 80-year-old subjects produced the highest number of words (153.7 and 150, on average, respectively). Teenagers produced strikingly short narratives (with a mean length of 103.7 words). The average number of words produced in the narratives was almost identical among the speakers with a mean age of 35, 50 and 65 years (140, 142 and 139.4 words, respectively). The fewest words were used by a 16-year-old speaker (63), while a 50-year-old speaker used the most words (366). Statistical analysis did not show significant age-related differences in the number of words ($F(5, 57) = 1.011$, $p = 0.42$).

The durations of the narratives were partly similar, partly different, depending on age. The mean values (from teenagers to old-old speakers) were as follows: 70.2 s, 85.3 s, 84.7 s, 81.3 s, 87.6 s and 86 s, respectively. Narrative durations ranged widely, resulting in overlaps among the values of different age groups. Considerable individual differences were found among speakers in all age groups, reflecting their heterogeneous nature. There were no significant age-specific differences in narrative durations ($F(5, 57) = 5.42$, $p = 0.744$). Pearson' correlation showed a strong, significant interaction

between the duration of the narratives and the number of the words used ($r = 0.831$, $p < 0.001$).

Phrases: occurrences and durations

The total number of phrases in all the narratives was 1,896, with a mean incidence of 25.8 phrases per minute (mean number of phrases from teenagers to old-old speakers: 33.2, 26.3, 26.4, 23.8, 22.1 and 25.8, respectively). Statistical analysis confirmed a significant, medium interaction between the number of phrases and the durations of the narratives (Pearson's rho: 0.469, $p < 0.001$). No significant age-related differences were found in the number of phrases measured either per minute or in terms of 100 words (Chi-Square = 8.673, $p = 0.123$ for occurrences per minute). However, there was a tendency: the younger the speakers were, the more phrases they produced. In other words, pauses interrupt young speakers' speech flow more frequently than that of older speakers.

The durations of phrases show close interrelations with age, but there were considerable individual differences in all age groups. Statistical analysis revealed significant differences in phrase durations depending on age ($F(5, 1895) = 22.500$, $p = 0.001$); however, pairwise comparisons did not show significant differences between the three young groups, and between the 50- and 65-year-olds. Phrase lengths show a tendency for an increase toward old age (Table 1).

Table 1. Durations of phrases across age groups

Mean age (year)	Durations of phrases (ms)	
	mean	standard deviation
16	1285	850
25	1445	1229
35	1548	1161
50	1820	1374
65	2050	3818
80	2287	1565

Pauses: occurrences

A total of 1,830 silent pauses occurred in the narratives, 28 to 38 occurrences per age group, on average. Speakers older than 50 had fewer silent pauses (an average of

29.8 occurrences per 100 words) than young speakers (an average of 20.6 occurrences per 100 words). Silent pauses were found least frequently with the old-old speakers (12.3 per minute; 18.6 per 100 words) while most frequently with teenagers (28.5 occurrences per minute; 36 per 100 words). Speakers between these two ages produced similar numbers of silent pauses per minute (25.7, 26.9, 20.8, and 20.7 occurrences, respectively). Significant differences were found in the occurrences per minute of silent pauses depending on age (Chi-Square = 11.678, p = 0.039). Pairwise comparisons (Mann–Whitney U-test) showed significant differences only between 35-, 65 and 80-year-olds (Z = -2.419, p = 0.016; Z = -2.830, p = 0.005).

Filled pauses occurred less frequently than silent pauses; a total of 596 occurrences were recorded in the narratives. Speakers of various ages produced various numbers of filled pauses from the teenage group to the old-old speakers (65, 115, 166, 137, 90, 23, respectively). Statistical analysis confirmed a significant difference in the incidence of filled pauses per minute depending on age (Chi-Square = 18.884, p = 0.002). Pairwise comparisons confirmed significant differences between the 35-, 50- and 65-year-olds as opposed to 80-year-olds and between teenagers and 35-year-olds. Filled pauses play a decisive role in the temporal structure of the narratives, therefore we analyzed their data together with those of silent pauses. However, filled pauses are ultimately disfluencies (of the uncertainty type), so their data will also be mentioned in that section.

Pauses: durations

The durations of silent pauses seem to be different, particularly between young and older speakers, while the differences in filled pauses are more pronounced (Table 2). The ranges of both pause durations are wide in each age group, suggesting large individual variability within age groups. Statistical analysis confirmed significant age-related differences both for silent pause durations (F(5, 1829) = 5.962, p = 0.001) and filled pause durations (F(5, 595) = 10.199, p = 0.001). Pairwise comparisons confirmed significant differences between teenagers and 35-year-olds, 25-, 50- and 65-year-olds, as well as between 35- and 65-year-olds in the case of silent pauses, while significant differences were confirmed between teenagers and 65-year-olds, and between 25- and 35-year-olds vs. 50- and 65-year-olds. A medium, significant correlation was found between silent and filled pause durations (Pearson's rho = 0.444, p = 0.001), showing

that speakers who produced longer silent pauses also held longer filled pauses and vice versa.

Table 2. Durations of pauses (ms)

Mean age (years)	Durations of pauses (ms)			
	Silent pauses		Filled pauses	
	mean	standard deviation	mean	standard deviation
16	676	722	373	188
25	527	522	341	139
35	479	445	333	186
55	617	1066	442	239
65	752	1024	511	335
85	570	452	429	240

Disfluency phenomena: occurrences

A total of 1,004 disfluency phenomena were observed in the analyzed narratives. The occurrences of all disfluencies were measured in terms of 100 words for each speaker, following the procedures recommended in the literature (the mean values of all disfluencies from teenagers to old-old speakers were 12.1, 13.6, 14.4, 11.6, 12 and 13.2 occurrences per 100 words). The data show that young speakers produced more disfluencies (13.6 occurrences per 100 words, on average) than old speakers did (12.3 incidents per 100 words, on average). However, the difference is not significant ($F(5, 57) = 1.590$, $p = 0.180$). The most disfluencies were produced in two age groups, that of the 25-year-olds and that of the 35-year-olds. Disfluency occurrences were further analyzed as error type disfluencies (false starts, false words, grammatical errors, anticipations, perseverations, slips of the tongue) and uncertainty type disfluencies (re-starts, repetitions, prolongations, fillers), see Fig. 1. Filled pauses are illustrated separately on the figure.

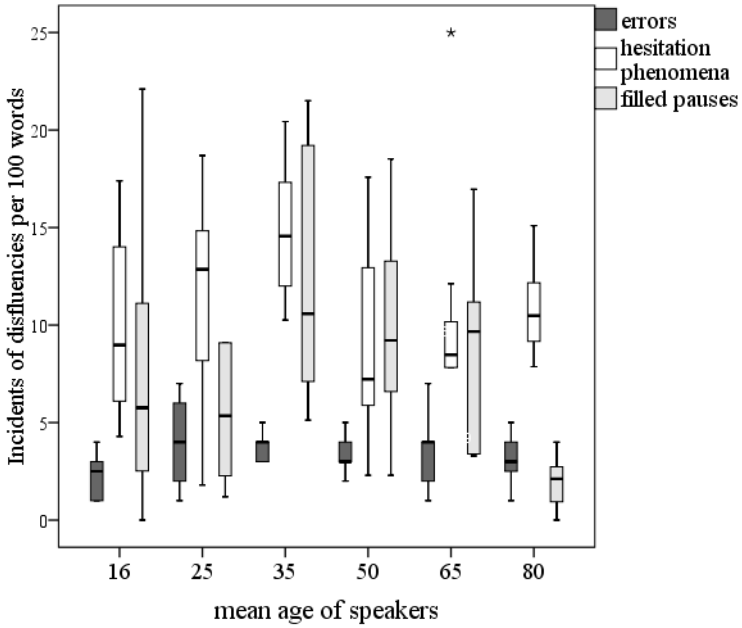

Figure 1

Occurrences of the error type and the uncertainty type disfluencies in narratives across age ranges (medians and interquartile ranges)

As expected, more occurrences of the uncertainty type than of the error type were found in the narratives (mean values: 14.2 and 3.2 occurrences per 100 words, respectively). The difference is statistically significant (Chi-Square = 70.841, p = 0.001). Filled pauses count towards disfluencies of the uncertainty type. What is remarkable here is that error type disfluencies seem to occur similarly across ages but there are considerable differences in the occurrences of uncertainty type disfluencies. In our material, 25- and 35-year-olds produced the highest number of uncertainty type disfluencies.

Conclusions

This study analyzed the temporal and disfluency characteristics of immediate recall narratives across ages from teenagers to old-old speakers. The results showed large overlaps between neighboring age groups for almost all parameters. Significant differences were found between the young and the old speakers' groups in a number of temporal and disfluency parameters (see Rodríguez-Aranda and Jakobsen 2011). Old

speakers produced significantly fewer silent and filled pauses and used significantly longer and more phrases in their narratives than young speakers did. No differences were found, however, in the relative frequency of error type disfluencies across ages. Fewer uncertainty type disfluencies were found in old than in young speakers.

We assumed that the temporal characteristics of the narratives would show large overlaps depending on age, and this was confirmed by the data. Thus, decisive temporal differences were found between 'young' and 'old' speakers rather than between neighboring age groups. This can be explained primarily by the large individual differences in each age group (see Jacewicz et al. 2010). As a result of the considerable cognitive and speaking workload involved in immediate recall narratives, pauses show remarkable age-specific patterns. Older speakers gain advantage from their experience in verbal communication and better speaking skills (sometimes at the expense of reduced information content, see Juncos-Rabadán 2005), but the investigation of this feature of their narratives is beyond the scope of the present study.

We hypothesized that younger people would produce more disfluencies than older people. This assumption was confirmed for the uncertainty type disfluencies (including filled pauses) but not for errors. Filled pauses were rare only in the old-old speakers' narratives.

On the basis of these findings we can conclude that covert speech planning processes and articulation itself are well controlled even in elderly people. Transformation of thoughts into language forms seems to be more difficult in the case of less experienced young speakers. Finally, we can claim that the age of the speakers does not inevitably correspond to their speaking capability (Bortfeld et al. 2001).

There are limitations to this study. All our statements are relevant only for those speakers that we included into this study. Although our analysis focused only on some of the features of the narratives, the findings add relevant new information to our knowledge about the nature of recall narratives.

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