Travaux du 19ème CIL | 19th ICL papers

Congrès International des Linguistes, Genève 20-27 Juillet 2013
International Congress of Linguists, Geneva 20-27 July 2013

19 ICL
19th International Congress of Linguists
July 21-27 2013
Geneva - Switzerland

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Self-monitoring strategies: the factor of age

oral presentation in session: 7 Psycholinguistics
(Uli Frauenfelder)

Published and distributed by: Département de Linguistique de l'Université de Genève, Rue de Candolle 2, CH-1205 Genève, Switzerland
Editor: Département de Linguistique de l'Université de Genève, Switzerland
ISBN:978-2-8399-1580-9

Self-monitoring strategies: the factor of age

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Abstract

The mental lexicon is the central mechanism of speech production process as it contains indispensable information for speaking. Speakers often face with difficulties during lexical retrieval in spontaneous speech, the examination of these disfluency phenomena may provide an insight into covert processes. The aim of the present research is to examine the self-monitoring strategies of adults and children by analyzing two types of disfluency phenomena: false starts and false words. The data set consists of a significant amount of spontaneous speech samples from the largest Hungarian database. Results indicate that 'age' has a great effect both on the occurrence of disfluencies and on the strategy of repair. This research contributes to the closer exploration of self-monitoring by age and highlights the factor of language development in this respect.

Key words: mental lexicon, self-monitoring, self-repair, false word, false start

Introduction

The retrieval of lexical entries from the mental lexicon is one of the major processes of the production of spoken language, according to various speech production models (Garrett 1980; Kempen–Huijbers 1983; Dell 1986; Levelt 1989). Research on children's and adults' mental lexicon has proved that its structure, the number of stored items and the activation strategies change with age (e.g, Cirrin 1983; Garlock et al. 2001; Newman–German 2002). Previous evidence also suggested that self-monitoring and self-repairing strategies related to lexical access and lexical selection (Levelt 1983; Levelt et al. 1999) might differ across ages. The purpose of the present paper is to investigate children's and adults' self-monitoring mechanism by analyzing two types of disfluencies (related to lexical retrieval) in their spontaneous speech.

The mental lexicon can be characterized by the following important parameters: the storage capacity and organization, and the speed and efficiency of retrieval. The huge number of stored words and the fast and efficient retrieval suggest that these words are carefully organized in the mental lexicon. The requirements of massive storage capacity and the fast retrieval are not necessarily the same; the system which allows the greatest storage capacity might not be compatible with efficient retrieval (Aitchison 2003). During the process of lexical retrieval, various difficulties may be encountered: difficulties in searching or articulating the right word, etc. These difficulties can be manifested in the surface structure as disfluency phenomena, or speech errors, such as false starts or false words. When facing some problem, the speaker generally interrupts the flow of speech; cut-offs may occur at any point of the emerging utterance: at a word in progress as well (resulting in false start). Alternatively the speaker may cut-off after s/he has completed a word (resulting in false word). The term ‘cut-off’ refers to the point at which the articulation of an erroneous utterance is interrupted (also called interruption point). The interruption may occur within a word; this phenomenon is called cut-off word (Berg 1986). The term ‘replacement repair’ refers to the interruption of the flow of speech for the purpose of replacing a word that has already been produced or whose production has begun (Kapatsinski 2010; see Table 1 for examples). The former phenomenon is called ‘false word’, while the latter one is called ‘false start’ in this study. False starts occur when the speaker realizes before articulating the complete word that it does not correspond with the target word, thus the utterance is stopped before the end of the complete production of the given word (Bouraoui–Vigouroux 2005). Contrarily, in case of the false words the repair takes place when the articulation of the word is already complete.

Table 1. Replacement repair: false word and false start

Disfluency type	Corpus	Example
False word	Switchboard Corpus cited by Kapatsinski 2010	We were surprised to see ‘Toyota’ **written**, I mean, *imprinted* on the engine.
	Present corpus	Megyünk **tavaszolni**, azaz, megyünk *Húsvétozni*. ‘We’re going to **spring**, I mean, *Easter holiday*.’
False start	Switchboard Corpus cited by Kapatsinski 2010	It was **pathe-**, I mean, it was *horrible*.
	Present corpus	**Visszará-** *visszaállít* minket az egyenes útra. ‘It **retur-** *directs* us back to the right path.’

Speech errors may provide valuable information about the organization of the mental lexicon and give insights into the self-monitoring mechanism underlying speech production processes (Fromkin 1973). As there can be various types of interrelations among the elements of the mental lexicon, difficulties of lexical selection may reflect to these patterns. The type of interrelation can be semantic (e.g., between the lexemes *mother* and *pregnant*), phonological (e.g., between the lexemes *mother* and *other*) or both (e.g., between the lexemes *mother* and *father*). In other terminology: Aitchison mentioned ‘single selection errors’ which may be based on meaning similarity, sound similarity, or both (Aitchison 2003). Meaning similarity is related to the semantic interrelation, while sound similarity is related to the phonological interrelation between two lexemes. Table 2 gives some examples to the types of errors based on various interrelations.

Table 2. Errors based on semantic, phonological and both kinds of interrelation

Type of interrelation	Corpus	Example
Semantic	Aitchinson 2003 ‘meaning similarity’	He came **tomorrow**. (*yesterday*)
	Present corpus	**Megütöttem** egy f- *megvertem* egy fiút.

		‘I **punched** a b- I *hit* a boy.
Phonological	Aitchinson 2003 ‘sound similarity’	The emperor had several **porcupines**. (*concubines*)
	Present corpus	Azzal én talán együtt egyet tudnék érteni. ‘I can go **among** with it, *along* with it.’
Both	Aitchinson 2003 ‘both’	You can hear the **clarinets** (*castanets*) clicking.
	Present corpus	Én nagyon **jóra** öö *jónak* tartom. ‘I find it **for good** er I find it *good*.’

Previous investigation confirmed that approximately 10% of the spontaneous utterances contain disfluencies involving self-correction (Shriberg et al. 1992; Nakatani–Hirschberg 1993). The self-monitoring system that is responsible for the successful corrections can operate in covert (based on the speaker’s inner speech) or overt way (relying on the outer auditory feedback) (Hockett 1973; Levelt 1983; Postma 2000; Nooteboom–Quené 2008). According to the Covert Repair Hypothesis (Postma–Kolk 1993), errors may be detected before they are actually articulated. Disfluent speech events may occur when the internal error detection and repair obstruct the concurrent articulation. The time necessary for repairing may be a cue for differentiating covert and overt self-monitoring. If an error is followed with a relatively short repair time, the repair is likely to arise by means of covert self-monitoring, without the outer auditory feedback.

The majority of the disfluencies that occur in spontaneous speech can be analyzed as having the following three-region surface structure (terms adapted from Levelt 1983, Figure 1): The first region of the disfluency is the reparandum, which is the erroneous form that will later be replaced. The end of this region corresponds to the interruption point or the location of the cut-off. By this point, the speaker has detected some problem. The editing phase consists of the region from the interruption point to the onset of the repair. This region may be empty, meaning it contains only a silent pause, or it may contain editing phrases or filled pauses *(I mean, um, uh)*. Finally, we have the repair region, which typically reflects the resumption of fluency.

During the last few decades there have been a number of studies whose aim was to investigate disfluencies and repairs in children’s and adults’ speech (Postma–Noordanus 1996; Hartsuiker–Kolk 2001; Nooteboom 2005; Gósy 2007; Horváth 2014a; Beke et al. 2014 etc.). Previous findings confirmed that besides many factors ‘age’ has a great effect on the ratio of disfluencies (Bortfeld et al. 2001; Gósy et al. 2014). Some research presented that the ratio of disfluencies is higher in children’s speech than in adults’ speech (Stemberger 1989; Bóna–Neuberger 2013); however, these findings need to be treated with caution because of the great variety of analyzed types. There may be age-related differences in disfluency rates depending on word type (content/function word); children can be seen to have a higher function word disfluency rate, whereas their content word disfluency is lower than that of adults (Dworzynski et al. 2003).The processes of monitoring and repair must be highly relevant during the early stages of speech development, already at about 2 years of age (Forrester

2008). It is supposed that children have the ability to correct erroneous utterances in others' and their own speech (Bóna et al. 2007).

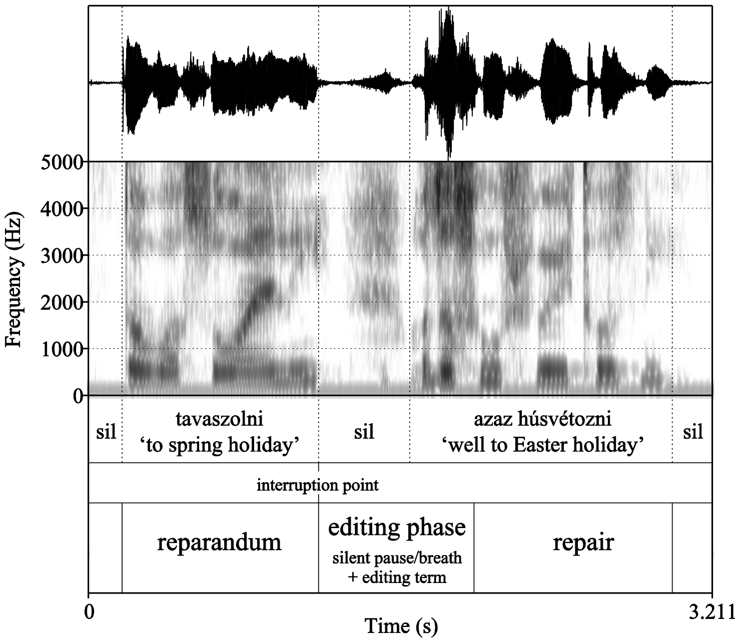

Figure 1. Reparandum, editing phase and repair
(illustrated by a Hungarian example, with translation in English)

The aim of the present paper is to explore similarities and differences between the self-monitoring strategies of children and adults. For this purpose we analyze two types of disfluency phenomena, false starts and false words, produced in children's and adults' spontaneous speech. The following research questions were addressed: What kind of age-related differences can be detected in the course of lexical access and self-monitoring process? Does the timing of self-repairs differ depending on age or other factors? Two main hypotheses were defined: (i) 'Age' has a great effect both on the frequency of occurrence of the phenomena and on the strategy of correction, and (ii) the duration of the editing phase depends on many factors, in particular, on the structure of the editing phase, on the relation between the reparandum and the repair, and on the type of the word (content/function word).

Participants, material and method

The present research was carried out on a large amount of spontaneous speech samples. Our corpus (22 hours) consists of narratives of 70 children and 70 adults. For the adult corpus we used 70 interviews of the BEA Hungarian Spontaneous Speech Data Base (Gósy 2012), in which the participants talked about their job, family, and hobbies. Thirty-five of the speakers were female, and thirty-five were male. All of them were native speakers of Hungarian from the capital city, Budapest. Their age ranged between 20 and 76 years. The mean age was 41 years. The total duration of the recording was 15 hours and 56 minutes. The duration of the interviews ranged between 5 minutes 7 seconds and 41 minutes 36 seconds. Recordings were made in the same room, under identical technical conditions: in the sound-proof booth, specially designed for the purpose, using AT4040 microphones. The interviewer was the same young woman in each recording.

For the child corpus we used 70 interviews of typically-developing, monolingual Hungarian-speaking children from the same kindergarten and elementary school in the capital city, Budapest. The task of the children was to talk about their everyday life and free time activities. There were thirty-three boys and thirty-seven girls. None of the children had any hearing disorders and their intelligence fell within the normal range. The analysis was cross-sectional including three age groups: 7–9-year-olds were from lower grades, 11–13-year-olds were from the upper grades of elementary school. In addition, 6-year-old pre-school children were included in the experiment for further comparisons. The mean age was 9 years. The total duration of the recording was 6 hours and 3 minutes. The duration of the interviews ranged between 2 minutes 27 seconds and 9 minutes 50 seconds. The interlocutor was the same young woman in all of the recordings.

All of the speech material was recorded using GoldWave software (at 44.1 kHz sampling rate and 16-bit resolution). The interviews with adults were recorded in a sound-proof booth of the Phonetics Department of the Research Institute for Linguistics, HAS. The children's samples were recorded in a quiet room of their kindergarten/school. All participants were tested individually. Speech samples were annotated using Praat 5.3 software (Boersma–Weenink 2012). The annotation contained three levels: (i) pause-to-pause intervals, (ii) disfluency phenomena (false words and false starts), (iii) editing phases (see Figure 1).

The data set contained 90 repaired false words and 222 repaired false starts from the adult subsample, and 44 repaired false words and 144 repaired false starts from the children subsample. A total of 500 items were analyzed from various aspects. We examined the occurrences of the two disfluencies per minute; we measured the duration of the editing phases, and also categorized them regarding to the structure of editing phase, to the interrelation between the reparandum (error) and the repair (target word), and to the type of the word (content or function word). Statistical analysis (univariate ANOVA, Bonferroni post hoc test) was conducted using SPSS 13.0 software. The confidence level was set at the conventional 95%.

Results

Occurrences of repaired false words and false starts

First, we analyzed the occurrences of the two disfluency phenomena in children's and adults' speech (Figure 2). The frequency of **false words** was 0.12 occurrences per minute on average (SD: 0.19) in children, and 0.10 occurrences per minute on average (SD: 0.15) in adults. 'Age' did not have significant main effect on the occurrences of false words (univariate ANOVA: $p < 0.005$). However, the frequency of false words showed some increase with age in the stages of childhood (Figure 3): preschoolers uttered 0.06, lower-graders uttered 0.08, and upper-graders uttered 0.19 false words per minute on average. The mean values of upper-graders significantly differed from the other two age groups' values (Bonferroni test: $p < 0.05$).

The frequency of **false starts** was 0.41 occurrences per minute on average (SD: 0.36) in children, and 0.24 occurrences per minute on average (SD: 0.24) in adults. In this terms, univariate ANOVA revealed significant main effect of 'age' [$F(1, 365) = 9.084$; $p = 0.002$]. A slight increasing tendency was found in our data concerning three age groups in the children's subsample: preschool children produced 0.32 false starts, while lower- and upper-grade school-age children produced 0.43-0.43 false starts per minute, respectively.

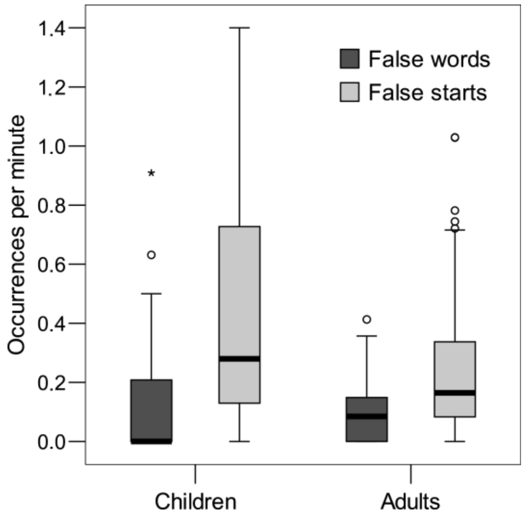

Figure 2. Occurrences of false words and false starts in children and adults

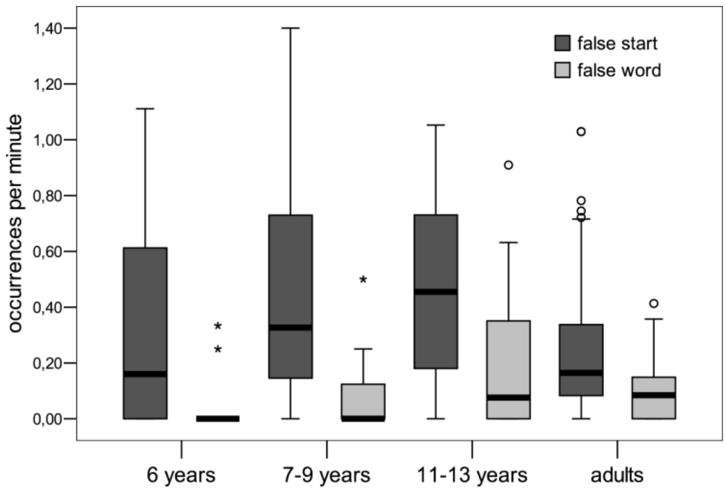

Figure 3. Occurrences of false words and false starts in each age groups

Overall, the occurrences of the two disfluencies were higher in children's speech than in adults' speech, particularly in the case of false starts. This finding shows similar tendencies to the findings of previous literature both in English (e.g., Stemberger 1989) and Hungarian (e.g., Menyhárt 2003). False starts occurred more frequently than false words in each age group. This result indicates that speakers irrespective of age tend to interrupt the flow of speech before articulating the complete erroneous word.

Timing of repair (duration of editing phase)
We next measured the duration of editing phase of each false starts and false words occurred in children's and adults' speech (Figure 4). This parameter shows how much time speakers need for repairing their errors. The longer the editing phase, the more time speakers needed for the repair.

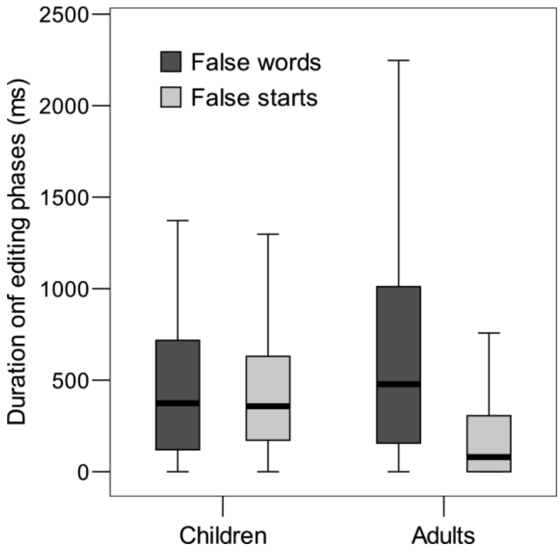

Figure 4. Duration of editing phases of false starts and false words in children and adults

Children repaired **false words** with an average duration of 585 ms (SD: 754), while adults repaired them with an average duration of 791 ms (SD: 1037). This result indicates that more time was needed for finding the target word for the adult speakers than for the children. However, this difference of duration was not significant between children and adults (univariate ANOVA: $p > 0.05$). More importantly, an increasing tendency was found in the time to repair false words in childhood (Figure 5). The mean duration of the editing phases of false words was 459 ms (SD: 368) in pre-schoolers, 528 ms (SD: 521) in lower-graders, and 627 ms (SD: 879) in upper-graders. Selecting and articulating the target word after producing the erroneous word are tasks of the lexical retrieval process. The efficiency of lexical selection and retrieval may be affected by the amount of stored items in the mental lexicon. The shorter repair duration in pre-schoolers speech may be associated with the less choice of word selection, which is due to the fewer amount of stored lexemes. The larger variety of words in adults' mental lexicon may slow down the process to find the appropriate lexeme.
In contrast to the results of false words, the repair time of **false starts** was longer in children than in adults. The mean duration of editing phases of false starts was 589 ms in children (SD: 703) and 211 ms in adults (SD: 306). Univariate ANOVA revealed a significant main effect of 'age' in this parameter ($F = 49.617$; $p < 0.001$), which means that children seemed to need significantly more time to repair false starts than adults. Regarding age groups in the children subsample, the mean duration of the editing phases of false starts was 541 ms (SD: 510) in pre-schoolers, 639 ms (SD: 736) in lower-graders, and 548 ms (SD: 735) in upper-graders.

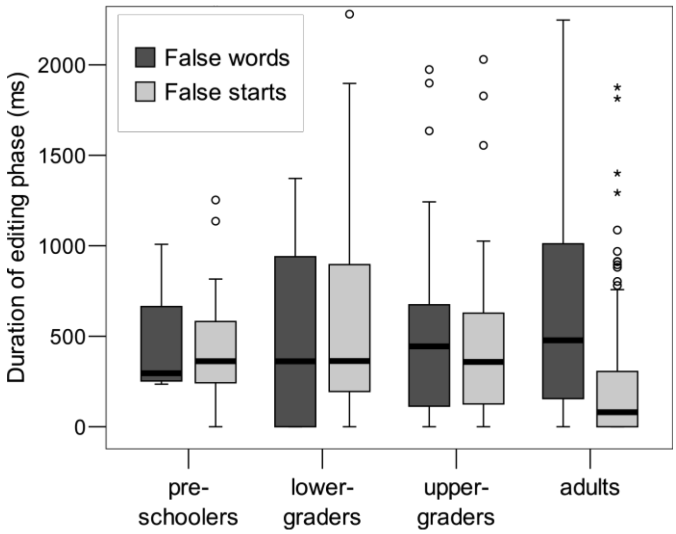

Figure 5. Duration of editing phases depending on error types and age groups

Statistical analysis showed that false starts can be repaired with a significantly shorter editing phase than false words in adults speech (univariate ANOVA: $F = 57.309$; $p < 0.001$). However, in childhood, 'error type' did not show significant main effect on the duration of editing phases (neither in the entire children subsample, nor in the three age groups). While younger children (between 6 and 9 years) repaired false words faster than false starts, this is not the case in older (11–13-year-old) children and adults. These latter two groups repaired false starts faster than false words. Based on our data, we can suppose that there might be a shifting point around the age of 9-10. It can be explained, inter alia, by the organization of the mental lexicon and the complexity of children's and adults' speech production.

Structure of editing phase

Besides the effects of 'age' (children–adult) and 'disfluency type' (false word–false start), the effect of 'structure of editing phase' on the duration of editing phases were tested by univariate ANOVA. Five types of editing phases occurred in our corpus, regarding the structure (based on what the editing phase contained): 1. empty (duration: 0 ms) or editing term (e.g., well, I mean), 2. silent pause, 3. filled pause, 4. filled and silent pause, 5. filled and/or silent pause and editing terms (we adapted the categorization of editing phases from Horváth–Gyarmathy 2012).

In the case of **false words** the most frequent structure was the combined editing phase (with filled and/or silent pause and editing terms) both in adults' (40.0%) and children's speech (53.1%). The least frequent ones were filled and silent pause in adults (4.4%). Children did not produce editing phases that contained only filled pause and the combination of filled and silent pauses (0-0%).

Statistical analysis (univariate ANOVA) revealed that he 'structure of editing phase' had a significant main effect on its duration both in adults [$F(1, 89) = 7.575$; $p < 0.001$; $\eta^2 = 0.263$] and in children [$F(1, 48) = 10.113$; $p < 0.001$; $\eta^2 = 0.305$] (Figure 6). The shortest editing phase consisted of silent pause in adults [mean duration: 247 (±360) ms], and the editing phase which was empty or consisted of editing term in children [mean duration: 45 (±156) ms]. The longest editing phases manifested in filled and/or silent pause and editing term [mean durations: 1429 (±1323) ms in adult, 966 (±858) ms in children]. The durations of editing phases were longer in adults' speech than in children's speech in the cases of 0ms/editing term and filled/silent pause and editing term, but shorter in adults than in children in the case of silent pause. 'Age' had significant main effect on the duration of editing phase in case when the editing phase was 0 ms long or consisted of editing term [$(F1, 38) = 4.703$; $p = 0.037$; $\eta^2 = 0.113$].

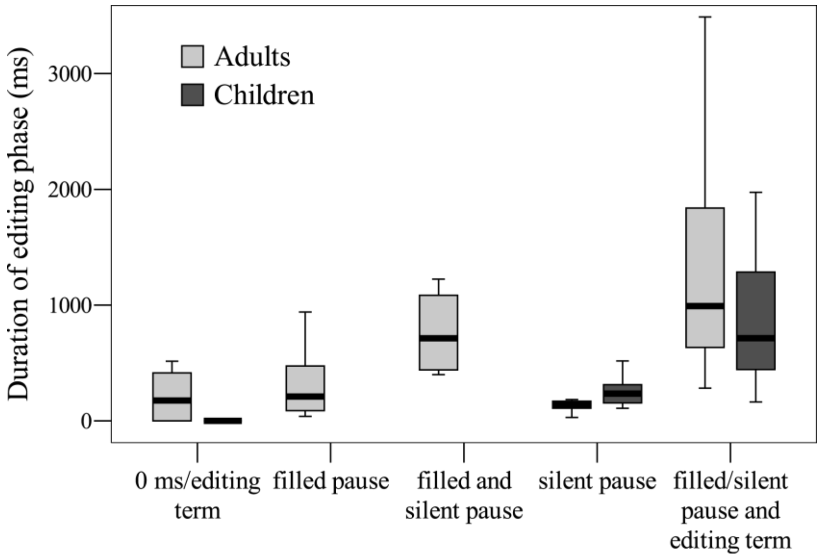

Figure 6. Duration of editing phases of false words

In the case of **false starts** the most frequent structure was the 0 ms-long editing phase in adults (36.9%) and the silent pause in children (47.9%). The least frequent ones were filled and silent pause in adults (9.0%) and the filled pause in children (1.4%).

The duration of editing phase significantly depended on its structure in both age groups [adults: $F(4, 221) = 41.454$; $p < 0.001$; $\eta^2 = 0.433$; children: $F(4, 143) = 15.995$; $p < 0.001$; $\eta^2 = 0.315$] (Figure 6). As expected, the shortest editing phases were the 0 ms-long/editing term editing phases [mean durations: 71 (±167) ms in adults and 22 (±72) ms in children], while the longest ones were the combined editing phases with filled and/or silent pauses and editing terms [mean durations: 667 (±465) ms in adults and 1093 (±916) ms in children]. The durations of editing phases were longer in children's speech than in adults' speech (Figure 7). 'Age' had significant main effect on the duration of editing phase in case when the structure of editing phase is silent pause [$F(1, 136) = 26.295$; $p < 0.001$; $\eta^2 = 0.163$], filled and silent pause [$F(1, 32) = 5.173$; $p = 0.030$; $\eta^2 = 0.143$], and filled and/or silent pause and editing term [$F(1, 75) = 5.093$; $p = 0.027$; $\eta^2 = 0.064$].

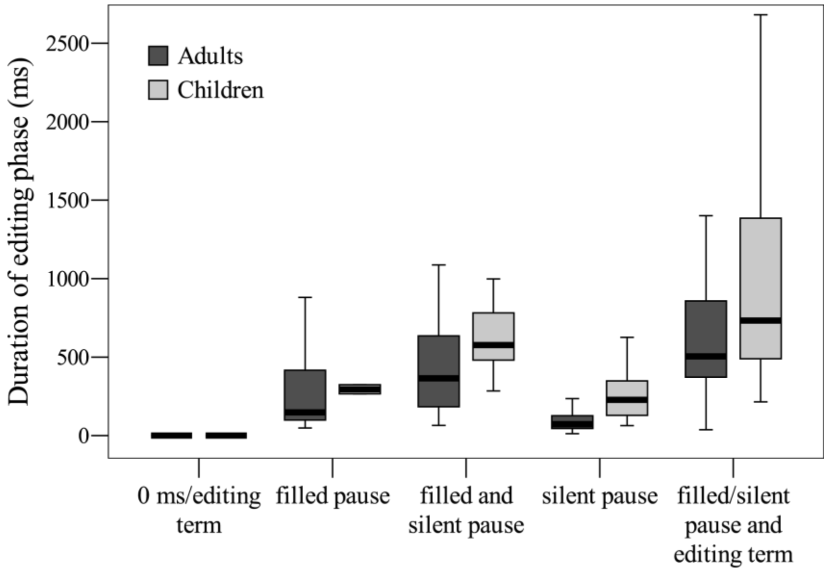

Figure 7. Duration of editing phases of false starts

The location of cut-offs in false starts (number of uttered speech sounds)

As it was mentioned earlier, cut-offs may occur within an erroneous word, thereby resulting a false start. This evidence might suggests that the locations of cut-offs are not linguistically motivated. The flow of speech can be interrupted at the boundaries of words or syllables, but even syllables can be interrupted. The location of cut-offs may reflect to the way of self-monitoring; speaker detect some problem of lexical retrieval by means of covert self-monitoring (based on his/her inner speech) or by means of over self-monitoring (based on his/her overt speech using auditory feedback).

We analyzed the number of uttered speech sound of each false start in our corpus. Erroneous words were generally interrupted after uttering 1–3 speech sounds. Children repaired their false starts after uttering one speech sound at 29.2%, two speech sounds at 28.5%, three speech sounds at 17.4% of the cases, while adults repaired false starts after uttering one speech sound at 11.3%, two speech sounds at 29.3%, three speech sounds at 20.7% of the cases (see Figure 8 for occurrences). The average number of uttered speech sounds was 2.7 in children’s and 3.4 in adults’ false starts. There was a decreasing tendency of occurrences of false starts as the number of uttered speech sounds increased. Research on a different corpus by 8- and 9-year-old children demonstrated the same tendency (Horváth 2014a, b).

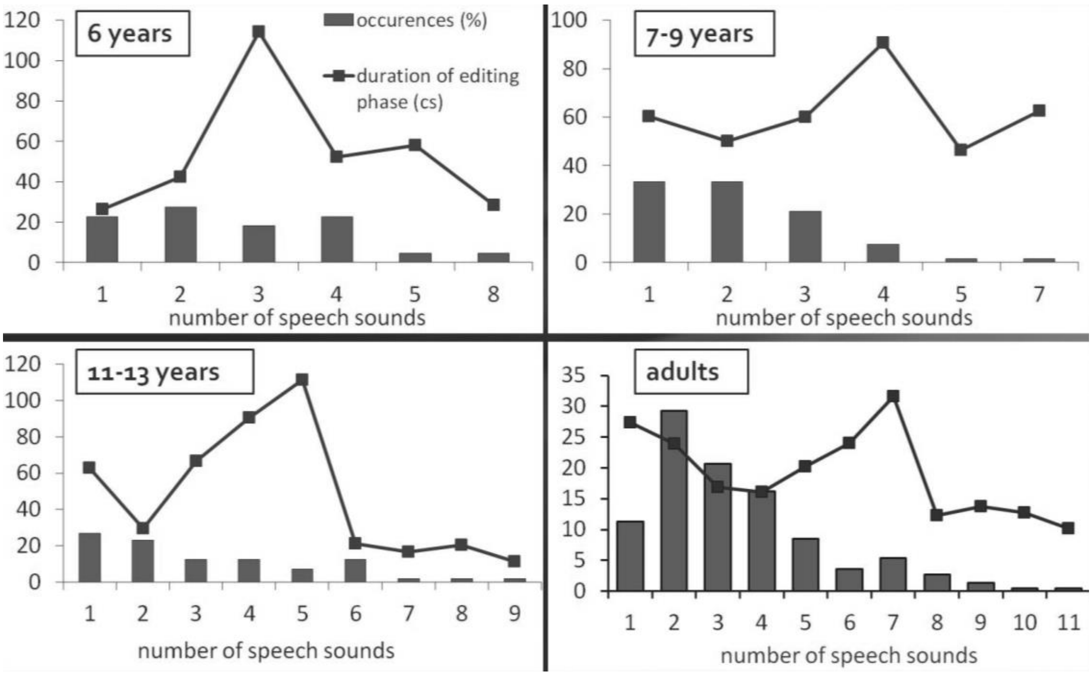

Figure 8. Occurrences of false starts and mean durations of editing phases depending on the number of uttered speech sounds

We also examined the duration of editing phases depending on the number of uttered speech sounds. There was a tendency to repair false starts faster as the number of uttered speech sounds increased. Results showed that this tendency is characteristic of each age group (see Figure 8 for mean durations of editing phases). Interestingly, in the diagrams of each age group we can notice one point where the duration of editing phases sharply goes up. In the 6-year-olds this is in the case of three speech sounds, in the 7-9-year old group this is by four speech sounds, in the 11-13-year olds five, as well as in the adults' group this rise occurred by the seventh speech sound.
After uttering this amount of speech sounds, the articulation of almost an entire erroneous word may hold back the speaker to find the correct target word. The explanation of this result needs further investigations, although it might be associated with the timing of error detection.

Repair of false words depending on word type (content/function word)
We categorized false words depending on the word type, whether it is a content word (like nouns) or a function word (like conjunctions). The duration of editing phase was longer in the case of content words than in the case of function words in almost each age group (Figure 9). In the speech of 6-year-old children there was no repaired false word related to function word. In the adults' subsample univariate ANOVA revealed significant main effect of type to the duration of editing phases [$F(1, 88) = 5.118$; $p = 0.026$], while in the children's subsample no such difference was yielded between content and function words.

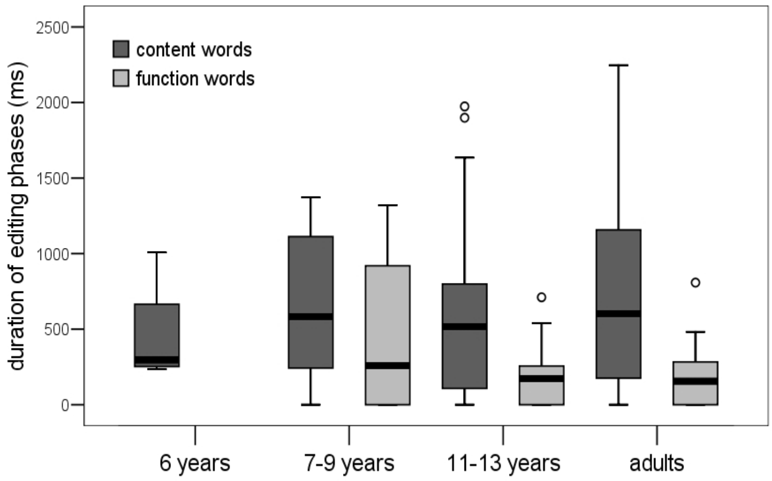

Figure 9. Duration of editing phases of false words depending on word type

Relationship between the erroneous and the target words

The relationship between the erroneous and the target words were analyzed in every false word. The interrelation can be categorized in four groups: semantic, phonological, both, none. Table 2 illustrated some examples of false words depending on the type of relationship of reparandum and repair. In the children's subsample in 27% of the cases there was semantic interrelation. We found less proportion of cases of phonological interrelation (9%). The most frequent (59%) was that case when both semantic and phonological interrelation was manifested. In the adults' subsample the semantic interrelation seemed to dominate (44% of the cases), phonological interrelation was yielded in 8% of the cases, and both type of interrelation was yielded in 35% of the cases. 5% in children and 13% in adults' false words did not show any type of interrelation.

Conclusions

The paper investigated the self-monitoring strategies of children and adults in the case of two types of disfluency phenomena: false words and false starts. The main results show that false starts occur more frequently in the speech samples of all age groups than false words do (in total 366 false starts and 134 false words). Research on other speech corpora revealed the same pattern in adults' spontaneous speech. In the speech of 18 Hungarian-speaking participants false starts were produces by 83.3%, while false words were produced by 38.9% of the participants (Gósy 2003). This finding indicates the appropriate functioning of the covert self-monitoring; speakers (regardless of age) tend to detect lexical errors before articulating the whole lexeme. However, the repair strategies showed age-group contingent differences. For instance, adults can repair their false starts significantly faster than children. This demonstrates that the self-monitoring mechanism changes with age.

The mean duration of the editing phase of false starts showed shortening with age. Statistical analysis revealed significant main effect of 'age' in this terms, however, no significant differences were yielded in the case of false words. The decreasing of the mean duration of editing phases was also proved by Horváth 2014b in 8- and 9-year-old children's and adults' speech (287 ms, 282 ms and 211 ms, respectively). Generally, the duration of editing phase of false words was realized longer than that of false starts, which means that false starts can be repaired faster than false words.

Results confirmed that the duration of editing phase is affected by its structure in both cases of the analyzed types of disfluency. The longer the duration and the more complex the structure of editing phase the greater the speech planning difficulty.

Previous research supposed that recognition of lexemes is based on the first 200 ms of the sound sequence (Marslen-Wilson 1990). In Hungarian, this duration spans about seven speech sounds in articulation of adult speakers. This amount of speech sounds could reflect to the threshold between covert and overt self-monitoring. However, further investigations are needed to confirm this assumption.

In adults, there is a remarkable difference in lexical access between function words and content words; however, this is not the case in children. In the adults' subsample we found that function words are used as clichés, in which case the lexical access and the monitoring is faster than in the case of content words. No such difference was found in children's repair of content and function words. This age-related difference can be explained mainly by the fewer number of content words and their less developed interrelations in the children's mental lexicon.

Results regarding the type of interrelation between the erroneous and the target word may highlight the role of language acquisition in the development of mental lexicon, even though the findings showed many similarities between children and adults. In childhood lexical access is influenced characteristically by both semantic and phonological interrelations between the erroneous and the target word. In adults the semantic interrelations seem to dominate.

It is a widely accepted fact that children acquire language and speech skills through participation in a variety of communicative situations both with adults and other children (Tomasello 2003). Parents' repairs of the child's and their own speech errors are crucial feedbacks to learn and practice the operation of self-monitoring mechanism. By participating in more and more interaction, with increasing age, children get more experience about how make their expressions more accurate and understandable to others (Laasko 2010). Age-related changes of disfluency rate and repair strategies might be due to the more complex cognitive skills and the more advanced linguistic practices for making self-repair. The finding related to the occurrence of disfluencies and self-repairs may provide useful cues to the mental lexicon of speakers with speech disorders both in childhood and adulthood.

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