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UNSTRESSED VOWEL DELETION AND *NEW* CONSONANT CLUSTERS IN ENGLISH

DOROTA GŁOWACKA
Adam Mickiewicz University, Poznań, Poland

1. Introduction

A common phonological reduction of casual speech is vowel syncope in unstressed syllables (e.g. Fokes and Bond 1993; Ashby and Ashby 1990; Bald 1990; Nolan and Kerswill 1990; Laver 1994; Lodge 1984; Dalby 1984; Wells 1982, 1995; Shockey 2000; Utman, Blumstein and Burton 2000). The two juxtaposed consonants resulting from the syncope can create consonant clusters already existing in English (e.g. /kr/ *correct*) as well as clusters unattested in English before (e.g. /dm/ *diminish*).

This paper reports the results of an experimental study of the contexts in which unstressed vowels in English are more likely to undergo the deletion process thus giving rise to 'new' types of consonant clusters. The clusters resulting from the deletion process were confronted with the consonantal combinations existing in English. Other factors taken into consideration were the following: the influence of morphological and syntactic boundaries, word frequency, position of the unstressed vowel with respect to the main word-stress, and position of the unstressed vowel in the word.

Nineteen subjects took part in the experiment. All the subjects were students of the Reading University. They were all aged between 20 and 30 and originally came, broadly speaking, form the South of England. The experiment consisted of two parts. First, the subjects were asked to read 39 sentences containing various contexts for unstressed vowel deletion. The subjects were instructed to read the sentences in a casual way. Then, they were asked to say a few words about their interests, their plans for the future, their summer holiday, etc. The aim of both parts of the experiment was to elicit a casual kind of speech. The experiment was conducted in a soundproof room. The speech was recorded on a DAT Aiwa tape recorder. Altogether the recorded material has about 90 minutes. The material was analysed both auditorily and acoustically. Spectrograms and waveforms were produced by means of *Speech Station* and *Cool Edit 96*, respectively.

In the data analysis a vowel was considered deleted if there was no sign of vowel formants on the spectrum and if there was no sign of vocal cords movements. The second criterion was particularly important in contexts with surrounding voiceless segments. Any sign of an intervening vocoid was analysed as an instantiation of a reduced vowel. This approach was adopted in all the analysed material. The main criteria for the selection of consonants surrounding the unstressed vowel in word-initial position were manner of articulation and voicing. In general, technical words and words of extremely low frequency were avoided. Certain combinations are not present in the material as words containing a particular context for unstressed vowel deletion are either unattested in English, e.g. VdF_VdS, N_N, N_Vd contexts in word initial position, or are infrequent, e.g. VsF_N (e.g. *semantic*), VdF_VdF (e.g. *vivacity*). Contexts where vowels, though in unstressed position, were not reduced were disregarded, e.g. /fænˈtæstɪk/ *fantastic*. Similarly, vowels in syllables bearing secondary stress were not taken into consideration.

2. Word-initial position

2. 1. Read sentences

The read material contained the following contexts for unstressed vowel deletion:

1. Voiceless (Vs) fricative (F) _ Vs stop (S): /s_p/ *suppose*, /ʃ_k/ *chicanery*, /s_k/ *succumb*, *succinct*;
2. VsS _ VsF: /p_f/ *performance*, /p_s/ *persuaded*;
3. VsF _ Voiced (Vd) S: /s_b/ *sublime*, /f_g/ *forgotten*;
4. VdF _ VsS: /v_k/ *vacate*;
5. VsS _ VdF: /p_z/ *position*;
6. VdS _ VsF: /d_s/ *discovered*, *distinct*;
7. VdF _ VsF: /v_s/ *vicinity*;
8. VdS _ VsS: /d_t/ *determine*, /b_k/ *became*, /d_p/ *depends*;
9. VsS _ VsS: /p_t/ *potential*, *particular*;
10. VsS _ VdS: /t_g/ *together*, /t_d/ *today*;
11. VsS _ Approximant (Ap): /k_l/ *collection*, *cholesterol*, /p_l/ *police*;
12. VdS _ Ap: /b_l/ *believe*, *below*;
13. VsS _ Nasal (N): /k_m/ *computers*, *compiled*, /k_n/ *contains*, /t_m/ *tomorrow*;
14. N _ VsF: /n_s/ *necessity*;
15. N _ VdS: /n_g/ *neglecting*, *negotiate*;
16. Ap _ VsF: /r_s/ *receives*, /r_f/ *refuses*;
17. VdF _ Ap: /v_r/ *variety*, /v_l/ *volition*;
18. VdF _ N: /v_n/ *vanilla*;
19. Ap _ N: /l_m/ *lamented*;
20. N _ Ap: /m_l/ *malicious*;
21. N _ VsS: /m_t/ *material*;
22. VdS _ VdF: /d_v/ *device*;
23. VdS _ VdS: /b_g/ *began*;
24. VdS _ N: /b_n/ *banana*, /d_m/ *diminished*;
25. VsF _ VdF: /s_v/ *severely*;
26. VsF _ VsF: /s_s/ *suspense*.

Altogether the read speech contained 47 words with the contexts for unstressed vowel deletion in initial position. The vowel deletion process was observed in 12.5% of all read sentences.

2.1.1. Results

Not all contexts fare equally well as far as unstressed vowel deletion is concerned (see Figure 1). Deletions are favoured in contexts involving two voiceless obstruents (e.g. *suppose*, *suspense*, *performance*, *potential*, *particular*), where the vowel deletion reached around 30%. In the VsF_VsS context (*suppose*, *succumb*, *succinct*) schwa was syncopated more in VsF_/p/ context (31.5%) rather than in VsF_/k/ context (6.1%). This discrepancy may be due to the place of articulation of the stop. The number of deletions drops rapidly when either the stop or the obstruents surrounding the vowel is voiced: VsF_VdS, e.g. *sublime*, *forgotten* (2.6%), VdF_VsS, e.g. *vacate* (0%), VdS_VsF, e.g. *discovered*, *distinct* (5%), VsF_VdF, e.g. *severely* (5.2%), VdS_VsS, e.g. *determine*, *become*, *depends* (4.3%), VdS_VdS, e.g. *began* (0%), VdS_VdF, e.g. *device* (5.2%). The VsS_VdF (*position*) and VdF_VsF (*vicinity*) contexts behave exceptionally. Here, deletions took place in 15.7% and 21% of cases, respectively. In both cases, however, the voiced fricative underwent the devoicing process: [ɣ̊sɪnəti] *vicinity*, [pz̥ɪʃən] *position*.

Voicing of obstruents also plays an important role in the contexts with the unstressed vowel situated between an obstruent and a nasal. No vowel deletions were observed between voiced stops and nasals, e.g. *banana*, *diminish*; while between voiceless stops and nasals the vowel syncope process reached 26%, e.g. *contain*, *computer*, *tomorrow*. Manner of articulation of the obstruent also affects the vowel deletion process. While no deletions took place between voiced stops and nasals (*diminish*, *banana*), a number of vowels were syncopated (10.5%) between a voiced fricative and a nasal (*vanilla*).

In contexts with obstruents and approximants the vowel deletion process took place both after voiceless as well as voiced obstruents: *believe*, *below*, *collection*, *variety*, *volition*. Interestingly enough, schwa was deleted more between /v/ and /r/ (52.6%) than between /v/ and /l/ (5.5%).

A problem arises in connection with the analysis of contexts with initial voiceless stops. In English voiceless stops, in particular in onset initial position of stressed syllables, are strongly aspirated, while stops preceding an unstressed vowel are unaspirated. In the analysed material, however, a number of words the whole unstressed syllable is represented by an aspirated stop, e.g. [tʰdeɪ] *today*. In such cases

the unstressed vowel may be devoiced and 'hidden' behind the aspirated portion of the stop. In fact, voiceless vowels and aspiration are acoustically very similar (Bald 1990). Laver (1994: 348) defines aspiration as late onset of voicing which occurs syllable internally between a voiceless segment and a following voiced one. In aspiration, the onset of voicing is of the second segment is delayed for a period of 30-40 msecs, giving an onset to the second segment that has a phonatory state that is whisper or voicelessness. Bald (1990) notices, however, that in fast speech the period of voicelessness can be extended over the whole vowel following a voiceless obstruent. In the analysed material a vowel was considered deleted if the release of the preceding voiceless stop was not followed by aspiration. In strongly aspirated stops the aspirated portion was analysed as a voiceless vowel. Strong aspiration of the stop, or devoicing of the unstressed vowel, occur in all contexts beginning with a voiceless stop: VsS_VsS (*potential*, *particularly*), VsS_VdS (*together*, *today*), VsS_N (*computers*, *contains*, *tomorrow*), VsS_Ap (*collection*, *police*). In VsS_VsS context vowel deletion (28.9%) is preferred to vowel devoicing (18.4%). The opposite can be said about VsS_VdS contexts (*together*, *today*), where only 5.6% of unstressed vowels underwent deletion, while 31.5% were devoiced.

In VsS_Ap contexts (*collection*, *police*) only 9% of vowels were clearly deleted, while aspiration of initial stops was present in as much as 66% of cases. Similarly, in VsS_N contexts (*computer*, *contain*, *tomorrow*) 26.3% of unstressed vowels were syncopated as compared to 48.6% of initial aspirated stops. Here, however, arises a problem of a different nature. Aspiration of the initial stop does not have to be necessarily covering an unstressed vowel. In fact, in a number of cases the aspiration bears visible signs of formants of the following nasal or approximant rather than of a vowel. In instances where the articulation of the nasal or approximant begins already in the aspiration phase of the stop, the unstressed vowels may have been deleted and the word reanalysed as initiating with a /SN/ or /SAp/ cluster. In the mental lexicon of native speakers of English words like *tomorrow* or *police* are stored as items initiating with a /tm/ or /pl/ onset (see e.g. Fokes and Bond 1993; Utman, Blumstein and Burton 2000). In English, stops in onsets of stressed vowels are strongly aspirated. Once words such as *police* or *collection* are reanalysed as items beginning with /pl/, /kl/ or /tm/ clusters followed by a stressed vowel, the initial stop is aspirated and articulators move directly from the stop articulation to the liquid or nasal articulation. In fact, *Longman Pronunciation Dictionary* treats [pli:s] as one of the citation forms of the word *police*.

Table 1. Aspiration of initial voiceless stops and unstressed vowel deletion in read speech in contexts involving approximants and nasals

	VsS_Ap	VsS_N
Aspiration	66%	48.6%
Deletion	9%	26.3%

The remaining cases include contexts beginning with a nasal or an approximant: N_VdS (*neglect*), Ap_VsF (*receive*), N_VsS (*material*), Ap_N (*lamented*). In all these instances the deletion process was sporadic and ranged from 0% to 5%. Here, again a few contexts behave differently. The number of deletions in N_VsF (*necessity*) reached 15.7%, which might be due to the influence of the following coronal voiceless fricative. Coronal consonants can be characterised by several unique properties that differentiate them from the segments executed by other articulators (see Paradis and Prunet 1991 and references therein): coronals are the most frequent consonants in languages, they are one of the first consonants acquired by children, they are frequently epenthesised in aphasics speech, they are more prone to undergo assimilation processes than any other place of articulation, vowel spreading can take place across coronals but is blocked across noncoronals. These special properties of coronals lend evidence to the fact that coronals are the most neutral (unmarked) consonants. In other words, the coronal place of articulation is the default one and it does not require any specification in the underlying form. Davis (1991) examined an English Morpheme Structure Condition that prohibits homorganic consonants in sCVC words. The study revealed that this MSC rules out homorganic labials (**spep*) and velars (**skek*) but permits homorganic coronals (*stet*, *state*). However, a voiceless fricative, even a coronal one, does not seem the have the same impact on the contexts with a preceding approximant (*receives*, *refuses*), where the number of deletions reached 0.

The highest percentage of schwa deletions was observed in the N_Ap context (*malicious*), where schwa was deleted in 36.8% of cases. In the context with reversed order, i.e. between a nasal and an approximant (*lamented*) the percentage of deletions was much lower (5.2%).

2.2. Spontaneous speech

The following contexts for unstressed vowel deletion in word-initial position occurred in the spontaneous speech produced by the subjects (the number of occurrence of a given context is given in parenthesis)

1. VsF _ VsS: /s_p/ (3), /s_k/ (1), /s_t/ (1)
2. VsF _ VdF: /s_v/ (1)

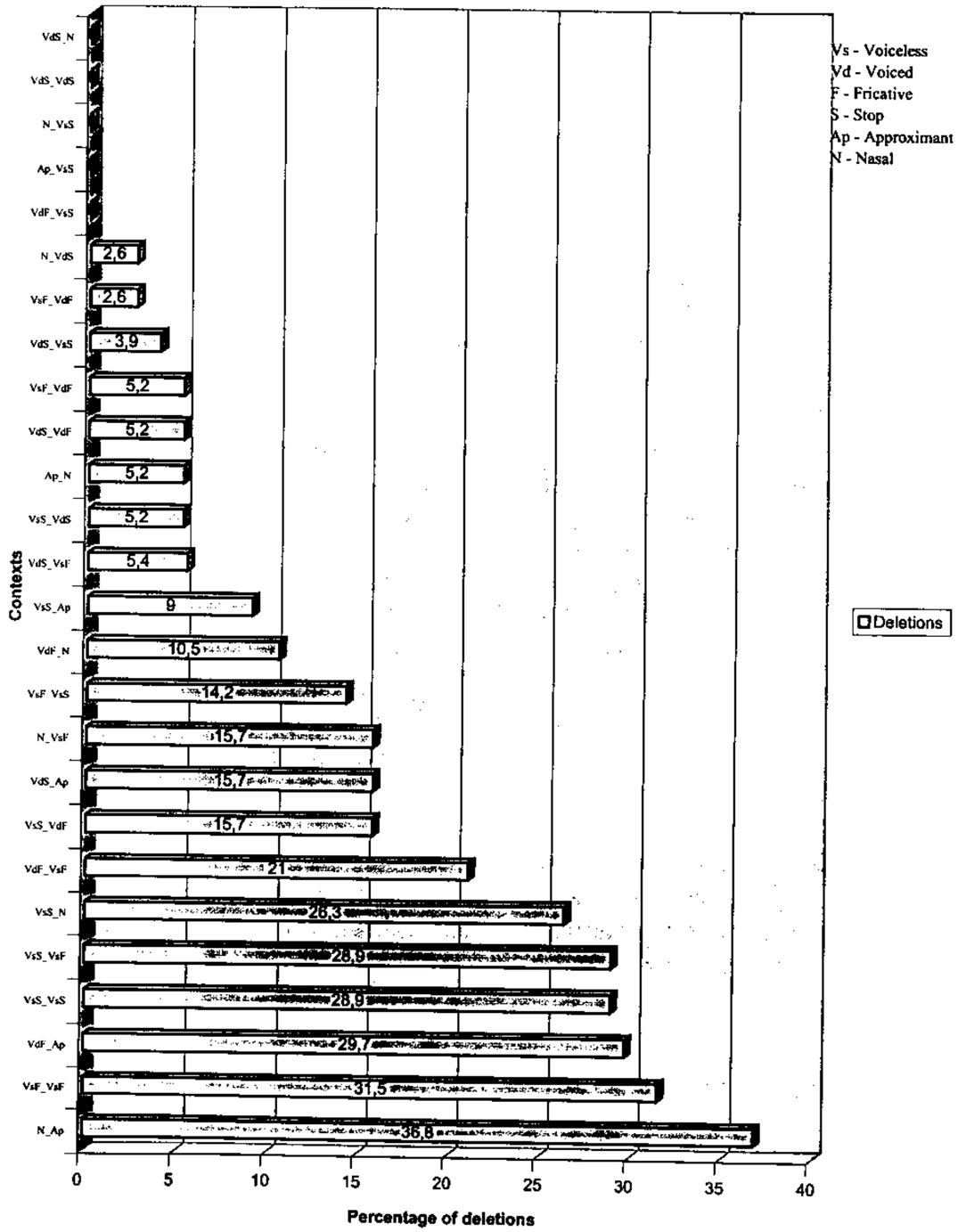

Figure 1. Unstressed vowel deletion in word-initial position in read speech.

3. VdS _ VsS: /b_k/ (5), /d_p/ (1)
4. Ap _ N: /l_ŋ/ (4)
5. VdS _ VdS: /d_g/ (5), /b_g/ (2)
6. VdS _ VdF: /d_z/ (1)
7. VsF _ N: /f_m/ (1)
8. N _ Ap: /m_l/ (1), /m_r/ (1)
9. VdF _ VsS: /v_k/ (1)
10. VsF _ VsF: /s_f/ (1)
11. VsF _ Ap: /s_l/ (2)
12. VsS _ VsF: /p_θ/ (5), /p_s/ (1)
13. VsS _ VsS: /p_t/ (8)
14. VsS _ N: /k_m/ (6), /k_n/ (4), /t_n/ (1)
15. VsF _ VdS: /s_g/ (1), /f_g/ (2)
16. VdS _ Ap: /d_l/ (2), /b_l/ (2), /b_r/ (1)
17. Ap _ VdS: /r_g/ (1), /r_d/ (2)
18. Ap _ Ap: /r_l/ (1)
19. Ap _ VsS: /r_p/ (4), /r_t/ (1)
20. Ap _ VsF: /r_z/ (1)
21. VdS _ VsF: /d_s/ (7), /d_f/ (1)
22. N_VsAF: /m_tʃ/ (1)
23. VsS _ VdS: /t_d/ (2), /t_g/ (1)
24. VsS_Ap: /t_r/ (1)
25. VdF_N: /ð_m/ (1)

Altogether the spontaneous speech contained 88 tokens with initial unstressed vowels. The vowel was deleted in 17 tokens (19.3%).

2.2.1. Results

The analysis of the data coming from spontaneous speech largely supports the findings presented in the previous section concerning unstressed vowel deletion in read speech. The best contexts for unstressed vowel deletion are the ones including two voiceless obstruents: VsF_VsS (*suppose*, *certificate*) and VsS_VsF (*pathology*, *persuade*), VsF_VsF (*safari*), VsS_VsS (*particularly*), where the vowel was deleted in 55% of cases. Unstressed vowels following voiceless stops were often devoiced: VsS_N *completely*, *concern*, *tonight* (unstressed vowel devoiced in 60% of cases); VsS_VdS *today*, *together* (unstressed vowel devoiced in 100% of cases). Other contexts where unstressed vowel was deleted are the following: VsF_Ap (*solicitor*) or VsS_Ap (*Toronto*). Sporadically unstressed vowel was also deleted in contexts beginning with the voiced stop /d/: *degree*, *delays*. Vowel syncope occurred only after the coronal stop, never after the labial one, e.g. *beginning*, *believe*. No deletions were observed in contexts involving a resonant (with the exception of the words *solicitor* and *Toronto*), e.g. *linguistics*, *familiar*, *maroon*, *commutes*, *connect*, *regress-*

ing, *repair*, *proposal*, *mature*, or in contexts including a voiced obstruent, e.g. *survive*, *became*, *defence*, *today*, *department*, *forgotten* (with the exception of the two words initiating with /d/).

2.3. Summary

In summary, unstressed position is not a sufficient context for a vowel to be deleted. Other factors that need to be taken into consideration are manner and place of articulation, and voicing of the segments surrounding the unstressed vowel. The best contexts for unstressed vowel deletion in English are the ones which consist of two voiceless obstruents (e.g. *persuade*, *potential*), a voiceless stop followed by a resonant (e.g. *tomorrow*, *solicitor*), a voiced obstruent followed by an approximant (e.g. *believe*, *variety*), or a nasal followed by an approximant (e.g. *malicious*). The clusters resultant from the vowel deletion process do not necessarily have to obey English phonotactic rules. English legal onset clusters conform to the following generalisations (Gimson 1994: 217; Hammond 1999: 50-55): VsF + Ap (*fly*, *fry*, *shrine*, *slow*), Vs coronal F + N (*small*, *snow*), S + Ap (*play*, *pray*, *try*, *close*, *cry*, *blow*, *bright*, *dry*, *glow*, *green*). The data analysis also reveals that sonority distance does not play a major role in the emergence of new consonant clusters in fast speech. According to sonority scale,[1] onsets with rising sonority should be preferred to onsets with falling sonority or 0 sonority distance (Clements 1990; Zec 1995). /dv/ and /ps/ fare equally well on the sonority scale, however, the probability of occurrence of /ps/ is much higher than that of /dv/. Certain clusters with falling sonority distance (e.g. /ns/) are more likely to appear than certain clusters with rising sonority scale (e.g. /dv/).

3. Word medial position

The criteria taken into consideration in the analysis of unstressed vowel deletion in word-medial position were the nature of the consonants surrounding the unstressed vowel and the location of the unstressed vowel with respect to the main word stress.

The objective of the analysis is to establish whether the decisive factor determining the contexts for unstressed vowel deletion in word-medial position is the make-up resultant consonant clusters or whether there are also other factors involved, e.g. length of thus emerging consonants, the melodic pattern of the word.

[1] There have been many different sonority divisions proposed in the literature. One common scale proposed by Foley (1972) goes as follows:

[6] Vowels > [5] Glides > [4] Liquids > [3] Nasals > [2] Fricatives > [1] Stops

3.1. Read speech

Unstressed vowel deletion is much more widespread in word-medial position than in word-initial position. The read material contained 24 words with contexts for unstressed vowel deletion in medial position. In 14 words the deletion process exceeded 50% (in word-initial position the highest percentage of deletions reached 36%). Generally, vowel deletion was observed in 53% of all read words with a medial unstressed vowel.

Position of the unstressed vowel with respect to the main word stress does not have much impact on the deletion process. The process is equally likely to occur in pre- as well as post-stress position. In pre-stressed position the vowel was deleted in 52.4% of cases (e.g. *seventeen*, *information*, *Waterloo*, *correspondent*, *civilisation*), while in the post-stressed one in 55% of cases (e.g. *centimetres*, *company*, *government*, *answering*, *finally*, *beautiful*, *necessity*).

Length of the resultant consonant cluster does not seem to play a major role in the vowel deletion process, either. The tested material contained 10 contexts where unstressed vowel deletion might give rise to clusters consisting of three or more consonants: *centimetres*, *seventeen*, *information*, *correspondent*, *cholesterol*, *Mexico*, *company*, *government*, *answering*, *explanation*. The overall percentage of unstressed vowel deletions in these words reached 66.8% as compared to 44.7% of deletions in the remaining 14 contexts, where the outcome of the deletion process would be a two-consonant cluster (e.g. *Waterloo*, *finally*, *necessity*).

The consonant clusters emerging as a result of unstressed vowel syncope do not have to adhere to English phonotactic rules.[2] Out of the 24 contexts for unstressed vowel deletion in word-medial position present in the tested material only 10 could potentially end up as legal English medial clusters: *cholesterol*, *particularly*, *available*, *archaeologist*, *Waterloo*, *vicinity*, *necessity*, *Mediterranean*, *finally*. Vowel deletion in the remaining 14 contexts would produce an illegal medial consonant cluster: *centimetres*, *beautiful*, *seventeen*, *information*, *correspondent*, *chicanery*, *civilisation*, *Mexico*, *company*, *government*, *terrorists*, *answering*, *Mediterranean*, *explanation*. The difference in the percentage of deletions between the two groups is not great. In the words in which unstressed vowel syncope could result in a legal cluster schwa was deleted in 48.4% of cases, while in the other group the deletion process attained 58.3%. Interestingly enough, the percentage of unstressed vowel deletion was higher in the contexts producing illegal English clusters than in the contexts producing the legal ones. Still, the data analysis indicates that not all 'new' medial consonant clusters are equally acceptable in English. In two words the resultant clusters were regularly reduced. In the word *government* sixteen subjects reduced the resultant [vnm] cluster to [vm]. Only two subjects preserved the original

[2] I adopted Hammond's (1999: 69) approach according to which medial consonant clusters should be decomposable into legal initial or final clusters.

[vnm] cluster. In the word *explanation* the resultant cluster [kspln] was reduced either to [kspl] or [kspn]. This cluster simplification process can be easily accounted for in the word *explanation*. Here, vowel deletion gives rise to a super heavy consonant cluster consisting of five elements. No such interpretation is possible in case of the word *government*, where a three-consonant cluster would emerge as a result of schwa syncope. In the remaining words novice triple consonant clusters do not undergo the reduction process, e.g. *centimetres*, *seventeen*, *information*. Moreover, there are other medial consonant clusters that might potentially emerge, e.g. [ksk] *Mexico*, [nt] *vicinity*, [ldʒ] *archaeologist*. In these three cases there was not even one instantiation of unstressed vowel deletion. All this suggests that in spite of the great combinatorial possibilities of medial consonant clusters, there exist some preferences or constraints determining their shape.

The factor determining the schwa deletion process seems to be the consonant standing to the right of the unstressed vowel. In almost all the cases where the consonant in this position was a resonant (a nasal or an approximant) the deletion processes reached at least 50%, particularly when the consonant to the left of the unstressed vowel was an obstruent. In C(onsonant)_R(esonant) contexts the deletion process took place in 87% of cases, of which 56.1% in R_R contexts (e.g. *finally*, *chicanery*) and 75.6% in O(bstruent)_R contexts (e.g. *answering*, *cholesterol*, *company*). In C_O(bstruent) contexts unstressed vowels were deleted only in 23% of cases, of which 12.2% in R_O contexts (e.g. *vicinity*, *available*, *archaeologists)* and 36.8% in O_O contexts (e.g. *beautiful*, *necessity*, *Mexico*).

The percentage of deletions was not evenly distributed among the words with the O_O contexts for unstressed vowel deletion. Here, the S_F context (*beautiful*) is definitely in the lead. In the F_S context deletion was favoured in the s_t context (*necessity*) rather than in the s_k context (*Mexico*). Similarly, in word-initial position schwa was deleted only sporadically between /s/ and /k/. One might argue that in the word *Mexico* vowel deletion would result in a cluster of three obstruents. Such clusters, however, do exist in English, e.g. *expert*, *extra*, *exclaim*. The data indicate that vowel syncope may be blocked by velar consonants.

All in all, the contexts for unstressed vowel deletion in word-medial position can be arranged into four gradient groups:

Table 2. Gradient contexts for unstressed vowel deletion in word-medial position in read speech.

context	percentage
Obstruent_Resonant (S_N, F_N, S_A, F_A)	75.6%
Resonant_Resonant (A_A, N_A, A_N)	56.1%
Obstruent_Obstruent (S_S, S_F, F_S)	36.8%
Resonant_Obstruent (A_F, A_S, N_S)	12.2%

3.2. Spontaneous speech

The spontaneous speech material contains 281 tokens with 321 contexts for unstressed vowel deletion in medial position. Unstressed vowel syncope was observed in 49.6% of all the contexts. In an overwhelming majority of words the unstressed vowel occurred in post-stress position (e.g. *travelling*, *cycling*, *suffering*, *poisonous*, *frightening*, *Canada*, *family*, *Emily*, *accident*, *marketing*, *hospital*). There were only 47 instantiations of contexts for unstressed vowel deletion in pre-stressed position, 15 of which in the word *university* (other examples include: *competitions*, *civilisation*, *decoration*, *nationalities*, *dissertation*, *accommodation*). The deletion took place in 29.7% of contexts for unstressed vowel deletion in pre-stress position and 47.4 % of contexts for unstressed vowel deletion in post-stress position. The contexts for unstressed vowel deletion in post-stress position, however, were much more varied than the ones found in pre-stress position.

The material contains 126 contexts where unstressed vowel deletion could result in a cluster of 3 or more consonants (e.g. *absolutely*, *seventeen*, *recently*, *accident*, *hospital*). Unstressed vowels were deleted in 56.3% of the contexts. In the remaining 195 contexts in which unstressed vowel syncope could lead to the emergence of two-consonant clusters the processes was observed in 44.1% of cases (e.g. *library*, *Italy*, *specially*, *gardening*, *listening*, *Canada*, *activity*, *marketing*, *beautiful*). The results clearly indicate that length of the resultant consonant cluster does not have much impact on the application of the process of unstressed vowel deletion in word-medial position. As a matter of fact, the deletion was more frequent in contexts involving three or more consonants than in contexts involving only two consonants.

Not all the resultant consonant clusters obey the rules of English medial consonant clustering. Out of the 157 contexts that might end up as legal English consonant clusters, the vowel deletion processes occurred in 82 of them (52.2%), e.g. *properly*, *Nicola*, *personalities*, *dissertation*. In the 164 remaining contexts unstressed vowel syncope reached 45.1% (74 occurrences), e.g. *seventeen*, *actually*, *recently*, *accident*. Certain consonant clusters that emerged due to vowel deletion were simplified. The cluster of two nasals [nm] in the word *environmental* was reduced to [m]. A similar simplification process occurred in read speech. Combinations of two nasals seem to be generally avoided. In spontaneous speech four N_N contexts (*badminton*, *Birmingham*) were found but unstressed vowel deletion took place in none of them. Another commonly reduced clusters were the ones consisting of two approximants. Thus, [ll] and [rl] in *regularly*, *particularly*, *literally* were regularly simplified to a single [l]. In the word *literally*, however [r] left its traces in that the preceding [t] was palatalised: [lɪtʃli]. The cluster of two stops [bb] in the word *probably* was also shortened to a single stop but not in all instances. There are 14 occurrences of this particular word in the collected material. The unstressed vowel was deleted in 10 cases: in 6 of them the [bb] cluster was reduced, while in 4 of them it was preserved. This observation indicates that clusters of two stops enjoy greater tolerability than clusters of two nasals or approximants. This generalisation cannot be extended to all the possible resonant clusters as, e. g. nasal + approximant clusters are perfectly acceptable (e.g. *family*, *primary*). Another simplification process affecting the resultant medial consonant clusters is stop deletion between resonants. [t] was regularly dropped in the [ntl] cluster, e.g.: *(un)fortunately*. A similar process, i.e. stop deletion in various environments is extremely widespread in connected speech (Shockey 2000, Lodge 1984, Crystal and Davy 1975).

The decisive factor as far as unstressed vowel deletion in word-medial position is concerned is the consonantal environment of the vowel. Schwa syncope is mostly likely to take place when the consonant standing to the right of the vowel is a resonant. In spontaneous speech the highest percentage of deletions (78.3%) was observed in contexts with two resonants: Ap_Ap (*regularly*, *literally*, *particularly*), N_Ap (*family*, *finalist*, *primary*), Ap_N (*apparently*, *environmental*); with the exception of the N_N context (*badminton*, *Birmingham*), where not a single vowel deletion took place. N_Ap is the only context in which unstressed vowel deletion reached 100% (e.g. *general*, *family*, *Emily*, *finalist*, *primary*).

The runners-up were contexts involving an obstruent and a resonant: S_N (*gardening*, *frightening*, *company*), F_N (*recently*, *seventies*, *socialising*), S_Ap (*totally*, *Niagara*, *luckily*, *decoration*), F_Ap. (*socialising*, *travelling*, *absolutely*). Here, the deletion process reached 74%, only slightly less than in the previous contexts. Voicing of the obstruent does not have much effect on the vowel syncope. In the contexts with voiceless obstruents the process attained 76.8% (e.g. *literally*, *factory*, *hopefully*, *suffering*, *traditional*, *listening*) while in the contexts with voiced obstruents 67.7% (e.g. *library*, *Niagara*, *travelling*, *seventeen*, *poisonous*, *gardening*).

In the contexts where both consonants flanking the vowel were obstruents the deletion process occurred in 51.2% of cases: S_S (*marketing*, *hospital*, *probably*, *competition*), S_F (*beautiful*), F_S (*university*, *activity*, *accident*, *education*). Vowel syncope was favoured in contexts with two voiceless obstruents. Obstruent clusters of mixed voicing are generally avoided (no schwa deletions in such words as: *wonderful*, *opposite*, *independent*, *visiting*), though a number of schwa deletions occurred between obstruents of different voicing: *accident*, *education*, *activity*. In the O(bstruent)_S contexts place of articulation of the stop also affects the vowel deletion process. There were more deletions before the coronal /t/ (86.2%), e.g. *university*, *activity*, *solicitor*; than before the velar /k/ (18.1%), e.g. *difficult*, *certificate*.

The context in which unstressed vowel deletion is least likely to appear is the one with a resonant followed by an obstruent: Ap_F (*elephants*, *interesting*), N_F (*university*, *anaesthetic*), Ap_S (*Africa*, *charity*, *secretary*), N_S (*community*, *clinical*). Here, unstressed vowel deletion was detected only in 5.5% of cases and only in the N_Vs/VdS contexts: *Canada*, *accommodation*, *unfortunately*.

In summary, contexts for unstressed vowel deletion in word-medial position in spontaneous speech pattern as follows:

Table 3. Gradient contexts for unstressed vowel deletion in word-medial position in spontaneous speech.

context	percentage
Resonant_Resonant (A_A, N_A, A_N)	78.3%
Obstruent_Resonant (S_N, F_N, S_A, F_A)	74%
Obstruent_Obstruent (S_S, S_F, F_S)	51.2%
Resonant_Obstruent (N_S)	5.5%

3.3. Summary

In word-medial position the process of unstressed vowel deletion is most likely to take place in the C(onsonant)_R(esonant) context. There can be observed certain restrictions regarding the composition of future medial Consonant + Resonant clusters. Clusters of two resonants of the same type, i.e. two nasals or two approximants, are generally avoided. 'New' clusters of this type are either simplified or the vowel deletion process does not occur, e.g. *government*, *literally*.

Other factors: stress position, adherence to English phonotactic rules do not exert a significant influence, if any, on the deletion process. The vowel can be deleted in pre- and post-stress position, or in contexts giving rise to consonant clusters so far unattested in English. The only restriction arises in connection with the length of the clusters. Super long clusters (consisting of 5 or 6 consonants), e.g. *explanation*, are either shortened after the vowel was syncopated or the deletion process is blocked.

The data analysis reveals that there exist certain similarities as regards the shape of preferred 'new' consonant clusters in initial and medial position. In both positions preference is given to clusters consisting of two voiceless obstruents.

4. Word-final position

The main criteria taken into consideration in the analysis of unstressed vowel deletion in word-final position were, as previously, manner of articulation and voicing of the consonants surrounding the vowel. The influence of morphological boundaries on vowel syncope was also examined.

4.1. Read speech

4.1.1. Unsuffixed words

In read speech the deletion process took place in 30.6% of contexts for vowel syncope without an intervening morpheme boundary.

In word-final position preference is given to C_R contexts, in particular to O_R contexts. Voicing of the obstruent definitely plays an important role in the vowel deletion process. Vowel syncope reached the highest percentage (53.7%) in VsO_R contexts (e.g. *collection*, *lesson*, *potential*, *forgotten*, *settled*). The percentage of deletions was not equal among all the words containing the same context. For example, in the test material there were 8 words with a final /ʃ_n/ context. In 5 of them (*collection*, *information*, *civilisation*, *nation*, *temptation*) the percentage of vowel deletions ranged from 50% to 78%, while in the remaining 3 (*position*, *volition*, *explanation*) only from 15% to 21%. All the words with low percentage of deletions occurred in phrase- or sentence-final position. An analogous phenomenon was observed by Dalby (1984) in American English. Generally, words in sentence-final position tend to be quite resistant to various kinds of reduction processes. In my data consonant clusters occurring in sentence-final position were rarely simplified, while the same type of clusters in sentence-medial position were often shortened.

Another discrepancy can be observed in the VsS_N context (*forgotten*, *system*). In *forgotten* schwa was deleted in 94.7% of cases, while in *system* only in 10.5%. Here, phrase or word boundary cannot be held responsible for this diverse behaviour of the two contexts. The discrepancy may be due to the place of articulation of the nasal. A cluster of two coronal consonants [tn] is more tolerable than a cluster of a coronal stop and a bilabial nasal [tm].

Unstressed vowel syncope is less common in contexts involving voiced obstruents and resonants. The overall percentage of vowel deletions in these contexts reached 29.8%. Here, again the number of vowel deletions was not evenly distributed. VdF_N (*seven*, *thousand*) and VdS_Ap (*legal*, *available*) were the best contexts for vowel deletions, while VdS_N (*correspondent*, *abandoned*) and VdF_Ap (*vestigial*) the worst ones.

In R_R contexts vowel deletion took place only between /r/ and the following /n/ (*children*). No vowel syncope was attested in contexts including /l/ and a nasal (*Helen*) or two nasals (*determine*, *performance*). Clusters of two nasals are also avoided in word-initial and word-medial position.

The remaining contexts, i.e. the ones involving two obstruents (*malicious*, *tickets*) or a nasal followed by an obstruent (*terrorists*, *diminished*) block the process of vowel deletion in word-final position. Even contexts with two voiceless obstruents do not trigger vowel syncope.

4.1.2. Suffixed words

Vowel deletions in contexts including morphological boundaries are sporadic. They cover only about 2.9% of all the contexts present in the read material. There were only a few instances of vowel syncope in contexts with two obstruents (*metres*, *cases*).

4.2. Spontaneous speech

4.2.1. Unsuffixed words

The spontaneous speech material contains 316 tokens with 316 contexts for unstressed vowel deletion in word-final position of unsuffixed words. The deletion process was observed in 99 contexts (31.3%).

Again, C_R is the best context for unstressed vowel deletion. Not all contexts of that type, however, fare equally well as triggers of vowel syncope. Schwa was more readily dropped in the environment of a voiced fricative and a nasal (e.g. *seven*, *Devon*, *given*, *dozen*: 52.3% of deletions) rather than a voiceless fricative and a nasal (e.g. *direction*, *sections*, *dissertation*, *medicine*: 28.5% of deletions). Similarly, unstressed vowel deletion was more widespread in contexts with voiced stops and a following nasal (e.g. *London*, *garden*, *student*, *Sweden*: 55.5% of deletions) than in contexts with voiceless stops and nasals (e.g. *second*, *happen*, *forgotten*: 28% of deletions).

In contexts with obstruents and approximants vowels were most often deleted after stops, both voiced and voiceless, e.g. *local*, *little*, *cycle*, *couple*, *middle*, *needle* (77.2% of deletions). The number of deletions was lower in contexts with fricatives, both voiced and voiceless, e.g. *travel*, *proposal*, *castle*, *social*, *painful* (47.3% of deletions).

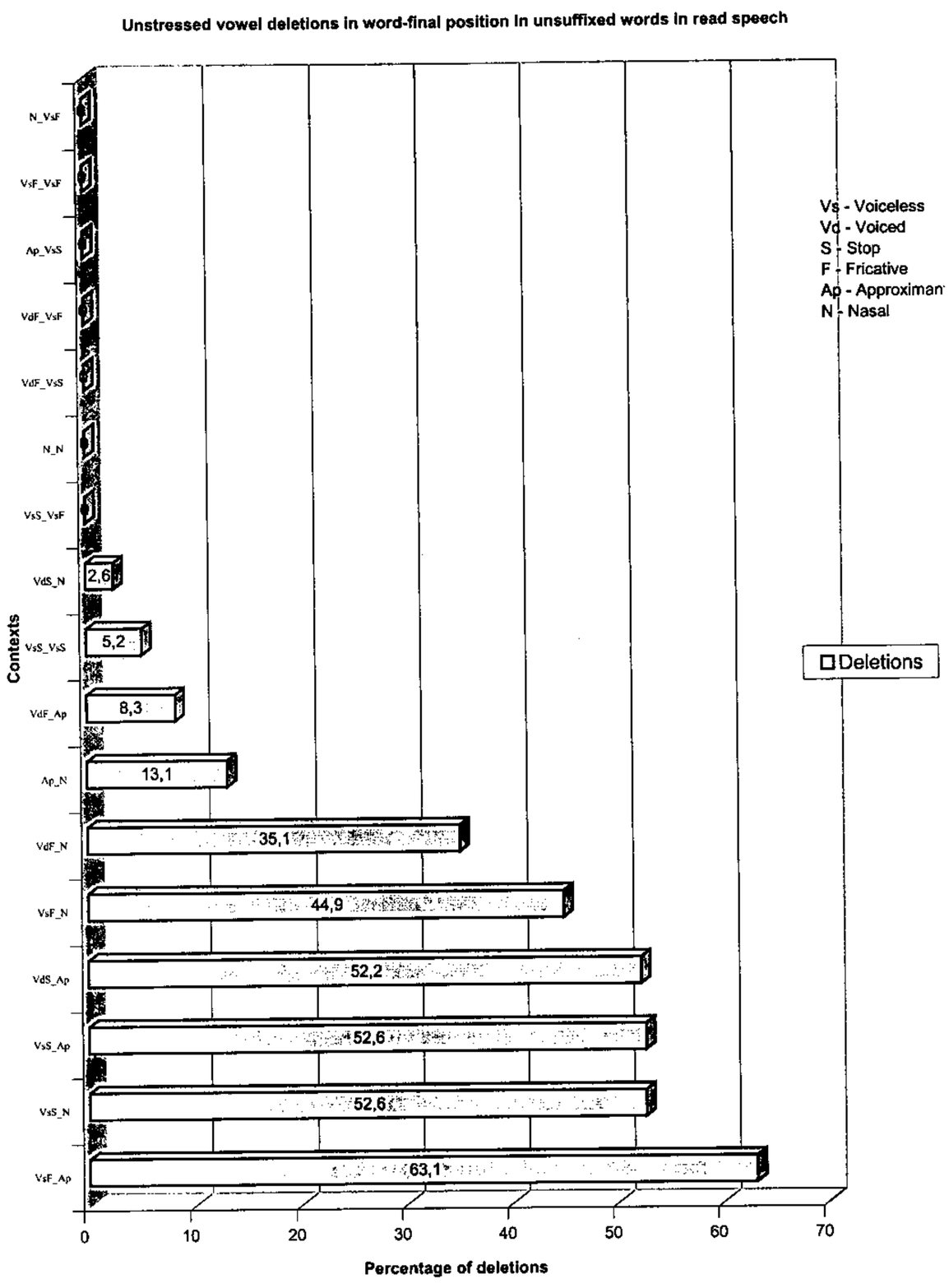

Figure 2. Unstressed vowel deletions in word-final position in unsuffixed words in read speech.

In contexts with two resonants /r/ appears to be the best trigger for vowel deletion, whether the following resonant is a nasal (e.g. *different*, *children*, *parents*) or an approximant (e.g. *central*, *general*). Not a single schwa deletion took place between /l/ and a nasal, e.g. *England*, *island*, *balance*, *Poland*. Unstressed vowel syncope occurred, however, in the context of reversed order, i.e. between a nasal and /l/, e.g. *international*, *final*). The environment of two nasals (e.g. *placement*, *fulfilment*) also blocks the deletion process.

Resonant + obstruent (both voiced and voiceless) context does not trigger unstressed vowel deletion: Ap_VsF (*English*, *finalist*), Ap_VsS (*pilot*, *chocolate*), Ap_VdAf (*college*, *village*), N_VsS (*clinic*, *minute*), G_VdAf (*language*). In all these cases only one instance of vowel deletion was found, i.e. in the word *hundred*. Contexts with nasals followed by /s/ behave exceptionally (e.g. *Christmas*, *poisonous*, *tennis*) as here the process of vowel deletion reached 63.3%.

Contexts involving two obstruents, regardless of voicing and manner of articulation, are absolutely immune to the vowel deletion process, e.g. *certificate*, *delicious*, *music*, *rabbit*, *surrogate*, *campus*, *Oxford*, *perfect*.

4.2.2. Suffixed words

As in read speech, in spontaneous speech occurrences of unstressed vowel deletions in contexts with morphological boundaries are very rare. They were observed in 5.6% of all cases. Most of the attested deletions took place in VsS_N context, e.g. *working*, *cooking*, *marketing*. This particular consonantal combination also frequently triggers vowel deletions in contexts not involving morpheme boundaries.

4.3. Summary

Unstressed vowel deletion is blocked by an intervening morphological boundary. The main factor influencing the process of unstressed vowel deletion and at the same time the creation of new types of consonant clusters in word-final position of unsuffixed words is the nature of the consonant surrounding the vowel. The deletion is virtually impossible if the vowel is followed by any consonant other than a nasal or an approximant (in Standard British English, which is a non-rhotic accent, it can only be /l/). The preceding consonant can be either a resonant (e.g. *final*) or an obstruent (e.g. *seven*). The only exception to this rule is the N_/s/ context, which also triggers vowel syncope (e.g. *Christmas*). There are, however, certain restrictions on the shape of future clusters of two resonants, i.e. they cannot be composed of two nasals (e.g. *placement*) or of the approximant /l/ and a nasal (e.g. *balance*).

The data coming from read and spontaneous speech make contradictory predictions as to the impact of the voicing of obstruents on vowel syncope in O_R contexts. Analysis of read speech suggests that vowel deletion should be more apt to occur after voiceless obstruents, while the analysis of spontaneous speech implies that voiced obstruents also serve as good triggers of the vowel deletion process. This dis-

crepancy does not necessarily have to be caused by voicing of the obstruents. The read speech data analysis have shown that syntactic boundaries may also be at play when it comes to phonological simplification processes.

The 'new' consonant clusters do not have to adhere either to English phonotactic rules[3] or to the general principles of sonority scale. Final clusters terminating in resonants are banned by English phonotactic rules. If the resultant clusters were to be faithful to the laws of consonant combination in English, they should rather consist of obstruents or of resonants followed by obstruents. According to the sonority scale principles, on the other hand, the preferred word-final consonant clusters should have a falling slope, e.g. they should consist of a fricative and a stop or a nasal and a fricative. No such tendencies can be observed as regards the make-up of 'new' final consonant clusters in English. In fact, almost all the clusters arising due to schwa deletion in word-final position have a rising sonority slope, e.g. *garden*, *cycle*.

5. Conclusions

5.1. Word-position

In general, unstressed vowel deletion is more frequent in word-medial position than at word margins.

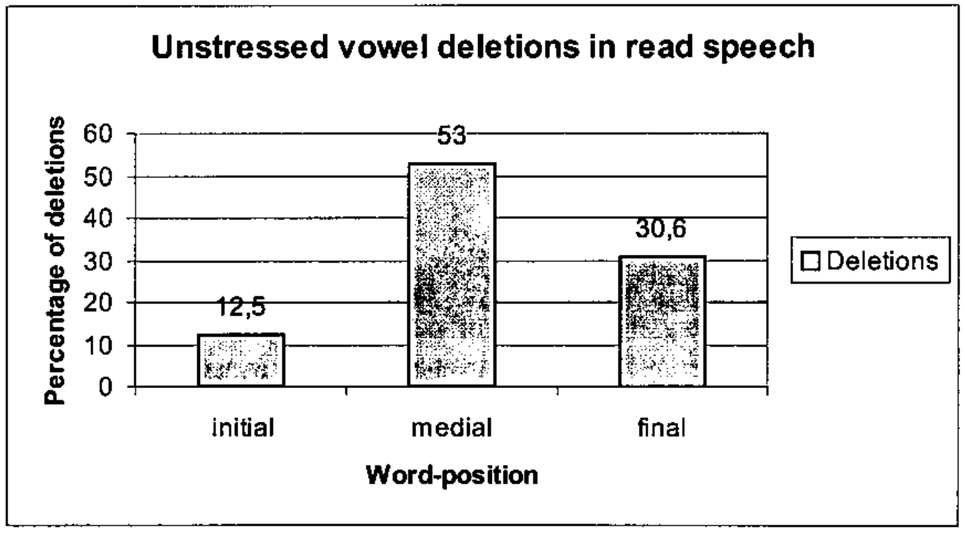

Figure 3. Word position and unstressed vowel deletions in read speech.

[3] English word-final clusters obey the following generalisations (Hammond 1999: 58-65):
1. Unsuffixed NC codas are composed of a nasal followed by a homorganic voiceless obstruent or /d, z/;
2. /s/ can be followed by any voiceless stop;
3. /l/ can occur freely with any following obstruent or nasal;
4. Any voiceless stop or fricative followed by a voiceless coronal stop or fricative constitutes a well-formed unsuffixed C+COR coda;
5. Any obstruent followed by a coronal stop or fricative constitutes a well-formed suffixed C+COR coda;
6. Sequences larger than CC are always built on well-formed smaller sequences.

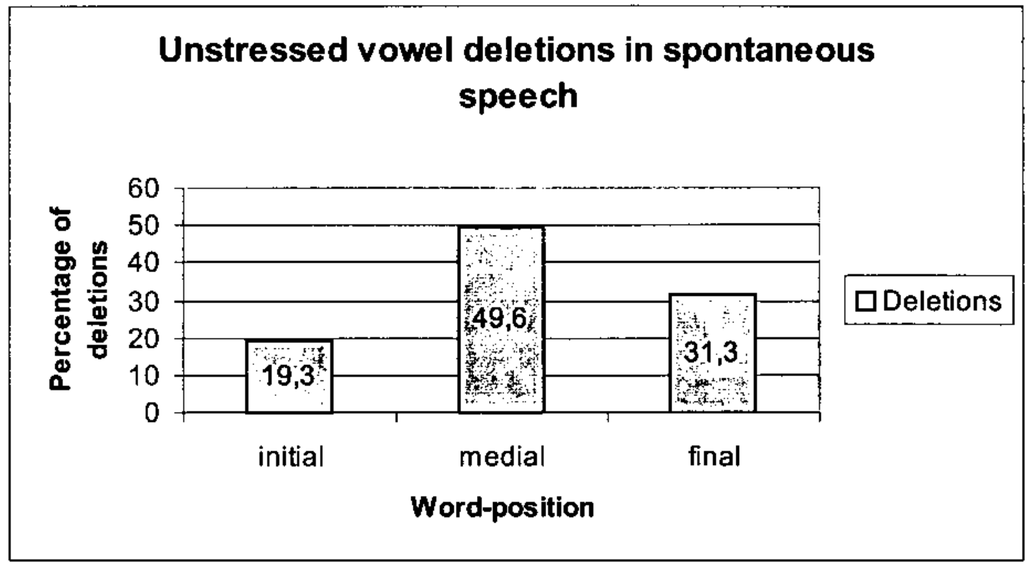

Figure 4. Word position and unstressed vowel deletions in spontaneous speech

The lowest percentage of deletions was reached in word-initial position. In the framework of Gestalt psychology (Dressler 1996), for example, word onsets play an important role in perception and the decoding of word meaning. That is why they are more resistant to reductions than word-medial or final syllables.

5.2. Manner and place of articulation

Nasal + approximant clusters (e.g. [ml]) as well as obstruent + resonant clusters (e.g. [kn], [vn], [kl], [sl]) arising due to vowel deletion are acceptable in all word positions. On the other hand, clusters consisting of two nasals are unacceptable in all word-positions. Clusters beginning with /l/ (whatever the second element of the cluster might be) are also inadmissible. In the class of approximants /r/ fares better as vowel syncope trigger than /l/. For example, in read speech the percentage of schwa syncope was much higher between /v/ and /r/ (*variety*) than between /v/ and /l/ (*volition*). In word-medial position we can find a few examples of vowel deletion between /r/ and an obstruent (e.g. *correspondent*) but none between /l/ and an obstruent (e.g. *holiday*, *validation*). Similarly, in word-final position schwa can be easily dropped between /r/ and /n/ (e.g. *children*) but not between /l/ and /n/ (e.g. *balance*). Only in word-initial position no deletions took place after /r/ (e.g. *refuses*, *traditional*, *proposal*).

Not all types of consonant clusters are equally likely to emerge in all word-positions. 'New' clusters consisting of two obstruents arise only in initial and medial position (e.g. *potential*, *marketing*), not in the final one (e.g. *malicious*). Clusters of two approximants occur in final position (e.g. *central*, *general*); while in the medial one they are reduced to just one approximant (*literally*, *regularly*, *particularly*). The

material contained only one example of a potential two-approximant cluster in initial position (*relax*) so it is difficult to draw any conclusions. Various nasal + obstruent clusters emerge more readily in word-medial position (e.g. *Canada*, *unfortunately*) than at word margins. At word margins only nasals followed by /s/ are acceptable (e.g. *necessity*, *Christmas*).

Table 4. Possibility of occurrence of new types of consonant clusters in English according to manner of articulation (voicing was not taken into consideration).

	N + Ap e.g. [ml]	**O + R** e.g. [kn], [sl], [vn]	**/l/ +C** e.g. [ln], [ls], [lt]	**/r/ + C** e.g. [rl], [rs], [rn]	**O + O** e.g. [ps], [tg], [vs]	**Ap + Ap** [ll], [rl]	**N + O** (except /s/)	**N + /s/**
Initial	+	+	–	–	+	–	–	+
Medial	+	+	–	+	+	+ (reduced)	+	+
Final	+	+	–	+	–	+	–	+

Coronals enjoy a special status as far as the creation of new types of consonant clusters is concerned. In certain contexts unstressed vowel deletion is blocked unless one of the surrounding consonants is a coronal. Thus, for example, after a nasal schwa is most likely to be deleted when followed by the coronal fricative /s/. In spontaneous speech in word-initial position in contexts beginning with voiced obstruents unstressed vowel was syncopated only after the coronal stop /d/, but not after other stops.

5.3. Voicing

Voicing plays a vital role in the formation of new types of consonant clusters, in particular in the formation of obstruent clusters. In initial and medial position (in final position new types of obstruent clusters do not arise) unstressed vowel deletions are almost exclusively limited to voiceless contexts. Even if a vowel is deleted in the vicinity of a voiced obstruent, the resultant cluster is wholly devoiced. Quite high percentage of deletions occurred in Vd_Vd context in word-medial position in spontaneous speech. Here, however, this context was attested in one word only, i.e. *probably*, and in most cases the resultant cluster was reduced to just one stop.

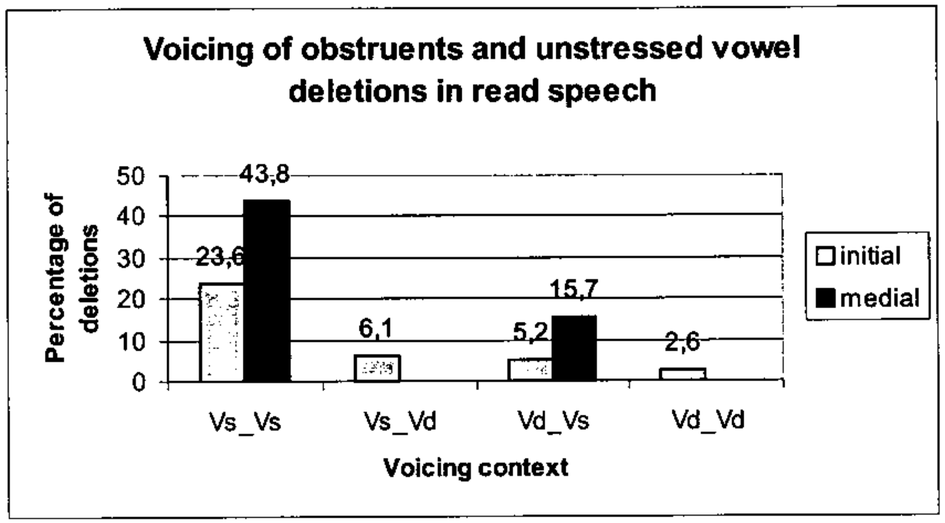

Figure 5. Voicing of obstruents and unstressed vowel deletions in read speech.

Voicing appears to be of less importance in contexts with obstruents and resonants. In all word positions, both in O_R as well as R_O contexts the number of deletions was higher in the environment with voiceless obstruents. The difference in the number of deletions in contexts with voiced obstruents and nasals in contexts with voiceless obstruents and nasals were not, however, as significant as in the environments discussed above. Here, what really matters is the position of the obstruent with respect to the resonant.

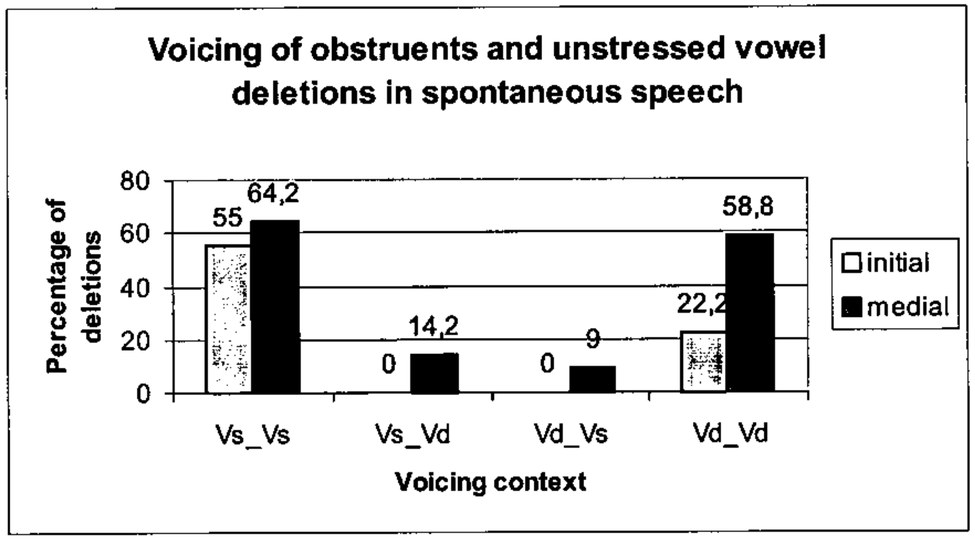

Figure 6. Voicing of obstruents and unstressed vowel deletions in spontaneous speech.

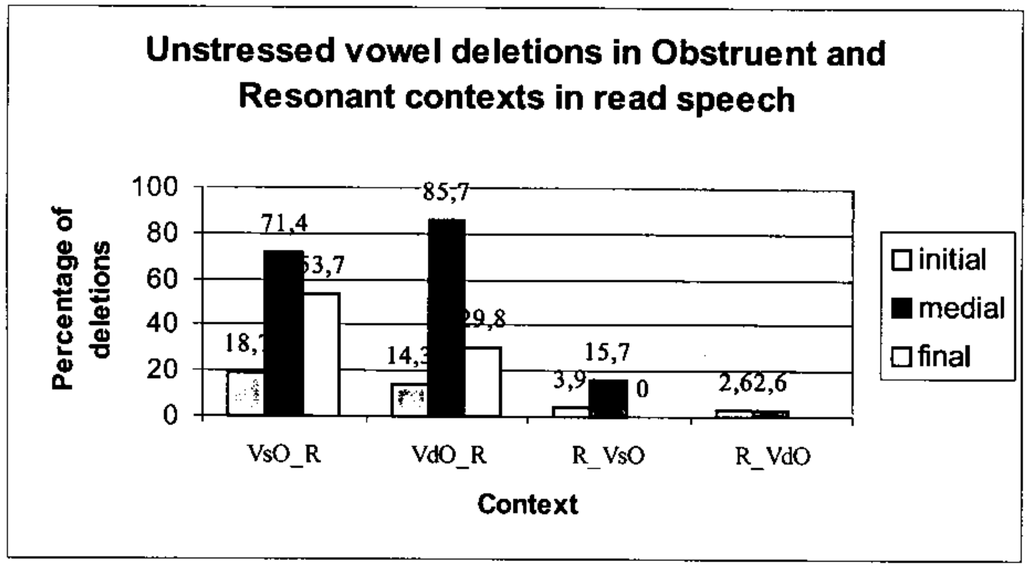

Figure 7. Unstressed vowel deletions in obstruent + resonant contexts in read speech.

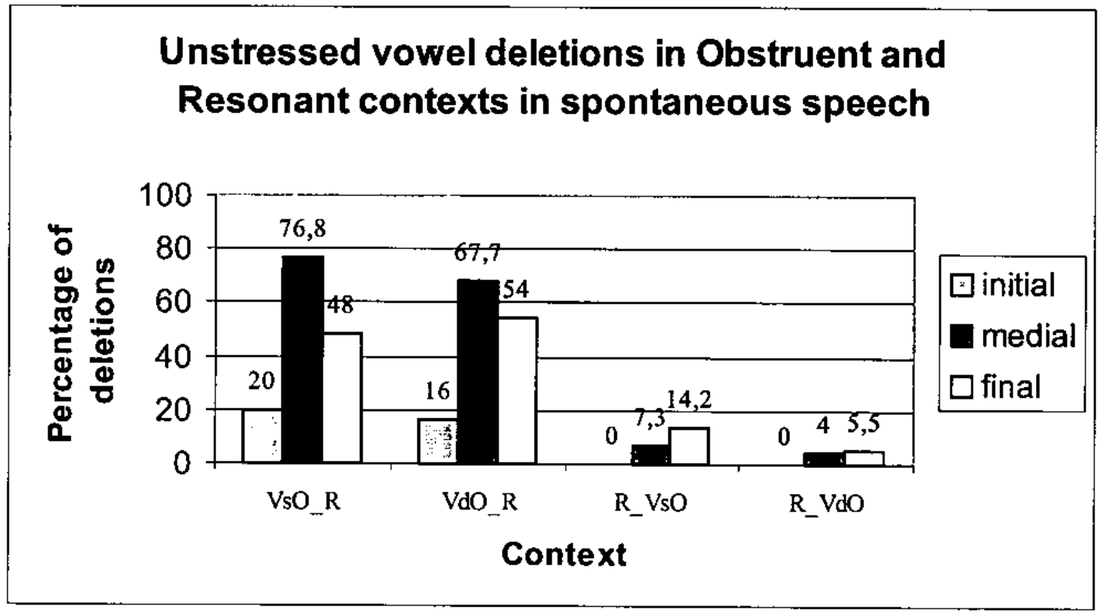

Figure 8. Unstressed vowel deletions in obstruent + resonant contexts in spontaneous speech.

5.4. Other factors

Morphological boundaries block the unstressed vowel deletion process and prevent the emergence of new types of consonant clusters. Syntactic boundaries have the same effect on vowel syncope.

The clusters arising after a schwa is lost do not have adhere to the rules of English consonant clustering, though not to the same extent in all word positions. The highest percentage of clusters that do not obey English phonotactic principles occurred in word-final position, while the lowest in word-medial position. However, clusters in word-medial position are much less restricted than clusters at word margins.

Sonority distance principles do not determine the shapes of the 'new' consonant clusters either. In spontaneous speech in word-initial position 47% of the resultant cluster had rising sonority slopes. In word-final position, on the other hand, only 7.9% of the 'new' clusters had falling sonority slopes.

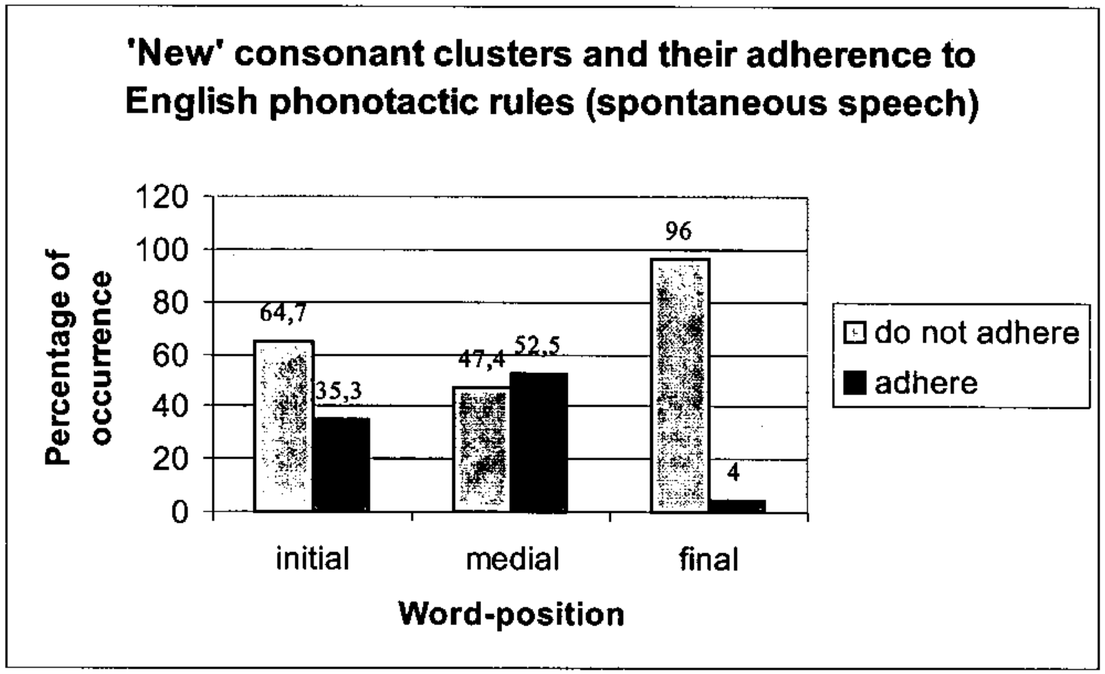

Figure 9. English phonotactic principles and 'new' consonant clusters.

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