

THE EFFECTS OF FOREIGN LANGUAGES PROFICIENCY AND COGNITIVE PROCESSING  
ON TEMPORAL STRUCTURE OF SPEECH

E.L. NOSSENKO

Dept. of English Philology  
Dnepropetrovsk State University  
Dnepropetrovsk, Ukraine, USSR 320625

ABSTRACT

Oral proficiency in a foreign language can be automatically evaluated by using as an interface to computer an electronic speech analyzer designed for detecting unfilled pauses in speech. Proficiency evaluation is based on a psycholinguistic approach to the analysis of cognitive processing in speech through its reflection in the temporal structure of oral discourses.

INTRODUCTION

A number of studies of the temporal structure of oral discourses produced by the speakers in their mother tongue showed the relevance of pauses in spontaneous speech to its cognitive processing [1]. The analysis of the location of these pauses in speech has revealed that they tend to precede relatively unpredictable lexical items [2] and occur with greater than chance frequency at the beginning of phonemic clauses [3]. It has also been shown that pauses are associated with intuitively determined "idea boundaries" in speech text [4]. On the basis of these findings it has been concluded that pauses in spontaneous speech are used for lexical selection, holistic planning of phonemic clauses, suprasegmental ideational planning. Further research of the temporal organization of spontaneous speech showed that cognitive nature of pauses predetermines a universal pattern of their distribution in speech of the native speakers of different languages with "hesitant" and "fluent" phases following each other in cycles [5]. The hesitant phases are characterized by longer and more frequent pauses and it was hypothesized that during these pauses speakers make anticipatory decisions of what to say next. The fluent phases of sequentially alternating cycles reflect the execution of semantic plans formulated in hesitant phases. These phases are not hesitation free

either, but, unlike hesitant phases, in which pauses may be distributed randomly, fluent phases are characterized by the localization of pauses at grammatical boundaries and at the points of lexical selection, where this selection is guided by a preformulated semantic plan. In spite of the predominantly random distribution of pauses in hesitant phases their cognitive nature leaves no doubt. It has been demonstrated experimentally that the mean hesitancy of hesitant phases cannot be diminished without causing a decrement in the quality of the utterance (its ideational content) [6]. Attempts to make speakers consciously modify the number and length of pauses in spontaneous speech under experimental conditions resulted in the substitution of pauses by other hesitation phenomena: "filled pauses" (non-phonological vocalic sequences "er", "hm" and the like), repeats, false starts etc. It proves that pauses are necessary for speech planning and that there are no modifiable noncognitive pauses in spontaneous monologue. This conclusion is also supported by the finding that there is a positive relationship between the duration of speech pauses and difficulty or abstractness of experimental tasks involving speech production [7]. As F. Goldman-Eisler demonstrated, oral descriptions of concrete events (cartoon-stories) are accompanied by shorter pauses than the formulation of their meaning. As a result of the above reviewed studies it became clear that pauses in speech can be regarded as manifestation of the more general blocking of activity, which occurs when organisms are confronted with situations of uncertainty, i.e. when selection of the next step requires an act of choice. When a person speaks his mother tongue, the situations of uncertainty arise mainly on the ideational level of speech production. The speaker of a foreign language, whose vocabulary diversity is naturally much more limited than that of the native speaker and who, unlike the native speaker, doesn't feel the so called "transition probabilities", i.e. words combinability

rules, is expected to pause longer at the points of lexical selection. For him the syntactical structuring of speech also remains for a long time a conscious time-consuming act of recollecting appropriate grammar rules. Therefore his total pause time in speech will include not only the time, necessary for semantic planning, but that, required for lexical selection and grammatical processing of speech, i.e. for fulfilling the operations, which are performed by native speakers to a great extent automatically. In addition to the above formulated assumptions we also claim that the degree of continuity of speech utterance as measured by lengths of phrases pronounced without hesitation pauses (i.e. pauses, exceeding in length 250 ms) is positively related to the level of foreign languages proficiency. The higher is the level of oral proficiency in a foreign language the less frequently the speaker has to interrupt his speech by pauses and thus the higher is the degree of continuity of his speech utterance. This claim is based on the following data. While the difference of level of verbal planning in spontaneous speech of the native speakers of a language, as exemplified, for instance, by the description of concrete events and the formulation of their meaning, is clearly reflected in the length of pauses, it is not reflected in the degree of continuity of speech utterance as measured by lengths of phrases, uninterrupted by pauses [7]. This experimental finding made it possible to conclude that phrase length is an indicator of how automatic the utterance of speech sequence has become and to which extent its production ceased to be a conscious effort. The importance of this observation for the solution of the task of automatic objective evaluation of oral proficiency in a foreign language cannot be overestimated. It is just the degree, to which speech utterance in a foreign language gradually ceases to be a conscious effort, that we are after, when trying to evaluate the progress, made by the learner in the process of mastering a foreign language.

HYPOTHESES

1. Since all pauses displayed in spontaneous monologues of the native speakers of a language are of cognitive nature, i.e. necessary for speech planning (except, perhaps, brief pauses at grammatical junctures), their length can be regarded as reflecting the degree of conscious efforts on the part of the speakers in the process of speech generation.

2. Since the difference in levels of verbal planning in spontaneous speech of the native speakers of a language is clearly reflected in the length of pauses and not reflected in the degree of continuity of speech utterance as measured by lengths of phrases uninterrupted by pauses, the latter can be regarded as indicating habit strength entering into production of speech.

3. Since different levels of foreign languages proficiency involve either essentially automatic or mainly cognitive lexico-grammatical processing of oral discourses, temporal patterns of these discourses will also differ.

EXPERIMENT

The hypotheses were tested by comparing temporal structures of spontaneous and preliminary planned oral discourses produced by speakers with different levels of foreign languages proficiency. The experimental procedure involved asking the subjects to speak on a suggested topic first spontaneously and then after preliminary preparation. The speakers were not restricted in time and speech was a monologue. The subjects were chosen in such a way as to form distinctly different proficiency groups (foreign languages instructors - university students majoring in a foreign language - university students doing a foreign language on a non-professional level). Tape-recorded speech was subjected to computer analysis through an interface designed to classify as "pauses" interruptions of the vocal utterance of not less than 250 ms. Breaks less than 250 ms were not counted and were included into vocalization time. The choice of 250 ms time interval as a border-line between pause/non-pause sequences was predetermined by earlier observations, reported by F. Goldman-Eisler in her above-reviewed papers, that pauses longer than 250 ms cannot occur within a word boundary without violating its integrity as a speech unit. Temporal structure of oral discourses recorded in the process of the experiment was described in the following terms:

- mean phonation time/pause time ratio;
- mean phonation time/frequency of pauses ratio;
- percentage of pauses exceeding 1000 ms (number of pauses exceeding 1000ms/number of all pauses in speech);
- mean phonation time/pause time ratio variance (per cycles of 15 s).

Mean phonation time/pause time ratio was chosen as an indicator of the degree of hesitancy in speech. It was expected to be the measure of conscious efforts on the part of the speaker related to se-

mantic planning of speech and to its syntactical structuring (if the latter is not automatized). Mean phonation time/frequency of pauses denoted the continuity of speech utterance, or the mean length of a word sequence, uttered continuously (without pauses equal to or exceeding 250 ms). This was expected to indicate habit strength, entering into production of speech. Percentage of long pauses (exceeding 1000 ms) was expected to be an additional measure of difficulties, experienced by speakers in the process of encoding. These difficulties were believed to be of linguistic rather than extralinguistic nature, since mean pause length in spontaneous speech of the native speakers of a language rarely exceeds 800 ms if they do not experience anxiety or emotional stress [8]. Mean phonation time/pause time ratio variance was chosen to designate sequential temporal patterning of speech. The higher variance was alleged to be an indicator of spontaneity of speech and the lower - of its previous preparation. The interval of 15 s was chosen not randomly, but on the basis of the observation that "hesitant" and "fluent" phases in spontaneous speech make cycles lasting approximately for 10-20 s.

#### RESULTS

Oral discourses of the speakers, included into a high-level-of-foreign languages proficiency group, appeared to be characterized by the highest mean phonation time/pause time ratio; longest continuity of speech utterance and lowest percentage of pauses, exceeding 1000 ms, as compared with the corresponding data for other groups. High level of foreign languages proficiency also finds reflection in a distinct sequential temporal patterning of spontaneous discourses and in a more even distribution of pauses/phonation ratio throughout a preliminary planned discourse. The lower is the level of foreign-languages proficiency, the more deteriorated is sequential temporal patterning of spontaneous speech, the lower is a mean phonation time/pause time ratio, the shorter are phrases, sandwiched between pauses, the higher is the percentage of long pauses in speech. The analysis of visual transformations of oral speech synchronized with the verbal content of the records showed that the lowest level of foreign languages proficiency is associated with the incidence of hesitation pauses within the boundaries of phonemic clauses not only in hesitant phases, but in what is expected to be a "fluent" phase. Pauses of the same duration at grammatical junctures, found in

the speech of the subjects with higher level of oral proficiency, are less detrimental to the textual cohesion of speech. The gain in fluency of preliminary planned speech, as compared with spontaneous one, is also characteristic of the level of foreign languages proficiency. The more pronounced is the difference in temporal structures of spontaneous and preliminary planned discourses, the higher is foreign languages proficiency. It is worthwhile mentioning that in the preliminary planned (thought over) speech of the foreign language learners, who have not yet achieved a sufficiently high degree of proficiency, the duration of hesitation pauses may decrease in the "hesitant" phases, during which the speakers make decisions of the "w h a t -to- say" type, while in the "fluent" phases pauses remain fairly long. The thing is the speakers with low degree of foreign languages proficiency cannot perform lexicogrammatical processing of their oral discourses automatically enough. That is why the variance of the mean duration of hesitation pauses in their speech is less pronounced than in the speech of the learners with higher degree of foreign languages proficiency. The above described data revealed a statistically significant difference in the temporal structures of oral discourses, produced by the speakers with considerable difference in foreign languages proficiency. It is evident that foreign languages instructors have undoubtedly better command of the language, they teach, than the students, who are being taught, particularly those, who do not major in a foreign language and who take it as a minor subject. Will temporal structures of oral discourses differ significantly if the levels of foreign languages proficiency of the speakers are not as strikingly different, as in the case referred to above? To answer this question we have carried out an additional experiment. This time the subjects were university applicants, seeking admission to the foreign languages division of the University. Their proficiency in a foreign language was naturally not known beforehand and had to be evaluated on the basis of the results of computer-assisted language testing. Tests were designed to evaluate reading comprehension, grammatical competence and diversity of the active vocabulary of the prospective students. Those of them, who were admitted to the university on the basis of the results of entrance examinations, were later on subjected to another foreign languages proficiency testing, which involved listening comprehension tests and computer-assisted analysis of the temporal structure of oral discourses of the subjects.

In accordance with the results of proficiency testing the subjects were split into three proficiency groups: "A", "B" and "C". The subjects, included into group "A" (50 persons), fulfilled 92% of the total number of examination assignments correctly. Those, included into group "B" (also 50 persons), scored lower. The average percentage of correct answers in this group was equal to 77%. The subjects, who made up group "C" (50 persons), managed to fulfil correctly only 55% of all examination assignments suggested. The difference between the results of group "A" and "B" turned out to be statistically significant at  $p < 0.003$  and of groups "B" and "C" - at  $p < 0.247$ . Similar distribution holds true of each separate type of examination tests. For example, average reading comprehension test scores for the subjects of group "A" were equal to 90.1%, for group "B" - 78% and for group "C" - 47.5%. Average grammatical competence test scores displayed a similar picture with 89.2% of correct answers in group "A", 78.2% - in group "B" and 50.7% - in group "C". The same distribution pattern is also true of vocabulary test scores with 92.2% of correct answers in group "A", 71.6% - in group "B" and 54.8% - in group "C". Auditory comprehension tests also revealed statistically significant difference among the above mentioned proficiency groups. The subjects, who made up group "A", followed 85% of the units of information, conventionally singled out in the text for auditory comprehension, of group "B" - 66.3% and of group "C" - 55.1%. Thus the difference in levels of foreign languages proficiency among the above described groups of subjects left no doubt. When we analyzed the temporal structures of oral discourses, elicited from the same subjects upon their admission to the University, we obtained the following data. Mean phonation time/pause time ratio in spontaneous oral discourses of 50 subjects, included into group "A", appeared to equal 1.34. The subjects, making up group "B", paused longer. Their mean phonation time/pause time ratio turned out to equal only 0.63. Group "C" ranked still lower - with 0.21 mean phonation time/pause time ratio. The continuity of utterance (mean phrase length as measured by phonation time/frequency of pauses ratio) also revealed difference among the three proficiency groups mentioned above. It ranged from 0.73 s for the group "A" subjects to 0.61 s - for group "B" and 0.39 s - for group "C". Average percentage of long pauses (exceeding 1000 ms) in oral discourses of different proficiency groups also appeared to be significantly different: 24.4% - for group "A", 34.7% -

for group "B" and 69.7% - for group "C". It is noteworthy that the corresponding data characterizing the temporal peculiarities of oral speech of the same subjects in their mother tongue revealed practically no difference among the above mentioned three groups of subjects. Suffice it to mention that mean phonation time/pause time ratio in oral discourses of the group "A" subjects appeared to equal 1.98; of group "B" - 1.82; and of group "C" - 1.83. Accordingly the continuity of utterance is equal to 0.84 s - for group "A"; 0.79 s - for group "B"; 0.83 s - for group "C". Percentage of long pauses varies from 18.3 to 18.7 for all experimental groups.

#### CONCLUSION

Temporal structure of oral speech as analyzed in terms of continuity of speech utterance, phonation time/pause time ratio and frequency of pauses of various length is indicative both of the level of foreign languages proficiency, gained by the learner, and of spontaneity of his speech utterance. Since temporal peculiarities of oral speech can be easily subjected to computer analysis the method of foreign languages proficiency evaluation, based on the assessment of temporal structure of oral discourses, appears to be most economic.

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