

LATERALIZATION FOR AUDITORY PERCEPTION OF FOREIGN WORDS

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ABSTRACT

This paper presents the experimental study of cerebral hemispheric engagement in auditory recognition of words depending on a set of linguistic factors. Words were native and foreign to the subjects. Listeners were normal right-handed adults with symmetrical hearing, native speakers of Russian; English was acquired as a second language at school. The stimuli were linguistically balanced lists of natural Russian and English words presented monaurally, white noise being contralateral masking. The data show strong overall left hemispheric advantage. The most significant factor for both hemispheres appeared to be 'frequency of usage' (contrary to 'word length'- characterizing the perception of native words). The second important factor was 'consonant ratio' for the RH and 'word length' for the LH. 'Part of speech' was shown to be of minimal importance for both the hemispheres, 'stress position' -slightly more significant.

1. INTRODUCTION

For decades the left cerebral hemisphere was traditionally described as playing a major role in language faculty of most individuals. The right hemisphere, however, has been lately demonstrated to possess considerable linguistic capabilities. It has been shown in dozens of studies carried out both in neurologic and psychiatric patients as well as in normal subjects via special techniques like dichotic, monaural and tachistoscopic stimulation and all kinds of functional brain

mapping. Recent neuropsychological data, however, demonstrate contradictory character of the state of the art, partly because of the methods and models that are difficult to compare. The last few years of research in functional cerebral asymmetry has brought a reconsideration of a number of crucial issues. The full range of data, therefore, should be discussed in the new perspective as well as further studies based on routine experimental paradigms do not seem to be promising, if the question of 'what kind of asymmetry is really being studied?' is not answered. The role of specific linguistic factors in the lateralization of auditory word processing is not quite evident as well, especially, when the presented words belong to a language not native to the listener. The objective of the research was to reveal hemispheric involvement in auditory perception and recognition of Russian and English words depending on a set of linguistic factors.

2. MATERIALS AND METHODS

2.1. Stimuli and Procedure

The test used monaural stimulation of either the left or the right ear, contralateral ear being masked by white noise. Headphone left- right orientation was switched at random. Initial orientation was alternated across subjects. Every stimulus, therefore, was presented, to the left and to the right ear. The stimuli were linguistically balanced lists of 150 Russian and 136 English words pronounced by native speakers of Russian and of American English and recorded with 3 sec. intervals. Linguistic factors balanced

over the list of stimuli were: 'word length' (in syllables), 'frequency of usage', 'consonant ratio', 'stress position', 'initial sound', and 'part of speech'. Listeners were asked to ignore the competing noise and monitor the stimulus, repeating the word as soon as the decision was made. All instructions were recorded on the stimulus tape. The answers were recorded and subjected to dispersion factor analysis, i.e. revealing the most and the least significant factors, important for correct auditory recognition. Reaction time and the number and the type of error was registered.

To evaluate lateral profile of the subjects a battery of tests was used supported by specially designed software system TOPOS, which is aimed to provide user-friendly interface for all the procedures related to psychophysiological experiments measuring one's left/right lateral profile together with other related data [1]. This software system contains two separate modules. The purpose of the first (TOPOS/1) is to carry out the experiments and gather the results in a database. The second (TOPOS/2) is used to process and interpret the data.

The functionality of the TOPOS/1 program supports:

- Management of the database, containing the respondents' test and personal data.
- Performing a questionnaire measurement of one's hand (eye, ear, leg) preference.
- Performing a drag-and-drop test on arbitrary clusterization of visually presented samples like (lexical, syntactical, metaphorical items, syllogistic reasoning etc.) .

The module TOPOS/2 is built on top of the Arity/Prolog interpreter version 5.1, a set of built-in predicates is enriched by some special routines, implemented in C/C++ and providing such services as mathematical statistics, database access (dBase and Paradox), text mode user interface. To evaluate the experimental data we have developed general and cognitive laterality scales necessary for subsequent interpretation of the results. Each

test item was assigned the value of a weight coefficient. The algorithm of overall estimation of laterality coefficient is proposed using standardization procedure within representative data samples and bringing the raw values to stens.

2.2 Subjects

Listeners were 14 normal adults (7 males, 7 females) with symmetrical hearing for all frequencies (thresholds of 15dB level or better), all native Russian speakers, with English acquired as a second language at school. All the subjects, aged 20 - 50, were right-handers with no family sinistrality, also dextral in other sensory, motor and cognitive dimensions.

3. RESULTS AND DISCUSSION

The data show strong overall left hemispheric advantage. The most significant factor for processing foreign words guided by either the left, or the right hemisphere appeared to be the 'frequency of usage' (contrary to the most significant factor characterizing the perception of words native to the listeners - 'word length'). The second-rank important factor is 'consonant ratio' for the right hemisphere and 'word length' for the left hemisphere. The third-rank significant factors were 'initial sound' and 'consonant ratio' for the left hemisphere, and 'word length' - for the right hemisphere. The forth factor for the right hemisphere and the fifth for the left - was 'stress position'. 'Part of speech' was shown to be a factor of minimal importance for both the hemispheres.

The results of the study offer more evidence of the involvement of both cerebral hemispheres in processing linguistic information in normal subjects. However, the data suggest that specific hemispheric prevalence in the processing is caused by different linguistic factors. Our data confirm the issue that the second

language learned systematically at school is to a great extent lateralized in the left hemisphere[2-6]. The most characteristic feature relevant for foreign words' recognition is the 'frequency of usage' - which is in contrast to 'word length' being most essential for the recognition of native words presented in the same conditions. As most researchers have demonstrated recently there is a lot of factors influencing hemispheric involvement in auditory processing of speech samples. Among them are such as individual psychophysiological and cognitive features, gender, linguistic and cultural background and some others. The importance of specific linguistic factors for cerebral hemispheric roles in speech processing can hardly be overestimated. However, these factors are much less known in this aspect.

4. CONCLUSION

Most important for the lateralization of auditory perception in foreign languages is the style and the level of second language acquisition as well as the types of both languages and the sequence of their acquisition. Our previous data allow to propose that cerebral lateralization of languages in polyglot or bilingual subjects depends on a set of factors: age, modalities and cultural context of acquisition, degree of proficiency in various elements of the language (phonology, syntax, oral comprehension, fluency, etc.). All these and many other heterogeneous factors interact and determine the type of the cerebral specialization. The more 'natural' and early was the way and age of second language acquisition the more right hemispheric is its lateralization. Vice versa: the more 'structural', theoretic, systematic and late in age was the acquisition - the more left hemispheric it is. Of course, the languages themselves are (metaphorically saying) more RH or LH (Japanese or Hebrew vs. English).

However, we know that a second language user has a kind of metalinguistic knowledge and operates with 'interlanguage rules' - at least up to a stage when he could be considered a balanced bilingual. So, as M. Paradis puts it, the difference in lateralization between monolinguals and bilinguals is quantitative, therefore both dichotic and monaural listening are indications of the degree of laterality, and speakers may use RH strategies to compensate their gaps in second -language linguistic competence. Lateralization of linguistic functions may show, among other issues, the hierarchy of the factors needed to make such a compensation satisfactory.

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