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ABSTRACT

Recent research in adult pronunciation of foreign languages has assigned a significant role to affective variables. It has been shown that certain language functions, including many aspects of pronunciation, are handled by the right brain hemisphere. An experiment was conducted to study the extent to which the right hemisphere might be activated during the task of listening to and pronouncing tone language sounds. The strategy employed was to study the effect of the pronunciation task on reaction time to light in the right or left visual field. The subjects, 12 male and 12 female right-handed university students enrolled in an elementary French course, attended three sessions. During the first two sessions they responded to light stimuli and heard and repeated Thai phrases. Reaction times to the stimuli, while listening to or repeating phrases, were measured and recorded. During the third session subjects repeated French sentences and had their eye movements assessed. Analysis of the results shows a correlation between the measure of hemisphere efficiency and approximation of native-like pronunciation. The conclusion is drawn that it is possible to associate "affective variables" with a specific neuroanatomical structure, and that right hemispheric activity will predict the quality of pronunciation in a foreign language. (AMH)

Right "Hemisphericity" and Pronunciation in a Foreign Language

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INTRODUCTION

von Humboldt offered, over 150 years ago, the following most eloquent words: "For in language the individualization within general conformity is so marvelous that we may state with equal correctness that the entire human race possesses but a single language, and each human possesses a particular one!" (von Humboldt, 1830).

Language is a unique phenomenon in the sense that it is both intensely personal, even idiosyncratic in its physical representation, and at the same time species-specific. As such it serves as a bridge between the individual and the species, offering a rare opportunity to study one and extrapolate to the other. Language and speech incorporate in a unique blend, intra- and interpersonal parameters, cognitive and affective aspects of information processing, allowing a view of the total person in a manifestation that lends itself to scientific inquiry.

Language is the vehicle for cognitive processes, for information processing which includes the formulation, the articulation and must, on some level, the conceptualization of affective experiences as well, thus creating a three-channel feedback loop between affect, cognition and available linguistic structures, each channel influencing, shaping, modifying the other.

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If the structure of the native language has an effect on the way we perceive and interpret the world around us, then confrontation with a second language, and its structure may present a conflict with, and a challenge to the native language by offering alternative ways of processing information.

Of all aspects of second language behavior, pronunciation seems to be the most baffling. While it is possible, for most adult learners, to assimilate a new vocabulary, and in an ascending order of difficulty, even the proper use of metaphors, the gender system and the tense system particular to a foreign language, most adult learners can rarely, if ever assimilate native-like pronunciation. They may, as in the case of learners of English, for example, master the stress rules (so particular to this language) yet will be apparently unable to produce truly native-like sounds.

Pronunciation seems to have a natural history of its own. While young children (up to 9-12 years of age) learn foreign languages with relative ease, around puberty their pronunciation skills seem to be dramatically reduced, although general learning capability, such as lexical and grammatical skills are not lost. Beyond this period, as noted above, it is virtually impossible to acquire native-like pronunciation in a foreign language.

Research on factors involved in the acquisition of native-like pronunciation in a second language has focused primarily on the age of the learner. Some investigators attempted to account for the superior performance by children through neurophysiological arguments. This theory, which states that there is a "critical period" for language development which ends at puberty when lateralization of the brain is complete, has not been supported conclusively by empirical evidence.

Beyond the critical period controversy, it appears that relatively little research has been done to determine why some adults develop a better, although not perfect, accent in a second language than others do. Yet, as you're bound to notice, there are real individual differences in the degree to which learners can approximate native-like pronunciation. My colleagues and I at the University of Michigan in our successive publications over the year developed the hypothesis that individual variations in the ability to approximate native-like pronunciation in a foreign language are, in part, determined by certain psychological variables best subsumed under the construct of empathy, or more broadly, that of permeability of ego boundaries. These variables have been investigated in three manifestations: 1) as stable characteristics of adults, 2) as milestones in the growth curve in the course of development, and 3) as experimentally induced behaviors. Our research has led us to assign a significant role to the so-called "affective variable hypothesis" in second language behavior by establishing that variation in a given personality template will have a demonstrable effect on an important facet of second-language behavior. These language behaviors can be predicted and can be experimentally manipulated.

Thus it would appear that personality has an enduring effect on second-language behavior. "Personality" and "affective variables" can of course be conceptualized, and on occasion be described, in neuroanatomical and neurophysiological terms. Speech functions, for example, for approximately 90-99% of right-handed subjects and 70-80% of non-right-handed subjects (left-handed and ambidextrous) are localized primarily within the left hemisphere, whereas other cognitive tasks are handled by the right hemisphere. These include visuospatial analysis, holistic perception of objects and faces,

the copying of figures, emotional behavior and some musical faculties. Additionally, the hemispheres may not only be adapted psychologically, neurologically, and biochemically, to particular kinds of cognition, but individuals may favor the use of one hemisphere over another thus providing a neurophysiological and neuropsychological basis for personality styles.

It has been assumed since Broca's research that language is heavily lateralized in normal right handers, and this view remains accepted to the present. However, studies over the last twenty years on four distinct populations: aphasia due to unilateral brain damage, dominant and non-dominant hemispherectomy cases, commissurotomy patients, and neurologically intact subjects, have revealed significant and specialized linguistic capabilities of the right non-dominant hemisphere.

The trend in recent investigations is to show that these linguistic capabilities are not simply redundant functions of those handled by the left hemisphere if and when the left hemisphere undergoes trauma, but are language characteristics that are handled only (or at least, handled best) by the right hemisphere. Such functions include: articulation, the need for abstract words to complete sentences involving abstract concepts ("extra-ordinary or super language functioning"); lower or prelanguage functioning; speaking in well-known phrases as opposed to step-by-step propositional discourse; certain expressive forms in speech such as singing; steady-state vowel comprehension as opposed to initial-stop consonants, voicing and place; intonation contours, rhythm, and the processing and production of pitch. Understanding and producing emotional qualities in speech have been shown to be disrupted by damage to the right hemisphere homologues of the posterior and anterior speech areas of the left hemisphere. Patients exhibiting signs

of posterior damage are able to impart emotional and expressive qualities to their speech but are unable to understand the significance of these same qualities in the speech of others. Conversely, patients exhibiting the "supra-Sylvian syndrome" (anterior lesion) are able to comprehend but not communicate emotional, expressive features of language. In fact, as reported by Ross and Mesulam "two patients lost the ability to impart affective qualities to their speech following lesions in the right hemisphere. The anatomical organization of the cortical areas subserving affective speech in the right hemisphere seems to be similar to the organization of cortical areas subserving receptive and propositional speech in the left or 'major hemisphere'".

Are then perhaps the "affective variables," discussed earlier, localized in the right hemisphere (for right-handed people)?

In a 1972 study, Bogen coined the expression "hemisphericity" to indicate that there are individual differences in the preferred use of one hemisphere or the other. Smokler and Shevrin, for example after reviewing the literature and conducting their own experiment conclude that one can distinguish between "hysterical style" and "obsessive-compulsive style" subjects based on their hemispheric preference as measured by the Lateral Eye Movement Procedure.

In light of the foregoing it is conceivable that some aspect of right "hemisphericity" may predict in part to better approximation of native-like pronunciation in a foreign language.

METHOD AND PROCEDURE

It is well known that subjects can perform more than one task simultaneously. However, it is equally clear that the performance of a second task can enhance, or interfere with, the level of performance of the first task,

and vice versa. Obviously, if one of the tasks requires the use of mechanisms located in one of the cerebral hemispheres, enhancement of or interference with other tasks may occur, depending on whether the second task makes use of the same mechanisms in the same hemisphere. As an example of enhancement effects, if a subject is carrying out a verbal memory task at the same time as a perceptual task (detection of a small gap in one side of a square) then there is an enhancement of the performance of the perceptual task in the right visual field, that is, the visual field that projects to the hemisphere activated by the verbal task. As an example of a competition effect, if the subject has to balance a dowel in the palm of the right or left hand, the addition of particular verbal tasks can reduce the amount of time that the subject can balance the dowel with the right hand, while left hand performance will remain practically unaffected.

A similar interference effect has been seen in simple reaction time to flashing lights on the left or right of visual fixation. In such studies, it has been seen that the addition of a simultaneous expressive verbal task lengthens reaction times to visual stimuli presented in the right visual field and thus projecting to the left cerebral hemisphere.

Our strategy in the experiment to be described here was to take a concomitant task (listening to and pronouncing tone language sounds) and study its effect on simple reaction times to light in the right or left visual field. The analysis of the results, we hoped, should demonstrate a differential effect depending on the field stimulated, and would therefore indicate the extent to which the right cerebral hemisphere might be activated during the concomitant task.

Subjects. Twelve male and twelve female students at the University of Michigan, enrolled in the French 101-102 sequence were recruited as subjects for the pilot study. The initial assessment of handedness consisted of asking potential subjects which hand they used for throwing a ball. Only those who answered "right" were enlisted in the study. A more objective measure of handedness was later made by means of the Edinburgh Inventory. The subjects were between 18 and 22 years old; they had never received linguistic training, nor had they been to France or studied French previously. They spoke no other language than English and their parents were native speakers of English.

Procedure. Subjects attended three sessions. At the beginning of the first session, they were administered the Handedness Questionnaire and their eye movements were monitored while they were asked questions which required either primarily verbal or primarily spatial analysis. Electro-oculography (EOG) was used for determining eye position.

In the second part of the first test session, subjects made manual (button-push) responses to the onset of a 100 msec. light stimulus presented 10 degrees to the left or right of a central fixation spot. In all cases, subjects used their right (dominant) hand. At the beginning and end of the test session, subjects made simple reaction times to these visual stimuli without a concomitant secondary task. After the first simple reaction time measure, subjects responded to the visual stimuli while simultaneously hearing and repeating phrases that they heard over a loudspeaker located directly ahead. The phrases were either Thai (a language chosen because of its dependence on tone patterns and thus its probable involvement of right hemisphere receptive and expressive mechanisms) or nonsense words (English-

sounding and spoken in a monotone, expected to cause relatively little involvement of right hemisphere mechanisms). The phrases were presented in blocks of 55 (five practice and 50 test) with half of each block consisting of right visual field stimuli and the other half of left visual field stimuli. The order of left and right presentations was pseudorandom (Gellerman Series). The order of blocks was A B B A (e.g., Thai-nonsense-nonsense-Thai) for half the subjects during the first session and B A A B for the other half. At the second session (on a different day) the subjects received the order that had not been used on day one. Reaction times from the onset of light to the manual response (while listening to or repeating the phrases) were measured in milliseconds and recorded. Trials on which the eyes were not centered were excluded and replaced at the end.

Late in the French 102 term, subjects attended the third session during which they recorded the twenty French sentences of a French pronunciation test, the so-called FPT (Guiora et al., 1981). (A test we have used in previous studies). Subjects heard a female native French speaker pronounce each sentence once, with a lag period during which the repetition by subjects was recorded. A two-track recording was made, with the stimuli on one track and the subject's repetitions on the other. Pronunciation accuracy was scored by three linguistically trained native French-speaking judges. Prior to completing the French pronunciation task, subjects were administered another lateral eye movement questionnaire using a slightly different procedure to see whether that might yield a positive result. Whereas in the former case, subjects looked into a blank space while answering the questions, on this occasion the subjects sat opposite the investigator and were asked the question only when they had established eye contact. Direction of eye movement was assessed by the investigator on the basis of the first movement

occurring after the completion of the question and prior to or during the subject's answer.

The subjects' pronunciation of the Thai stimuli was recorded and the accuracy of pronunciation was judged by two Thai-speaking, linguistically trained judges.

RESULTS

Lateral eye movements. Since half of the questions in the lateral eye movement tasks were of a spatial nature and half were of a verbal nature, one might expect the lateral eye movement to be, on average, to the left on one half the trial and to the right on the other half of the trials. In both versions of the lateral eye movement task, there was considerable variation from subject to subject in this regard. The range of left movements in the first version was from 0% to 100%; in the second version it was from 12% to 100%. The lateral eye movement scores for the two tasks do not correlate with each other (correlation coefficient = + 0.112); nor do the lateral eye movement scores correlate significantly with the French pronunciation score for each subject (first task correlation = 0.159; second task correlation = 0.299.

This lack of significant correlation between lateral eye movement and French pronunciation suggests that the direction that a person looks when answering questions is not related to the processes that determine whether a subject's pronunciation of a foreign language will be accurate or inaccurate. However, since the results of lateral eye movement studies have been widely criticized, and the possible underlying mechanisms are still controversial, we cannot conclude that this result shows that "hemispheric preference" does

not differentiate between subjects who pronounce French well and those who pronounce it poorly.

Reaction Time Findings. Two experimenters ran the subjects in this study. One of them presented the visual stimuli while the subjects were listening to the word that they would have to pronounce. The other presented the stimulus after the subjects began their repetition or during the final planning stage of verbal expression. For this reason, we have divided the subjects into two groups for an analysis of the reaction time in the two visual fields as influenced by the concomitant tasks (Thai or nonsense English). The subjects that responded to the light while listening to the verbal stimulus were more influenced by the concomitant task (reaction times longer as compared to simple reaction times in the absence of a second task: $p < 0.02$). These same subjects tended to be slower in responding to left visual field stimuli as contrasted with the subjects that responded to the light while pronouncing the verbal stimulus; the latter tended to be slower in responding to the light in the right visual field as compared to the left visual field ($p < 0.04$). This implies that the relative contributions of the left and right halves of the brain are related to whether the person is listening to speech or producing it. Such a result is consistent with previous concomitant task studies (Kinsbourne, 1970; Kinsbourne and Cook, 1971; Rizzolatti et al., in preparation).

Now, when the variable of French pronunciation ability is applied to these groups, a very striking relationship is observed, especially for the group that responded while reproducing the Thai stimuli.

There is a significant correlation (correlation = $-.627$; $p < 0.05$) between the scores on the French pronunciation test and the speed of responding to the left visual field light while reproducing the Thai stimuli. No

other correlations between experimental condition and performance on the French pronunciation test were statistically significant. There was, however, a tendency for a correlation in the same direction even for the subjects who were listening to the Thai phrases while responding to the left visual field light (correlation -.429; n.s.).

The negative correlations in these cases are an indication of either facilitation or reduced inter-task competition during the concomitant tasks (listening or responding) with the reproduction task having a statistically significant effect.

DISCUSSION

A correlation was thus found, as predicted, between a measure of hemispheric efficiency and approximation of native-like pronunciation, yielding an effect that accounts for 20 to 40% of the variance. It is thus possible to associate "affective variables" with a specific neuroanatomical structure. These findings, if upheld in future studies, are of some consequence.

Looking at the correlation between what we choose to call, in deference to parsimony, right "hemisphericity" (thus taking no position as to whether we are talking about right hemispheric preference or simply more effective right hemispheric function) and pronunciation of a foreign language, one can place the following construction on the effect found: right hemispheric activity as measured by its effect on simple responses to visual stimuli, under conditions apparently activating the foreign pronunciation apparatus (in this case the Thai Test) will predict to the quality of pronunciation in a foreign language (in this case French).

One consequence of this finding of course, is additional and strong support for our affective variables-in-pronunciation theory; this time

however the support coming without recourse to mediating psychological constructs; there seems to be a direct connection between a measurable language behavior (pronunciation) and the implicated neuroanatomical structure, with cumulative evidence from diverse sources pointing to this structure as the site of the so-called affective parameter.

Beyond a general support for the affective variables-in-pronunciation theory, the fact that right hemispheric activity correlates with pronunciation gives rise to interesting speculations. It has been our contention all these years that a degree of openness, empathy, or more precisely permeability of language ego boundaries will, in part, determine how far can a person approximate native-like pronunciation in a foreign language. It would seem that right hemispheric activity might very well be the neurophysiological substrate underlying this psychological construct. Clearly, the evidence presented here is not sufficient to affirm this connection, but certainly warrants further research, and before everything else replication preferably by others of the research reported here.

On a practical level, one consequence of our findings would be the availability of a linguistic tool (i.e., a pronunciation test) for the study of certain right hemispheric functions. The increasing implication of the right hemisphere in certain forms of aphasias and agnosias, psychiatric syndromes, integration of emotional and conceptual thinking, and learning disorders suggests the importance of developing an instrument that will make possible the objective, non-intrusive and relatively precise measurement of right hemispheric contribution to cognition on a standardized scale useful for research and clinical purposes. On the other hand, for the applied linguist or language teacher, our simple, fully instrumented and objective

interference measure can be a useful tool in predicting foreign language pronunciation, that is to the tune of 20 to 40% of the variance. But then, as I so often say, truth in science is rarely more than accounting for a portion of the variance, and in the behavioral sciences 20 to 40% is not bad at all.