ABOUT THE JAPANESE BRAIN: EVALUATING THE TSUNODA METHOD

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ABSTRACT

In this paper I will describe and evaluate the Tsunoda Method, a procedure for determining hemispheric dominance of speech and nonspeech stimuli. Tsunoda contends that Japanese process sounds in the brain differently from non-Japanese. I will show that Tsunoda's research should be regarded with skepticism until more sophisticated procedures of studying neurological systems are developed and corroborate Tsunoda's findings. In addition I will suggest that even if there is validity to the Tsunoda hypothesis, this alone cannot account for unique qualities of Japanese culture.

INTRODUCTION

In this paper I will describe and evaluate the research of Tadanobu Tsunoda, an audiologist at the University of Tokyo Medical and Dental School. I will discuss specifically his thesis which claims that Japanese process stimuli in the brain differently from non-Japanese, and that this processing accounts for the unique nature of Japanese culture, viz., Japanese reverence of nature; unique nature of the Japanese language; ability of Japanese to adopt, adapt, and integrate foreign ideas into their culture; emotional preoccupation of the Japanese; and the illogical (by Western standards) nature of Japanese thinking.

The Tsunoda Method

Tsunoda (1975:153-4) constructed a Delayed Auditory Feedback (DAF) device in order to test for hemispheric dominance of speech and nonspeech stimuli. The test requires the subject to rhythmically tap a key (resembling a telegraph key) which is connected to an electronic switch that controls the conduction of stimuli to headphones the subject is wearing. As the subject taps the rhythmic pattern, synchronous sounds (the stimulus being tested) are heard simultaneously in both ears. After the tapping pattern is firmly established, the synchronous auditory feedback mechanism is switched to a delayed mechanism, in which the stimulus is delayed in one ear (0.2 sec.). Prior studies have shown that DAF stimuli result in disruption of motor performance, i.e., changes in tapping pattern or speed of tapping (Chase, et al., 1961; Ruhm and Cooper, 1962).

In his study of 92 Japanese subjects, Tsunoda (1975) tested cerebral dominance for the steady state vowel sounds /a/ and /u/ and a 1 KHz pure tone. The subjects were presented these stimuli (each sound separately) binaurally through the DAF apparatus. First the sounds were kept constant at 40 decibels and were synchronous with the tapping pattern (xx xxxx xx xxxx) followed by a switch over to the DAF, first in the right ear, then in the left. The delayed tone was first presented at 5 decibels and was increased gradually until the tapping pattern was disrupted. The least number of decibels needed to cause disruption in the tapping pattern Tsunoda called the *tapping threshold*. If, for instance, the tapping threshold for the delayed stimulus in the right ear was found to be 55 decibels, and the left ear, 75 decibels, the difference (20 decibels) would represent the functional difference between the left and right hemispheres. The right ear/left hemisphere would be dominant since stimuli to the left hemisphere facilitated disruption of the motor task at a lower decibel level than the left ear/right hemisphere. For the 92 subjects the functional difference dominance pattern for each was plotted.

Tsunoda (1975:156) found that in 79.3% of Japanese subjects, cerebral dominance in decibels for vowel sounds and nonverbal sounds were symmetrically distributed. That is to say, dominance for vowel sounds was found in the dominant verbal hemisphere (left hemisphere for most subjects, but Tsunoda reports individuals with the normal reverse pattern) and dominance for the pure tone in the lesser verbal hemisphere (right hemisphere). If a subject showed left ear dominance of 10 decibels for the pure tone, then he would show a 10 decibel dominance in the right ear for the vowel sound /a/ or /u/. In every case the Japanese subjects showed dominance for vowel sounds and nonverbal sounds in opposite hemispheres or showed no dominance at all for one or both stimuli.

In a previous study (1971), Tsunoda, emplying the DAF method to 12 non-Japanese subjects in Tokyo (6 French, 5 American, 1 Austrian) found that in every case the vowel sound /a/ and the pure tone were processed in the lesser verbal hemisphere (9 subjects normal, 3 subjects normal reverse). Where Japanese subjects were found to process vowels as language, non-Japanese subjects processed them as noise. This implies that there may be differences in cerebral dominance patterns between Japanese and non-Japanese.

In yet another study, Tsunoda (1978:59) confirmed differences in cerebral dominance patterns between Japanese and non-Japanese. He tested 25 subjects from a variety of Indo-European language groups, including Italians, Australians, and one from Bangladesh. All subjects perceived both the /a/ sound and the pure tone in the lesser verbal hemisphere.

To find out if these differences were due to racial characteristics, Tsunoda tested cerebral dominance for the vowel sound /a/ and 1 KHz pure tone in nine second generation Japanese from Brazil, Peru, and the United States (Tsunoda, 1973). Subjects spoke English, Spanish, or Portuguese as a first language. In all cases except one, subjects showed Western dominance patterns. The one exception, it was found, had learned Japanese as a first language while in Brazil until the age of 10 and had even had pronounciation difficulties in Portuguese, supporting Tsunoda's hypothesis that peculiarities of the Japanese language rather than genetic factors contribute to different cerebral dominance patterns.

Evaluating the Method

Before further investigating the claims that Tsunoda makes about cerebral dominance patterns in Japanese versus non-Japanese, I will evaluate the method he uses to collect his data. Since he bases the whole of his hypothesis on data collected by means of the DAF apparatus, a deeper view of this method seems in order.

Tsunoda (1975:154) claims that the DAF method is a variation of a dichotic listening device used to create dichotic competition between ears and thus, hemispheres. The procedure of dichotic listening was perfected by Kimura (1961), who found that studies in functional asymmetry of the brain could be done by presenting different stimuli (in this case digits) simultaneously to each ear and have the subjects recall the stimuli in any order. Subjects have shown to have a right ear advantage (left hemisphere) for digits (verbal) (Kimura, 1967) and a left ear advantage for melodies (Kimura, 1964).

Kimura (1967:170-1) argues that asymmetries in dichotic listening are a result of lateralized inputs. In other words, suppression of the left ear connections to the left hemisphere occurs when the right ear is simultaneously stimulated. This process she calls *central occlusion*.

Though Tsunoda (1975:154) claims to be creating "competition" with a delayed stimulus to one ear, the fact that two different stimuli are not presented simultaneously to each ear would not allow for central occlusion to take place. Though this does not invalidate Tsunoda's method, he should not be at liberty to draw dichotic listening research to support his hypothesis since the crucial "competition" aspect is deleted from his approach.

Shankweiler and Studdert-Kennedy (1967), using the dichotic listening technique, presented subjects with CVC and steady state vowel stimuli. Although the study showed a definite right ear advantage for CVC stimuli, an ear advantage for the vowel stimuli was inconclusive. The authors postulated that because steady state vowels could be either perceived as language or music, it is not surprising that statistically there is no ear advantage for vowel stimuli. If this is true, then how was Tsunoda able to show that non-Japanese in every case processed the vowels as music? If dichotic listening is a valid test and the DAF test is valid, how can one account for the disparity?

Moreover, O'Malley has attacked Tsunoda on the grounds that the DAF key-tapping task presupposes that language processors in the left hemisphere are affected by a delay of an incoming signal, if the signal is speech-like (1978:128-9). Chase, et al. (1961) have shown that a delayed stimulus need not be acoustic to cause motor disruption. Even a tactile stimulus immediately following the speech stimulus would cause disruption of the motor task. Tsunoda also assumes, according to O'Malley, that there is a specialized cortical processing center for nonspeech stimuli, for which empirical support is not available.

Given what is known about neurology today, it is difficult to prove or disprove hypotheses about cortical processing on the basis of empirical evidence. Although O'Malley's arguments do not disprove Tsunoda's theory, in their duplication of Tsunoda's DAF experiment, Cooper and O'Malley (1975) found no difference in motor disruption of subjects given delayed pure tone and vowel stimuli. Assuming that their 24 subjects were Occidental (they do not state specificially), this would be incongruous with Tsunoda's findings.

Furthermore, Bever (1976) has shown that latency to respond with the right hand when a language stimulus is heard in the right ear is shorter than when it is heard in the left ear. If this is true for nonspeech stimuli heard in the left ear, then whichever hand the subject uses to perform the tapping task might affect the measure of motor disruption. Because a substantial number of subjects in Tsunoda's studies exhibited normal reverse patterns, it is conceivable that measurement of motor disruption was not consistent throughout.

Another weak point in Tsunoda's research lies in the sample of subjects he selected. Although he seems to have studied a substantial number of Japanese (92), the number of non-Japanese he has studied has been few. In his 1971 study of 12 non-Japanese, all were residents of Tokyo and half had some knowledge of Japanese. It is difficult to make generalizations based on this very small sample. In a later study (1978:59) of 25 foreigners who spoke Indo-European languages, he selected only one representative of Indic languages (Bengali) from which he generalized about all Indo-European languages.

The Unique Japanese Language

Based on his studies with Japanese and non-Japanese, Tsunoda postulates that peculiarities in the Japanese language cause differences in cerebral dominance patterns between Japanese and non-Japanese (particularly Westerners). He goes on to specify this peculiarity in depth (Tsunoda, 1978: 65-8). Since vowels are perceived by Japanese as language and are subsquently processed in the dominant verbal hemisphere, and Westerners process vowels as noise in the lesser verbal hemisphere, Tsunoda claims that the vowels of Japanese are unique. The five Japanese vowels /a/, /i/, /u/, /e/, and /o/ are peculiar in that they, by themselves, have meaning, or are words in themselves: /a/ (mute, ah!), /i/ (stomach, medicine), /u/ (comorant), /e/ (picture, food, handle), and /o/ (tail) (Tsunoda, 1975:169). Combinations of these vowels also make up other words: /ai/ (love), /au/ (to meet), /ao/ (blue), /iu/ (to speak), /ie/ (house), /ue/ (up), /oi/ (hey!, nephew), and /ou/ (to follow). Because of these vowel-words, according to Tsunoda, Japanese naturally process vowels in the dominant verbal hemisphere.

The proposition that Japanese has unique vowels is shaky at best. Even in English there are words consisting only of single vowels or diphthongs. Consider the following: *I, a, ah, owe, ow, oh, ugh, aye, eye, eh,* and *awe*. Study of the frequency of vowel-word use in English will probably show greater usage than the vowel-words of Japanese. Looking at Spanish, a language whose vowel system is much closer to Japanese than English (at least on the surface), the vowel-words *ha, he, y,* and *hay*, appear frequently as connectives and auxiliaries. These examples from English and Spanish give some cause for questioning Tsunoda's claiming the Japanese vowel system and usage to be unique.

That the Japanese language differs from other languages by its vowel system seems hardly a case for proving the uniqueness of the language, especially since what are indeed unique about the language, intonation pattern and socio-linguistic aspects, are not included in Tsunoda's theory. This would suggest that perhaps the theory requires further study and some modification.

Nature-Loving Japanese

Tsunoda (1978:73-83) claims that Japanese perceive insect and animal sounds in the dominant verbal hemisphere. In contrast, he says Westerners perceive these sounds in the lesser verbal hemisphere. He tested this by taking portions of sounds of live insect recordings and made from them steady state sounds which were then used as stimuli for the DAF apparatus. In the same manner as with vowel and pure tone stimuli, subjects performed keytapping. Subjects were not told the content of the recording, nor were they able to distinguish the sounds as animal or insect. All Japanese subjects indicated perception of the sounds in the dominant verbal hemisphere, whereas all Westerners perceived them in the lesser verbal hemisphere (Table 1). Of course, one might question the validity of this test because the insect sounds were purposely abstracted from nature for it.

Table 1: Cerebral Dominance and Perception of Natural Sounds

subjects	dominant verbal hemisphere	lesser verbal hemisphere
14 Japanese	cricket, cicada, lion, cat, bird, frog, cow; sighing, crying, humming, singing, laughing	applause helicopter orchestra
4 French 2 American 2 Spanish 2 Swedish 1 Austrian 1 Dutch 1 Norweigian 1 Finn		cricket, cicada, lion, cat, bird, frog, cow; sighing, crying, humming, singing, laughing; applause, heli-copter, orchestra
7 second and third genera-tion Japanese from Peru, Brazil and the U.S.		cricket, cicada, lion, cat, bird, frog, cow; sighing, crying, humming, singing, laughing; applause, heli-copter, orchestra

Whereas Japanese perceive natural sounds as "language," according to Tsunoda, Westerners perceive them as "noise." To find out whether this phenomenon was racial or cultural, Tsunoda also tested second and third generation Japanese from various linguistic backgrounds and found them to exhibit Western patterns. The implications (which Tsunoda states quite clearly) for this study is supposed to be that cultural Japanese have a closer communion with nature. One must remember, however, that Tsunoda did not test any other Asians, not to mention Africans, and that the total number of subjects tested was surprisingly small.

It should also be noted that more than 50% of the Japanese population live in urban centers and rarely come into contact with the insects and animals tested (lions in Japan?). Tsunoda says that because nature sounds resemble vowels, they are perceived in the dominant verbal hemisphere. This negates the whole nature-perception distinction if one considers the population distribution, among other factors.

Integrating Foreign Ideas

Tsunoda continued in his pursuit to prove Japanese have cerebral dominance patterns determined by their culture. In another study using the DAF apparatus with Japanese and non-Japanese, Tsunoda tested perception of Japanese and Western music (Tsunoda, 1978:116). To place these sounds on the DAF recorder, he selected the steady state "A" note played by each instrument. Subjects were not told what stimuli they would be listening to, nor were they able to distinguish which instruments were being played. In all 12 cases, Japanese subjects perceived Japanese instruments in the dominant verbal hemisphere and Western instruments in the lesser verbal hemisphere. Westerners (15 subjects including those of Japanese ancestry), in contrast, perceived all musical instruments in the lesser verbal hemisphere (Table 2).

Table 2: Cerebral Dominance and Perception of Music

subjects	dominant verbal hemisphere	lesser verbal hemisphere
12 Japanese	shoo (reed instr.) koto shamisen shinobue shakuhachi biwa koyumi	recorder organ cello violin woodwinds strings flute
15 Europeans and Americans including those of Japanese ancestry		shoo recorder koto organ shamisen cello shinobue violin shakuhachi flute biwa woodwinds koyumi strings

The results of this experiment are held to imply that the lesser verbal hemisphere in Japanese takes on the role of adopting new ideas from other cultures. This, of course would explain the Japanese tendency to adopt, adapt and integrate new ideas into their culture, according to Tsunoda.

Another point to consider in hemisphere dominance is that Bever (1974) has shown that the musically experienced listener processes music in the left hemisphere while the naive listener processes it in the right hemisphere. Conceivably, Japanese could be more schooled in traditional Japanese music and would therefore show left hemispheric dominance, while the Westerner would tend to be more naive and consequently process these stimuli in the right hemisphere. But are Western or other children not also exposed to the music of their native culture at an early age? This needs to be considered and studied.

Illogical, Emotional Japanese

Looking at the total model of the Japanese versus the non-Japanese brain, one sees a marked difference in hemispheric processing. Tsunoda (1978) contends that because the dominant verbal hemisphere has taken on the functions of the other hemisphere, the Japanese brain has the *logos* and *pathos* in the one dominant hemisphere, while the Westerner follows the pattern of analytical logical processing in the dominant verbal hemisphere and holistic, affective processing in the lesser verbal hemisphere (Figure 1).

If this were indeed the case, it would be no wonder why it is sometimes said Japanese appear illogical and preoccupied with emotion. The fact that Japanese process certain stimuli in the dominant verbal hemisphere is no indication that they are illogical and emotional. In fact, it might more easily be argued that Japanese are "unemotional" because they

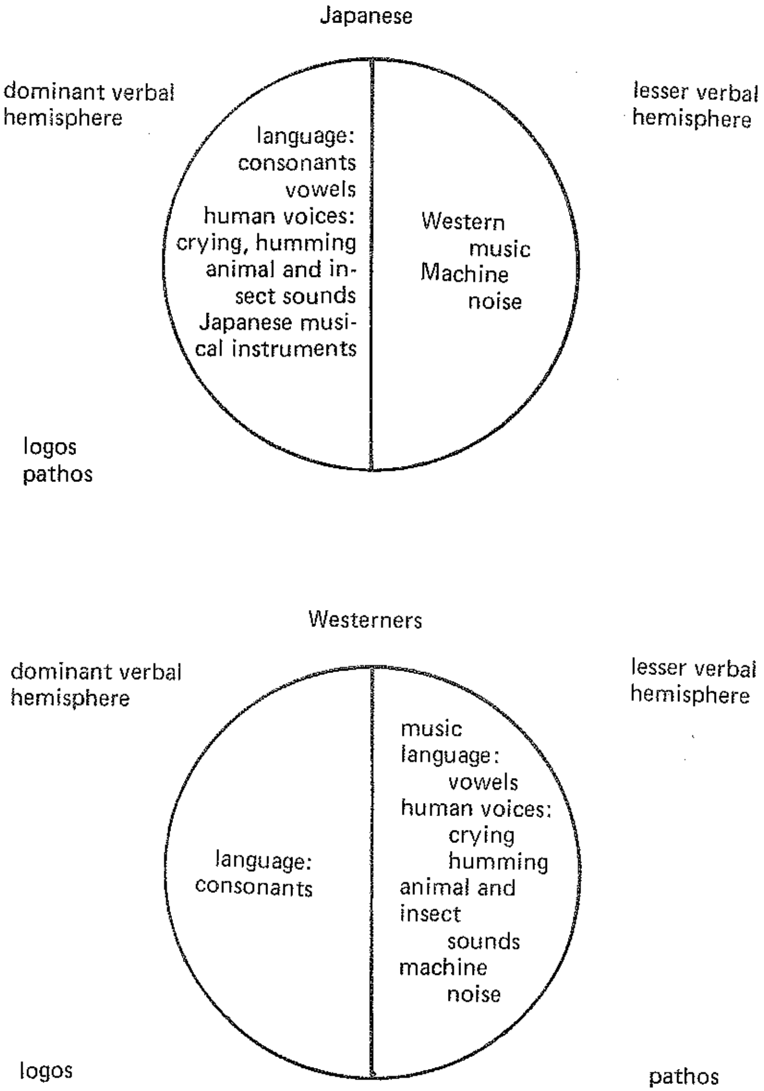

Figure 1: Difference of Cerebral Sound Perception Patterns

perceive these stimuli in the analytical hemisphere. Additional research would be necessary to validate any of these claims.

Conclusion

In this paper I have described and evaluated the Tsunoda Method of determining hemispheric dominance for speech and nonspeech stimuli in Japanese and non-Japanese. Although I have made only an attempt to objectively analyze his methodology, I feel new research into neurological systems may allow us to discard the theory totally. Until then, however, readers need be skeptical of the implications of Tsunoda's research. Even if it is true that Japanese do perceive vowel sounds in opposite hemispheres from their Western counterparts, nothing in the Tsunoda Method explains that this results in a typified Japanese character that reveres nature, has successfully adopted ideas from other cultures, and appears illogical and emotional by Western standards. Further analysis of the Tsunoda Method should deal with duplication of his experiments by neutral experimentors, as well as corroboration with other methods.

REFERENCES

Bever, Thomas G. and Chiarello, Robert J. Cerebral dominance in musicians and nonmusicians. *Science*, 1974, *185*, 537-539.

________, Hurtig, Richard R. and Handel, Ann B. Analytic processing elicits right ear superiority in monaurally presented speech. *Neuropsychologia*, 1976, *14*, 175-181.

Chase, R., Sutton, S. and Rapin, I. Sensory feedback influences on motor performance. *Journal of Auditory Research*, 1961, *3*, 212-223.

Cooper, William A. and O'Malley, Honor. Effects of dichotically presented simultaneous synchronous and delayed auditory feedback on key tapping performance. *Cortex*, 1975, *11*, 206-216.

Kimura, Doreen. Cerebral dominance and the perception of verbal stimuli. *Canadian Journal of Psychology*, 1961, *15*, 3, 166-171.

__________. Left-right differences in the perception of melodies. *Quarterly Journal of Experimental Psychology*, 1964, *16*, 355-358.

__________. Functional asymmetry of the brain in dichotic listening. *Cortex*, 1967, *3*, 163-178.

O'Malley, Honor. Assumptions underlying the delayed auditory feedback task in the study of ear advantage. *Brain and Language*, 1978, *5*, 127-135.

Ruhm, H. and Cooper, W.A. Low sensation level effects in pure tone delayed auditory feedback. *Journal of Speech and Hearing Research*, 1962, *5*, 185-193.

Shankweiler, Donald, and Studdert-Kennedy, Michael. Identification of consonants and vowels presented to left and right ears. *Quarterly Journal of Experimental Psychology*, 1967, *19*, 59-63.

Tsunoda, Tadanobu. The difference of the cerebral dominance of vowel sounds among different languages. *Journal of Auditory Research*, 1971, *11*, 305-314.

__________. The characteristic pattern of cerebral dominance for vowel sounds found in Japanese second-generations. *Medicine and Biology*, 1973, *87*, 29-34.

__________. Functional differences between right and left cerebral hemispheres detected by the key-tapping method. *Brain and Language*, 1975, 2, 152-170.

__________. *Nihonjin no No* (The Japanese Brain). Tokyo: Daishukan Shoten, 1978.