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Dichotic Digit Test in Intracranial Lesions

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Abstract

A Dichotic Digit Test (DDT) was administered on 6 subjects with confirmed intracranial lesions. Two subjects had lesion limited to one hemisphere, one had left deep subcortical lesion, yet another had bilateral cortical lesion while the remaining two subjects had brainstem lesions. The results indicated abnormal performance on the task. The test appears to be a sensitive clinical tool for evaluating the central auditory nervous system.

Key words -
Dichotic test,
Auditory processing,
Brain stem,
Cortical,
Speech discrimination

Kimura [1], [2] was among the first to use the dichotic digit test (DDT), in patients with brain lesions although it was earlier described by Broadbent [3]. Her patient population consisted of subjects with unilateral temporal lobe ablations. The results showed a reduced score in the ear contralateral to the side of ablation. She also found that the deficits were minimal when Heschl's gyrus was spared, but became significant when it was excised. Much of the research [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21] that followed Kimura's work corroborated her original findings.

Stephens et al [13] observed abnormal DDT results in almost one half of their subjects with brainstem lesions. Musiek [18] reported similar results in his subjects with cortical and brainstem lesions. No such reports are available in the Indian context. This may be due to the non availability of the tests, the clinical set-up and the infrastructure needed for such studies.

It is the purpose of this paper to describe the DDT constructed by the senior author [22] and to report the test results on six subjects with intracranial lesions.

Methods

Subjects

The clinical group consisted of six subjects with surgically, and/or neurologically confirmed intracranial lesions. There were four adult males (S1, S2, S3, and S4) with a mean age of 40 years

(range -35 to 45 years) and two children (S5 and S6-one male and one female) with a mean age of 11 years (range -10 to 12 years).

Subject S1 had a lesion in the left temporoparrietal region with squashing of the ipsilateral ventricle following a vascular insult, Subject S2 had malignant astrocytoma of grade III in the right temporal area, Subject S3 had left subcortical lesion (deep ganglionic infarct) and Subject S4 had bilateral infarcts involving left temporal and right parietal lobes with greater involvement of the left hemisphere. Among the two children, one child (S5) had right intrinsic pontine lesion and the other S6 encompassed right lateral and medial lemniscus with pressure on inferior and possibly on superior colliculus bilaterally and extended to right thalamus.

All these subjects had essentially normal hearing, i.e., 25 dB HL or better bilaterally (re: ANSI 1969) for octave frequencies from 250 Hz to 8 kHz. Speech discrimination scores were also within normal limits, i.e., 90% or better bilaterally. They all had adequate language functions as certified by a qualified speech-language pathologist.

Based on the normative data of the test (normals matched to age, language, education etc.), a 90% score was considered as the cut off point which is slightly greater than two standard deviations below the mean. This criterion was applied for both adults and children. This is because of the "near ceiling" performance of the normal subjects. In other words, scores below 90% were considered abnormal.

Description of the test

The dichotic digit tests were developed in English, Kannada, Hindi and Telugu. The test consists of naturally spoken digits from 1 to 10 excluding 2, 4 and 9 in Kannada, 7 in English and 1, 8 and 9 in Telugu. In Hindi, all the digits from 1 to 10 were included. This was to keep the number of syllables in each version balanced. The digits were taped with the help of a native speaker of the language in question. The stimuli were recorded so that two digits on one channel of the tape recorder were aligned with two digits on the other channel by using a timing cue to the talker. Onset of the digits were within 70 m.secs which is in accordance with the onset time critical for maintaining dichotic perception [23].

The intensity levels (by VU meter readings) of individual items were within ± 4 dB for intra and inter channel comparisons. The inter digit interval was approximately 0.5 secs and the inter trial interval was examiner controlled [18].

Test example: Right ear 1 3

Left ear 6 8

There were 20 pairs in Kannada resulting in 40 test items for each ear and 25 pairs in English, Telugu and Hindi resulting in 50 test items for each ear. There were also a minimum of 5 practice items for each version to familiarize the subjects with the task. The tests were later transformed on to a Maxell XL II S-60 cassette from the master type (Ampex). The digits in each language were computer generated and selected at random.

Procedure

The cassettes were played through Phillips cassette deck (F6121) and the signal was fed through the

speech circuit of a clinical audiometer (MAICO MA 24B). A calibrated signal of 1 kHz pure tone prerecorded on the test tape, prior to the stimulus material, was used to calibrate the audiometer speech gain control.

Only Kannada and Telugu version of the tests were used in the present study keeping in mind the linguistic background of the subjects. The stimuli were presented at 50dB SL (ref: SRT) in a sound treated room. The response strategy was free recall and the number of correctly reported digits for each ear was counted and a percentage score derived.

Results

The results of the dichotic digits test in subjects with cortical and sub-cortical lesions are presented in Table I, whereas the results on the two subjects with brainstem lesions are presented in Table II.

Table I - Results of the dichotic digit test in subjects with cortical and sub-cortical lesions

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Table II - Results of dichotic digit test in brainstem lesions

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The results were considered abnormal when the scores fell below the criterion established based on the normative data i.e., a score of 90%.

The results of the present study showed that subject S1 with left temporal lesion had total extinction of the responses in the right ear (0%) but with a normal performance in the left ear (98%). Subject S2 with right temporal lesion (astrocytoma grade III) showed poor performance in the left ear (7.5%) with normal performance in the right ear (100%). Subject S3 with subcortical lesion (deep ganglionic infarct in the left side) revealed bilateral ear deficits (right -56% and left-66%). The other subject S4 with left temporoparietal and right parietal infarcts also showed bilateral ear suppression (right 10% and left 45%).

Among subjects with brainstem lesions, Subject S5 with right intrinsic pontine lesion showed poor performance in the right ear (2.5%) an normal performance in the left ear (92.5%). On the other hand, Subject S6 with predominant involvement of the upper brainstem on the right side, performed poorly in the left ear (5%) and normally in the right ear (92.5%).

Discussion

Subjects with intracranial lesions in this study showed poor performance on DDT which is an agreement with results of previous research [1], [18], [19]. A significantly poorer performance in the ear contralateral to the lesioned hemisphere was evident in two subjects (S1& S2). This contralateral deficit is possibly due to the fact that the ear has more contralateral input to the cortex than ipsilateral. Bilateral suppression of the scores was evident in Subject S3 with sub-cortical lesion (left ganglionic

infarct). This may be due to the deep brain lesion prohibiting the optimum transfer of information from right to left hemisphere which is needed for verbal report of left ear stimuli in a dichotic condition [14]. Subject S5 with bilateral cortical lesions (left temporoparietal and right parietal) had bilaterally depressed scores.

Of the two subjects with brainstem lesions, Subject S5 with right intrinsic pontine lesion had ipsilateral ear deficit (right ear 2.5%) and Subject S6 with super brainstem lesion predominantly involving the right side had contralateral ear suppression (left 2.5%). It appears here that the more rostral the lesion, the greater is the likelihood of the deficit lateralizing to the ear contralateral to the side of lesion.

The dichotic digit test has thus been found to have clinical value in detecting brainstem or cortical dysfunction. However, it does not seem to differentiate between lesions in these two anatomical regions. There is need for accumulating large clinical data to draw any valid conclusion regarding the specificity of the site of lesion.

The ease of administration and scoring make the DDT an ideal item in the central auditory test battery. Also, the test can be applied to a wide range of subjects as it is influenced little by language skills. Since it is a "closed set" test with the digits running through 1 to 10 which are familiar to the majority of the population, it would definitely be a valuable clinical tool for evaluating the central auditory system.

Conclusion

Six subjects with confirmed intracranial lesions were administered dichotic digit test. Three of them had hemispheric lesions, one had subcortical lesion and the remaining had brainstem lesions. The results indicated significantly abnormal performance on the task. The test seems to have clinical value in detecting brainstem or cortical dysfunction, but does not appear to differentiate between these two anatomical sites.

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