MASTER YOUR CONCEPTS IN CENTRAL AUDITORY PROCESSING DISORDERS : A QUESTION BANK

Reg.No.M9807

Independent Project as a part fulfilment of first year M.Sc,
(Speech and Hearing), submitted to the University of Mysore,
Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MYSORE 570 006

MAY 1999

Dedicated
to

The support and inspiration of
my life : Amma and Papa
and
the light of my Hfe:Deepa.

॥ज्ञानं ज्ञेयं परिज्ञाता

त्रिविधा कर्मचोदना

॥करणं कर्म कर्तेति ॥

त्रिविधः कर्मसंग्रहः

...न हि ज्ञानेन सदृशं ॥

पवित्रमिह विद्यते...

"Knowledge, the known and the knower
form the threefold cause of action.
The instrument, the object, and the
agent are the threefold basis of action.
.. Verily there exists nothing in this
world purifying like knowledge . . . . ."

— Bhagavad Gita.

CERTIFICATE

This is to certify that this Independent Project entitled : MASTER YOUR CONCEPTS IN CENTRAL AUDITORY PROCESSING DISORDERS : A QUESTION BANK is the bonafide work in part fulfilment for the degree of Master of science (Speech and Hearing) of the student with Register No.M9807

Mysore
May, 1999

Dr. (Miss) S. Nikam
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CERTIFICATE

This is to certify that this Independent Project entitled : MASTER YOUR CONCEPTS IN CENTRAL AUDITORY PROCESSING DISORDERS : A QUESTION BANK has been prepared under my supervision and guidance.

Mysore
May, 1999

Vanaja C.S.
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DECLARATION

This Independent Project entitled : **MASTER** YOUR CONCEPTS IN CENTRAL AUDITORY PROCESSING DISORDERS : A QUESTION BANK is the result of my own study under the guidance of Ms. Vanaja C.S., Lecturer in Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other diploma or degree.

Mysore
May, 1999

Reg. No.M9807

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INTRODUCTION

Auditory processing is an important but yet somewhat complex aspect of hearing. Auditory Processing in "What we do with what we hear". This implies that auditory processing is the building that we do upon the auditory signal to make the information functionally useful. It involves not simply the perception of sound but more importantly how we clarify, locate, attend, analyze, store and retrieve the information. It has been reported that auditory perception is fundamental to learning language and that auditory processing deficits cause disorders in areas of language, reading and learning (Katz, 1992).

Auditory processing disorders have been difficult to conceptualize both for those who appreciate their importance and even more so for those who are convinced that speech requires little processing to be understood (Katz, 1992). Various tests (both speech and non-speech) have been developed for the identification and diagnosis of central auditory processing disorders. The beginning of central auditory testing can be traced back to 1950s, when researchers first recognized that traditional audiometry, including puretone and speech recognition were not sensitive to auditory problems of patients with central auditory processing disorders.

Bocca et al. (1954) first used monaural distorted speech to assess central auditory functions. They worked under the assumption that the 'psychic' function of hearing is located in the cortex and developed a monaural low redundancy speech tests, that is, low pass filtered speech to detect temporal lobe lesions) Another method used is where the temporal aspects of the speech signal are disrupted or altered. This includes the interrupted, accelerated or compressed speech. Beasely and Maki (1976) have used accelerated or time compressed speech methods for assessment of central auditory nervous system. Bocca (1958), Calearo and Antonelli (1963) were the first to use an interrupted speech test for assessing patients with central auditory processing disorder. Another monaural test which reduces the intrinsic redundancy of the speech message is the speech perception in noise test, given by Sinha (1959).

(Binaural interaction tasks to detect central auditory disorders were introduced in the 1950s. A development in this field was the introduction of masking level difference givey by Licklider and Hirsh (1948), as a clinical test procedure to assess the integrity of the brainstem. Matzker (1959) developed the binaural fusion using speech stimuli.

In early 1970s several researchers began to use temporal ordering or sequencing of non-verbal stimuli in the assessment of the central auditory nervous system. Swisher and Hirsh (1972) used a paradigm where two tones of different pitches were presented with various onset time differences. One of the most popular temporal ordering test is frequency (pitch) pattern sequence test by Pinheiro and Ptacek (1971).

History of the dichotic tests; now widely used on clinical population; can be traced back to 1960s. In 1961, Kimura administered a dichotic digit test where digit triads were presented simultaneously to each ear to a group of patients with unilateral temporal lobe lesions. Katz (1962) introduced a unique modification of this procedure and called it staggered spondaic word test. Musiek (1983) introduced a revised version of the dichotic digit tests where two rather than three digits were presented simultaneously to each ear. In 1968, Willeford developed a competing sentence test. A dichotic consonant - vowel test was introduced into the central auditory assessment area by Berlin et al. (1972). Jerger and Jerger (1974) developed the synthetic sentence identification with ipsilateral or contralateral competing messages. The former being sensitive to low brainstem lesion and the latter to high brainstem and hemispheric lesions.

Electrophysiological tests began to gain prominence by mid 1970s and early 1980s in the field of central auditory assessments. Auditory brainstem evoked responses detect the eighth nerve or brainstem pathology. Investigations are also being carried out to study the sensitivity of the mid latency and late vertex auditory evoked potentials in the detection of lesions of the higher auditory centers.

Thus, a number of tests are available to assess a central auditory processing disorder. The diagnosis of central auditory disorders will ultimately be made by a judicious combination of clinical observation coupled with carefully chosen behavioral test protocols and electrophysiological measures. Clinicians often express confusion in relating central auditory test findings to the myraid of academic, behavioural, communicative problems of the client. They find their work to be useful in aiding children and adults with their problem but they do not understand why their tests are sensitive to those with disorders of reading, spelling, speech and language. Without a reasonable theoretical base, it is difficult to improve the tests and protocols or correlate various tests to arrive at a diagnosis or to design management strategies.

The best way to approach the study of the central auditory nervous system and its audiological evaluation is to develop a good foundation in neuroanatomy, neurophysiology and disorders of central auditory system. This is crucial for interpretation of audiological tests and correlation of audiological findings with pathological findings.

The aim of this question bank is to provide the basic information regarding the central auditory processing and its disorders, the history, developments and modifications of the various tests used to study central auditory disorders, and the recent advances in central auditory testing. It aims at helping the students in the field of speech and hearing and budding audiologists by compiling the information available in literature. It aims at improving their knowledge regarding principles, administration and interpretation of central auditory tests. This question bank can be used by the practicing audiologists to update their knowledge regarding assessment and management of central auditoryprocessing disorders.

NEUROANATOMY AND NEUROPHYSIOLOGY OF CENTRAL AUDITORY NERVOUS SYSTREM

Questions

Ql Fill in the blanks

1. The auditory nerve fiber branches off into two parts. The rostral branch innervates the...... whereas the caudal branch innervates both.... and......
2. The axons of the dorsal cochlear neurons bypass the........ and end in the nuclei of the...... and......
3. .... nuclei receives only ipsilateral input in the central auditory nervous system.
4. In the cochlear nucleus....... frequencies are represented ventrally and anteriorly and........... frequencies more dorsally and posteriorly.
5. The superior olivary complex localizes low frequency signals on the basis of....... disparities and high frequency signals on the........ disparities.
6. In lateral superior olivary,..... stimulation is excitatory in nature whereas..... stimulation in inhibitory in nature.
7. During monaural stimulation, at lateral leminiscus, low frequencies are more..... represented than high frequencies.
8. Puretones excite most neurons in....... and.......
9. Apart from the auditory inputs, the medial geniculate body receives inputs from the...... cortex and.... pathways.
10. The kinocortex is tonotopically organized in the humans with the highest frequencies located .... and lowest frequencies located

11. The auditory areas in the cortex comprises of the................ and......

12. The auditory cortex encompasses a frequency range of one octave in a length of........mm.

13. Threshold of activation of auditory neurons by contralateral stimulation is generally.........dB lower than that for ipsilateral stimulation.

14. The blood supply to the primary auditory area, angular gyrus and supramarginal gyrus is by the..........and........arteries.

15. Interhemispheric connections in the corpus callosum occurs through the ....and ......

16. The fibers that originate at a certain locus in one hemisphere and connect to a similar locus in the opposite hemispheres are called the..........connections.

17. The area in the auditory nervous system which is called the "topography of acoustic space" is the.............

18. Olivo cochlear bundle contributes to the........auditory pathway.

Q2. **Choose the correct answer**

1. Neurons of the anteroventral cochlear nucleus have properties similar to those of the......
   (a) auditory nerve fibers
   (b) superior olivary nucleus
   (c) postero ventral cochlear nucleus
   (d) dorsal cochlear nucleus

2. Lateral superior olivary receives direct inputs from the........
   (a) contralateral and ipsilateral cochlear nucleus
   (b) ipsilateral medial superior olivary
   (c) contralateral medial superior olivary
   (d) auditory nerve

3 Response pattern of the superior olivary nuclei complex are direc function of a.......
(a) binaural intensity difference
(b) monaural time difference
(c) binaural time difference
(d) monaural intensity difference

4. The nuclei of inferior colliculus can control diffuse alerting responses to auditory inputs with the help of.........
(a) lateral leminiscus
(b) medial geniculate body
(c) reticular formation
(d) superior olivary

5. The main artery that supplies blood to the auditory cortex is.....
(a) posterior cerebral artery
(b) middle cerebral artery
(c) basilar artery
(d) anterior cerebral artery

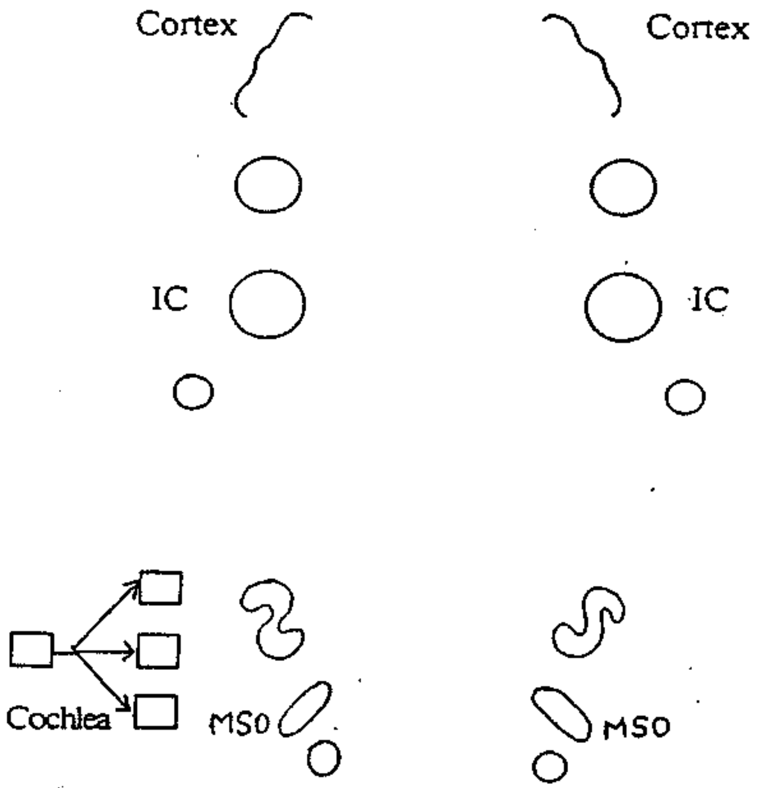
Q3. **Expand the following abbreviations**

(l)AVCN	(2)PYQN	(3)DCN	(4) (N) LL
(5)IC	(6)SC	(7)CPA	(8)AI
(9) All	(10)OCB	(11) CC	(12)TCAP
(13)SOC	(14)MTB	(15)LSO	(16)MSO
(17) MN			

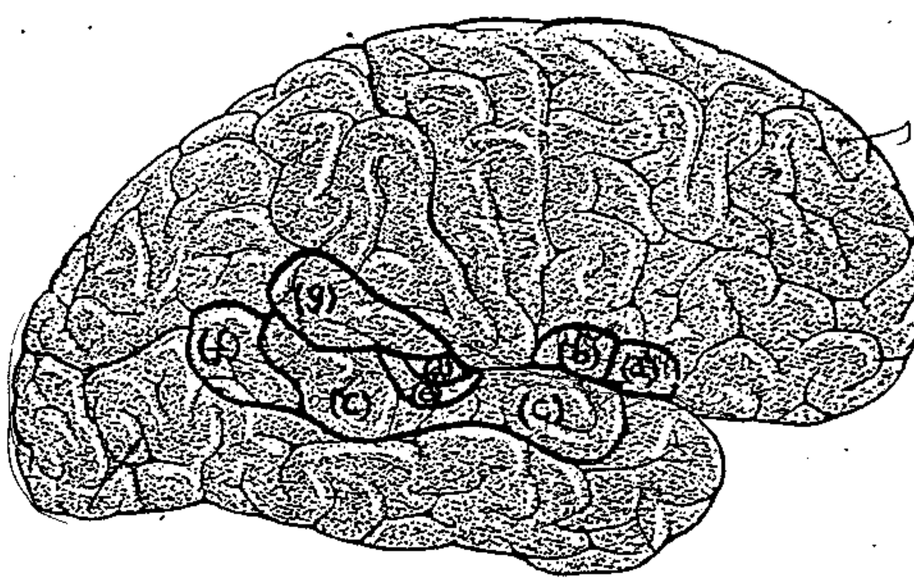
Q4. Know the afferent connections. Complete the following sentences

1. Axons of cochlear nucleus end in -
2. Lateral leminiscus receives fibers from -
3. Contralateral input to inferior colliculus is from -
4. Medial geniculate body receives inputs from -
5. Lateral superior olivary nucleus receives inputs from -

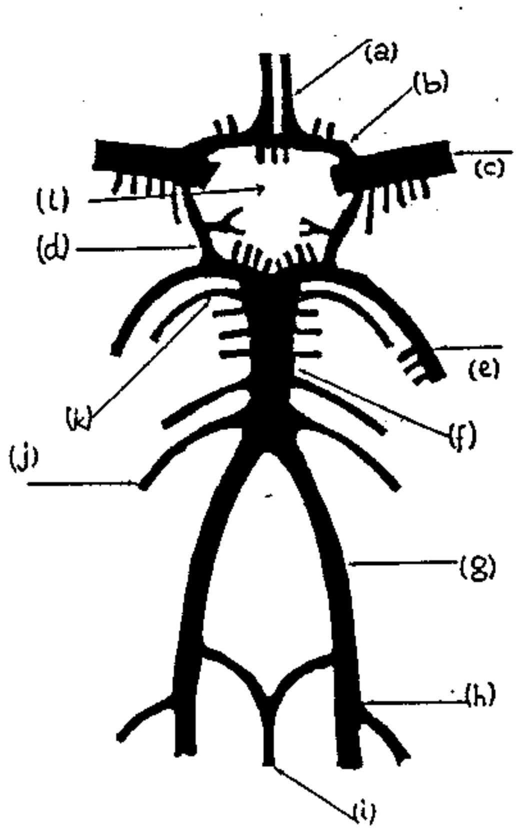
Q5. Draw the afferent connections and name the areas



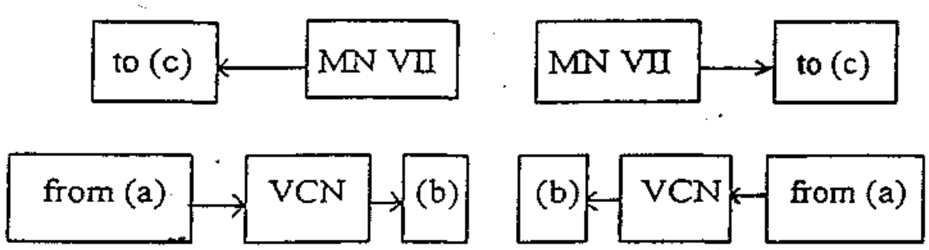
Q6. Name and number the areas



Q7. Label the following arteries supplying the brain



Q8. Complete the acoustic reflex arc connections (ipsilateral and contralateral) and name the areas a, b and c.



Q9. Match, the area with the functions

1.	Dorsal cochlear nucleus	a. Interaural intensity difference and coding of sound in space
2.	Antero ventral cochlear	b. binaural stimulation and nucleus intensity difference
3.	Posteroventral cochlear	c. coordination between nucleus hemispheres.
4.	Lateral superior olivary	d. complex signal analysis, with bands of inhibition, nonmonotonic.
5.	Medial superior olivary	e. interaural time difference and coding of sound in space.
6.	Inferior colliculus	f. on and off effect, interaural intensity and time difference
7.	Medial geniculate body	g. simple tuning curve, monotonic with no bands of inhibition.
8.	Corpus callosum	h. binaural interaction
9.	Dorsal nuclei of lateral leminiscus.	i. monotonic and nonmonotonic, offset and onset, interaural time and intensity difference.
10.	Auditory cortex	j. simple and complex tuning curves.

Q10. Separate the following functions into the right and left hemisphere functions.

1). Processing of speech and language
2) Abstract functions
3). Receptive functions
4) Sequencing (temporal ordering)
5) Analytic functions
6) Active functions
7) Gestalt functions
8) Music
9) Spatial and artistic functions
10) Detailed functions
11) Figure and facial recognition
12) Controlled functions
13) Emotional functions
14) Concrete functions
15) Reading and writing functions
16) General functions.

Answers

Al.

1. Anteroventral cochlear nucleus, postero ventral cochlear nucleus, dorsal cochlear nucleus.

-(Pickles, 1982)

2. Superior olivary nucleus, lateral leminiscus, inferior colliculus

- (Pickles, 1982)

3. Cochlear nucleus

- (Musiek and Baran, 1986 a, b)

4. Low, high

- (Pickles, 1982)

5. Phase, interaural

-(Pickles, 1982)

6. Ipsilateral, contralateral

- (Moller, 1983)

7. Dorsally

- (Aitkin, 1990)

8. Inferior colliculus, cochlear nucleus

-(Aitkin, 1990)

9. Visual, somesthetic

-(Pickles, 1982)

10. Caudomedially, rostro laterally

- (Aitkin, 1990)

11. Superior temporal lobe, inferior posterior frontal lobe, inferior perital lobe

-(Musiek, 1986)

12. 2 mm

- (Musiek, 1986)

13. 5 to 20 dB

- (Musiek, 1986)

14. Medial cerebral artery, posterior parietal artery

- (Musiek, 1986)

15. Anterior commissure and thalamus

- (Musiek, 1986)

16. Homolateral

- (Pickles, 1982)

17. Superior colliculus

-(Pickles, 1982)

18. Efferent

- (Buser and Imbert, 1992)

A2.

(1) - (a) - auditory nerve fibers

- (Pickles, 1982)

(2) - (a) - ipsilateral and contralateral cochlear nucleus

- (Pickles, 1982)

(3) - (c) - binaural time difference

- (Moller, 1983)

(4) - (c) - reticular formation

- (Buser & Imbert, 1992)

(5) - (b) - middle cerebral artery

- (Pickles, 1982)

A3.

(1)	AVCN	-	Anteroventral Cochlear Nucleus
(2)	PVCN	-	Posteroventral Cochlear Nucleus
(3)	DCN	-	Dorsal Cochlear Nucleus
(4)	(N)LL	-	(Nucleus of) Lateral Leminiscus
(5)	IC	-	Inferior Colliculus
(6)	SC	-	Superior Colliculus
(7)	CPA	-	Cerebello Pontine Angle
(9)	AI	-	Primary Auditory Cortex
(9)	AII	-	Secondary Auditory Cortex
(10)	OCB	-	Olivo Cochlear Bundle
(11)	CC	-	Corpus Collosum
(12)	TCAP	-	Transcallosal Auditory Pathways
(13)	SOC	-	Superior Olivary Complex
(14)	MTB	-	Medial Trapezoid Body
(15)	LSO	-	Lateral Superior Olivary
(16)	MSO	-	Medial Superior Olivary
(17)	MN	-	Motor Nucleus

- (Pickles, 1982)

A4.

1. Ipsilateral and contralateral olivary complex, nuclei of lateral leminiscus and inferior colliculus

- (Buser and Imbert, 1992)

2. Superior olivary complex contralateral nuclei of lateral leminiscus contralateral cochlear nucleus and trapezoid body

- (Buser and Imbert, 1992)

3. Bulbar pathways (trapezoid body), some lateral leminisus fibers, opposite inferior colliculus

- (Buser and Imbert, 1992)

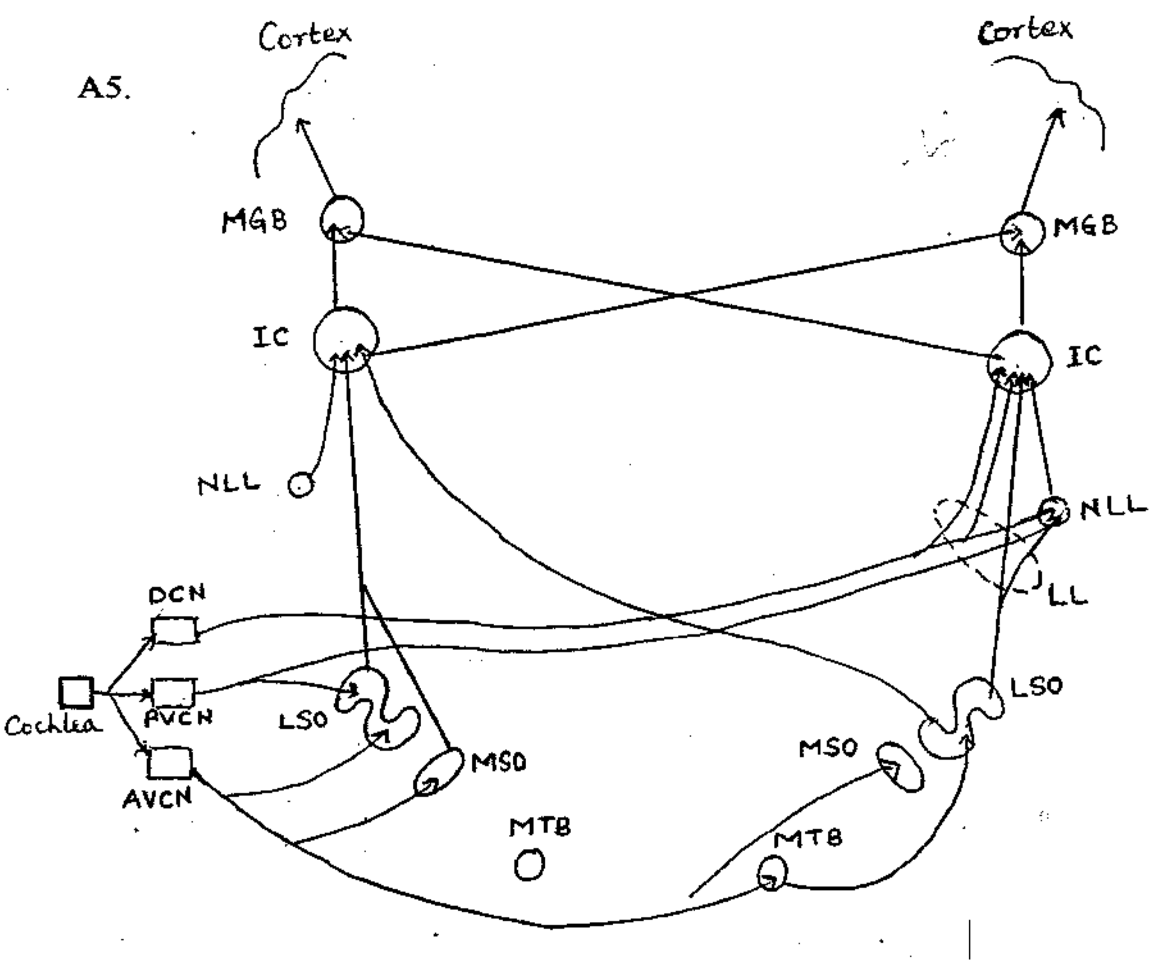
4. Inferior colliculus, superior colliculus, somesthetic system, visual cortex

- (Buser and Imbert, 1992)

5. Ipsilateral and contralateral cochlear nucleus via the medial tapezoid body

-(Pickles, 1982)

A5.



A6.

(a)44 } Broca's area or third inferior frontal convolution
(b)45

(c) 22 - Wernicke's area or first temporal convolution.

(d) 41 - Primary auditory area } Posterior l/3rd of the temporal
(e) 42 - Secondary auditory area } convolution (Heschel's gyms)

(f) 39 - angular gyrus

(g) 40 - supramarginal gyrus

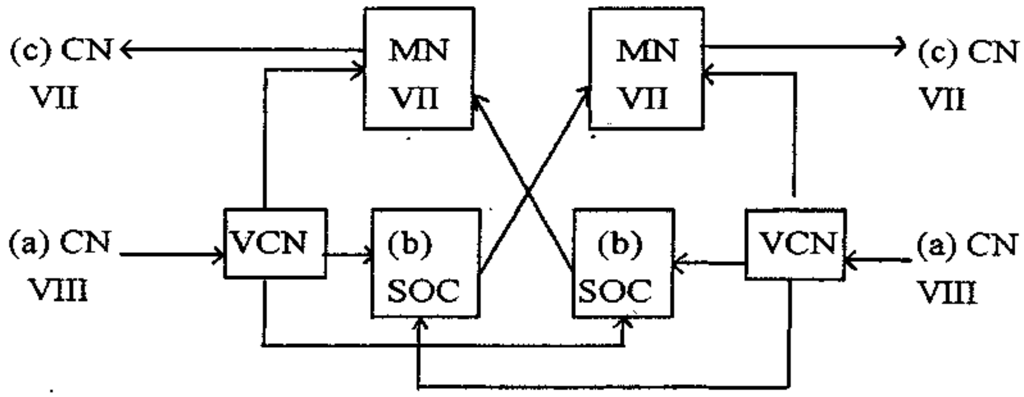
-(Murdoch, 1990)

A7

a) anterior cerebral artery
b) anterior communicating artery
c) middle cerebral artery
d) posterior communicating artery
e) posterior cerebral artery
f) basilar artery
g) vertebral artery
h) posterior inferior cerebellar artery
i) anterior spinal artery
j) anterior inferior cerebellar artery
k) superior cerebellar artery
1) internal carotid.

-(Zemlin, 1988)

A8.



-(Rintelman, 1979)

A9

1. - d	6. - f
2. - g	7. - b
3. - j	8. - c
4. - a	9. - h
5. - e	10. - i

- (Pickles, 1982)

A10.

	Left hemisphere	Right hemisphere
1)	processing of speech and language	(1) music
2)	sequencing (temporal ordering	(2) spatial and artistic functions.
3)	analytic functions	(3) general functions
4)	detailed functions	(4) gestalt functions
5)	reading and writing	(5) figure'and facial recognition
6)	controlled functions	(6) emotional functions
7)	concrete functions	(7) abstract functions
8)	active functions	(8) receptive functions

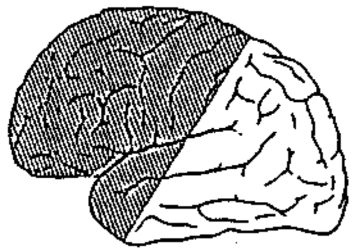
- (Bellis, 1996).

INTRODUCTION TO CENTRAL AUDITORY PROCESSING DISORDERS (CAPD)

Questions :

Q l. Recognize the area affected and term the kind of central auditory processing disorder it would cause. What is the name given by Katz (1992) for the disorders caused by this lesion? What is this model called?

(1)



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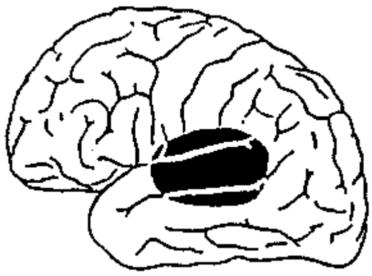

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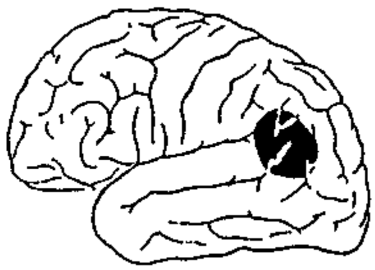

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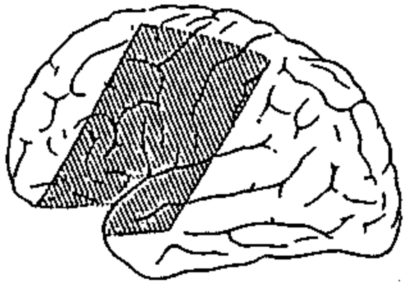
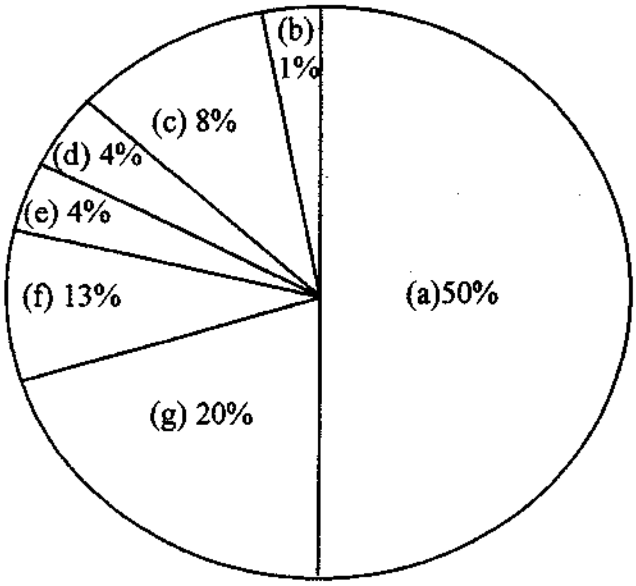


Q2. What is the incidence of different types of central auditory processing disorder in hearing disabled children. Study the figure and insert the following categories in the figure :



1. Normal
2. Tolerance - Fading Memory category
3. Organization category
4. Integration category Type 2
5. Others
6. Decoding category
7. Integration category Type 1

Q3. Match the following site of lesion (A) with the effects on auditory behaviour (B)

Site of lesion (A)	Effects on Auditory Behaviors (B)
1. Unilateral temporal lobe lesion	a) Bilateral deficits on any task that requires interhemispheric integration, left ear deficit on dichotic speech tasks.
2. Bilateral temporal lobe lesion	b) Possible difficulty hearing in noise due to disruption of inhibitory functions
3. Brainstem lesion	c) Contralateral deficit on dichotic listening tasks, impairment of location in contralateral auditory field.
4. Corpus callosum lesion	d) Behavioral indications may be unilateral or bilateral depending on locus and size of lesion, may cause deficits in both acuity and processing.
5. Efferent auditory system lesion	e) Likely to produce abnormal hearing acuity and/or difficulty understanding speech for the ear ipsilateral to the lesion.
6. VIII nerve lesion	f) Possible cortical or "central" deafness.

Q4. Auditory processing involves various processes. Unscramble these words and define or describe them in one sentence.

1. YIRAOTUD SERENAWAS
2. YIRAOTUD TENTOTINA
3. YIRAOTUD NOTINTATE PANS
4. OLIACOZITNA FO USNOD

5. NARTIDOSICIMIN ROF USNOD
6. YIRAOTUD REMYOM
7. YIRAOTUD REYMOM APNS
8. YIRAOTUD GENCBEQSN TD3AYIL
9. YIRAOTUD JOPRICTEN
10. YIRAOTUD TERISONAPA
11. YIRAOTUD DINNLEGB
12. YIRAOTUD REOSLUC
13. ZIRTOTOREINUADIA
14. YIRAOTUD CIPTEROPEN
15. YIRAOTUD NISTSHYSE
16. YIRAOTUD AVLOC-TISACONOSAI
17. YIRAOTUD AVLOC-MACTAOTUTHY
18. YIRAOTUD RETZINTLOLAAI

Q5. Expand the following :

1)CAPD
2) CAD
3) CANS
4)OAD
5) CAP

Q6. Fill in the blanks

1) Central auditory processing disorder in its severe form may manifest itself first and foremost as a......and.....problem in the preschool years.

2) What an audiologist calls a central auditory processing ability is referred to as auditory..........ability by the speech-language pathologist.

3) Central and processing incorporates both........processing, from one level to the next; as well as......processing, simultaneous transmission within a single hemisphere or on both sides.

4) The most common kind of etiology (> 75%) causing central auditory processing disorder in children is......

5) At the cortical level, auditory processing involves the......of neural message.

Q7. Describe the following terms in 2-3 sentences.

1. Intrinsic Central Auditory Nervous System redundancy.
2. Extrinsic redundancy of auditory signals.
3. Obscure auditory dysfunction (OAD)
4. Intra axial tumors
5. Extra axial rumors
6. Bottle neck principle
7. Subtlety principle
8. Central auditory processing disorders.

Q8. What are the auditory, speech and language and behavioural manifestation of children with the following deficits:

a) Decoding deficits
b) Integration deficits
c) Tolerance fading memory deficit
d) Organizational deficits

Q9. List a few causes of central auditory nervous system disorders.

Q10. List 10 auditory complaints reported by patients with central auditory nervous system lesions.

Q11. Here are listed a few subject variables which have to be considered in test selection and in data interpretation. Complete the blanks.

1) D.........and C...........of hearing loss.
2) E.......S.....for puretone thresholds and speech discrimination scores.

3) S........D........scores for undistorted stimuli.
4) A.......of the patient.
5) D.......effects (intoxicants)
6) Cognition : A.........and M.........
7) H.......data
8) R.........ability
9) E.........background
10) L........function
11) F........(physical endurance)

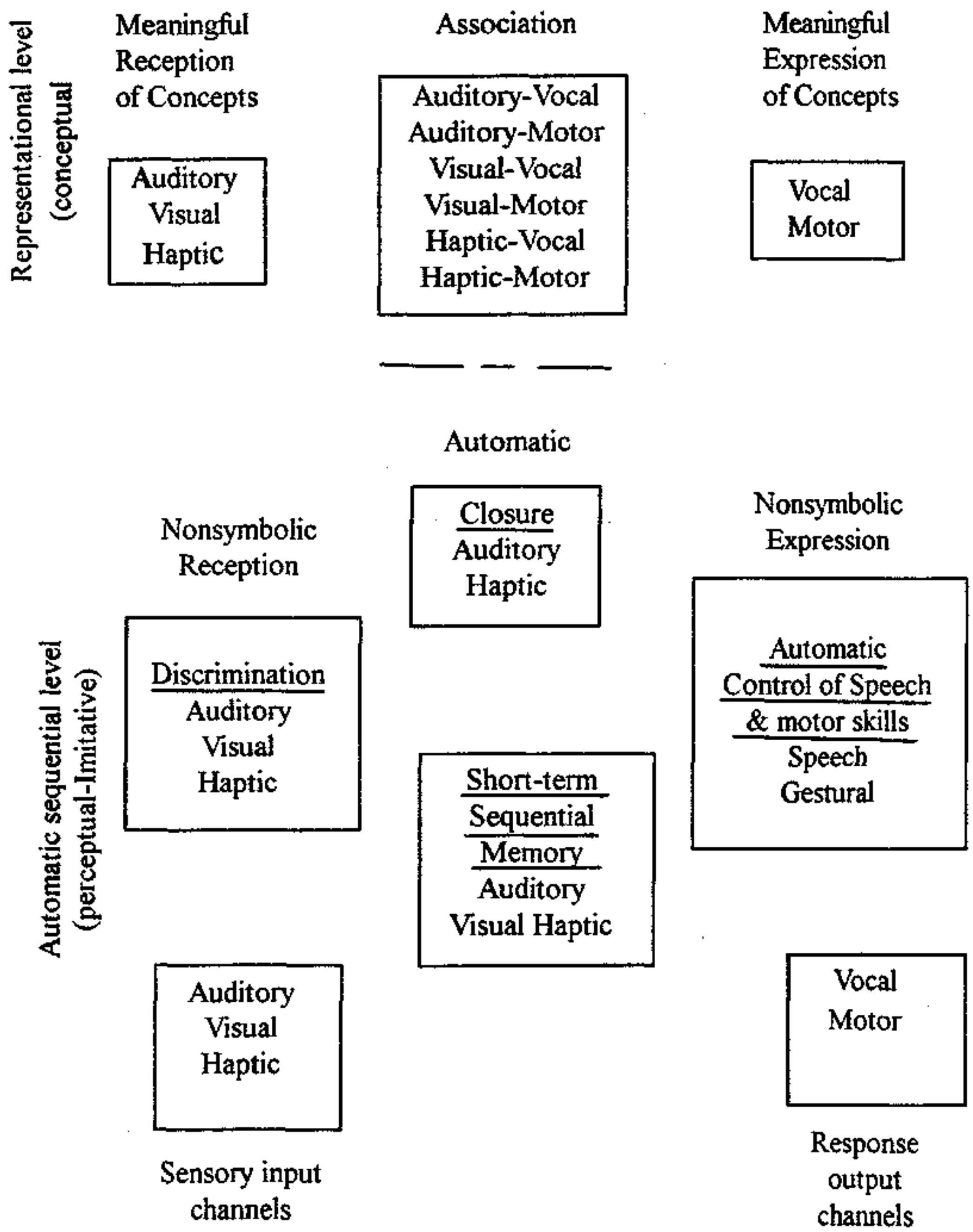
Q12. Brief describ the auditory complaints of patients with following deficits. Name a test to identify this deficit.

1) Auditory closure deficit.
2) Binaural separation and/or integration deficit.
3) Temporal patterning deficit
4) Binaural interaction deficit
5) Delayed neuromaturation.

Q13. List the auditory tasks which increase the auditory processing demands.

Q14) Is there a relationship between auditory processing dysfunction and language development? Study this schematic diagram, complete it by drawing the connection and then answer the question in 2-3 sentences.

P.T.O.


Representational level (conceptual
Meaningful Reception of Concepts
Auditory Visual Haptic
Association
Auditory-Vocal Auditory-Motor Visual-Vocal Visual-Motor Haptic-Vocal Haptic-Motor
Meaningful Expression of Concepts
Vocal Motor
Automatic
Closure Auditory Haptic
Nonsymbolic Reception
Nonsymbolic Expression
Automatic sequential level (perceptual-Imitative)
Discrimination Auditory Visual Haptic
Automatic Control of Speech & motor skills Speech Gestural
Short-term Sequential Memory Auditory Visual Haptic
Auditory Visual Haptic
Vocal Motor
Sensory input channels
Response output channels

(Feedback)

Answers

A1

1) frontal lobe region - Tolerance fading memory (TFM) category
2) posterior temporal region - Decoding category.
3) perito-occipital region - Integration category
4) part of the frontal lobe except the anterior part - Organization category.

This is called Buffalo Model (Katz et al., 1992).

A2)

(a) Decoding Category
(b) Normal
(c) Others
(d) Organization category
(e) Integration category type 2
(f) Integration category type 1
(g) TFM category

- (Katz etal., 1992)

A3) (1)-(c)
(2) - (f)
(3) - (d)
(4) - (a)
(5)-(b)
(6) - (e) - (Bellis, 1996).

A4)

(1) *AUDITORY AWARENESS* - The ability to recognize and respondto the absence or presence of sound.

(2) *A UDITORY ATTENTION* - The task of listening set under signal acceptance.

(3) *AUDITORY ATTENTION SPAN* - The ability to attend selectively for increased lengths of time to a task or series of tasks.

(4) *LOCALIZATION OF SOUND* - The ability to determine the apparent direction and/or distance of a sound source.

(5) *DISCRIMINATION OF SOUND* - The ability to recognize and respond appropriately to similarities and differences in sound.

(6) *A UDITORY MEMORY* - The ability to remember the characteristics of a given sound or series of sounds.

(7) *A UDITORY MEMORY SPAN* - The ability to remember for increasing lengths of time the characteristics of a given sound or series of sound.

(8) *A UDITORY SEQUENCING ABILITY* - The ability to identify a series of sounds in correct respective order.

(9) *A UDITORY PROJECTION* - The ability of the individual to attend to and process sound signals that originate from increasingly greater distances from the listener.

(10) *AUDITORY SEPARATION* - The ability to attend to a primary sound signal in the presence of extraneous (competing) sound stimuli.

(11) *AUDITORY BLENDING* - The ability to combine isolated syllables into words whether or not he has learned to associate the sounds with the corresponding letters.

(12) *AUDITORY CLOSURE* - The ability to recognize and synthesize discrete parts of a sound production into a whole production.

(13) *REAUDITORIZATION*- The unvoiced recollection and 'holding' of a sound production, whether at the gross sound level or at the speech level.

(14) *A UDITORY PERCEPTION* - The ability to receive and understand sounds and words.

(15) *A UDITORY SYNTHESIS* - The ability to combine smoothly all the sounds of syllables or words to make them a whole, or the ability to analyze a word into its separate sounds.

(16) *AUDITORY VOCAL ASSOCIATION*- The ability to draw relationships from what is heard, and then to respond verbally in a meaningful may to these spoken words.

(17) *A UDITORY VOCAL A UTOMATICITY* - The ability to predict future linguistic events from past experience.

(18) *AUDITORYLATERALIZATION*- The ability to determine the apparent direction of a sound either left or right of the frontal - midline - plane of the head.

-(Heasley, 1980)

A5)

1. Central Auditory Processing Disorders
2. Central Auditory Disorder
3. Central Auditory Nervous System
4. Obscure Auditory Dysfunction
5. Central Auditory Processing

A6)

1. Speech, language
2. Perceptual
3. Serial, parallel
4. Glioma
5. Decoding.

-(Katz et al., 1992)

A7)

1. Intrinsic central auditory nervous system redundancy stems from the bilateral representation of each ear, to each side of the brain via the system's multiple network of pathways and crossings, nuclear centers, interact and interhemispheric connections and projections to primary and secondary cortical areas.

-(Katz et al., 1992).

2. Extrinsic redundancy refers to the wealth of information inherent in the speech message. It refers to those aspects of normal speech such as frequency range, tempo, rhythm, duration and length. Also included are, individuals knowledge that a verbal message is going to follow, or at least should follow certain phonologic and synthetical rules.

- (Stevens, 1978)

3. Patients with obscure auditory dysfunction are those who complain primarily about difficulty hearing in noise and have normal audiograms.

- (Baran and Musiek, 1994)

4. They arise within the brain parenchyma from neuroepithelial tissue (dedifferentiation of adult glial or capillary cells).

- (Hall, 1992)

5. They originate from the meningeal coverings of the brain, including the dura, the capsular and grannular elements of the arachnoid, the subarachnoid blood vessels, fibroblasts in pia and from connective tissue in the choroid plexus. They also arise from nerve roots.

- (Hall, 1992)

6. According to this principle, a complex signal such as speech encounters neural congestion at the function of the VIII nerve and brainstem; lesions at these sites have a very deleterious effect on speech recognition scores whereas lesions more peripheral and central to these sites have less deleterious effects on speech recognition scores.

- (Jerger, 1960a).

7. This principle states that the subtlety of the auditory signs of central auditory dysfunction increases as the level of the lesion becomes more rostral. Thus, at peripheral levels, a lesion may be detected by simple tests such as the audiogram.

-(Jerger, 1960a).

8. It is a term used to describe a deficit in the perception or complete analysis of auditory information due to central auditory nervous system dysfunction, usually at the level of the cerebral cortex.

- (Jerger, Martin & Jerger, 1987)

A8.

(Refer page no. 33a)

A9. Main causes of central auditory nervous system disorders are :

1) Space occupying lesions : gliomas, schwannoma, meningiomas, cerebello pontine angle tumors, etc.

2) Vascular disturbances - congenital malformations, arteriosclerosis, transient ischemic attacks, aneurysms, basilar artery insufficiency, etc.

3) Toxicity - due to lead, mercury, alcohol, viruses.

4) Infections diseases - syphilis

5) Demyelinating/degenerative diseases - multiple sclerosis, Charcot Marie Tooth Syndrome, Alzheimers and Picks diseases

6. Trauma - Fracture and penetrating wounds.

-(Spitzer, 1983)

A10)

1. Difficulty hearing in highly reverberant rooms or in the presence of background noise.
2. Subjective tinnitus (generally localized at the midline or in the head).
3. Auditory hallucinations or unusual auditory sensations.
4. Difficulty following complex auditory directions.
5. Poor utilizations of prosodic cues.
6. Auditory inattentiveness and high distractibility.
7. Difficulty localizing sound sources.
8. Marked decrease in appreciation of music.
9. Unilateral hearing loss.
10. Poor speech discrimination.

- (Hall, 1979).

A11)

1. Degree, configuration
2. Ear symmetry
3. Speech discrimination
4. Age
5. Drug
6. Attention, Memory
7. Historical
8. Reading

9. Educational
10. Linguistic
11. Fatiguability

- (Spitzer, 1989)

A12)

Deficit	Auditory Complaints	Most sensitive central tests
1. Auditory closure deficit	Breakdown of the intrinsic redundancy of CANS: difficulty in filling the missing components when a part of the auditory signal is inaccessible.	Monoaural low redundancy speech tests
2. Binaural separation & integration deficits	Difficulty in processing an auditory message in one ear while ignoring a competing messge in the other (separation): Difficulty processing information presented to both ears simultaneously (integration). Difficulty hearing in background noise or when more than one person is talking at the same time.	Dichotic speech speech tests
3. Temporal patterning deficits	Difficulty recognizing acoustic contours i.e. difficulty recognizing, using prosodic features of speech. /	Tests of temporal patterning in both linguistic labell-ing & humming conditions.

4. Binaural interac -tion deficits	A breakdown in the brainstem ability to process binaural cues i.e. difficulty in localizing & lateralizing auditory information, leading to difficulty in detecting signals in noise.	MLD, ABR
5. Delayed Neuro-maturation	Can include any combination of the above given auditory complaints.	Left ear deficit on dichotic speech test combined with bilateral deficits on temporal pattering tests requiring linguistic labeling of stimuli.

- (Bellis, 1996)

A13) Factors that increase the Auditory Processing Demands

1) Briefness of signal or signal components.
2) Reduce content (linguistic, visual, situational)
3) Increased length of decontextualized material.
4) Verbatim retention or recall of material.
5) Increased phonetic complexity (consonant clusters, multiple syllables)
6) Increased phonetic similarity (rhythming words, phonetically similar syllables or words)
7) Decreased word familiarity
8) Poor listening conditions (noisy backgrounds, distance from speaker, reverberation)

9) Normal, fast speaking rates
10) Normal to high rate of presenting new information
11) Increased specificity of a response
12) Open response sets.

-(Sloan, 1998).

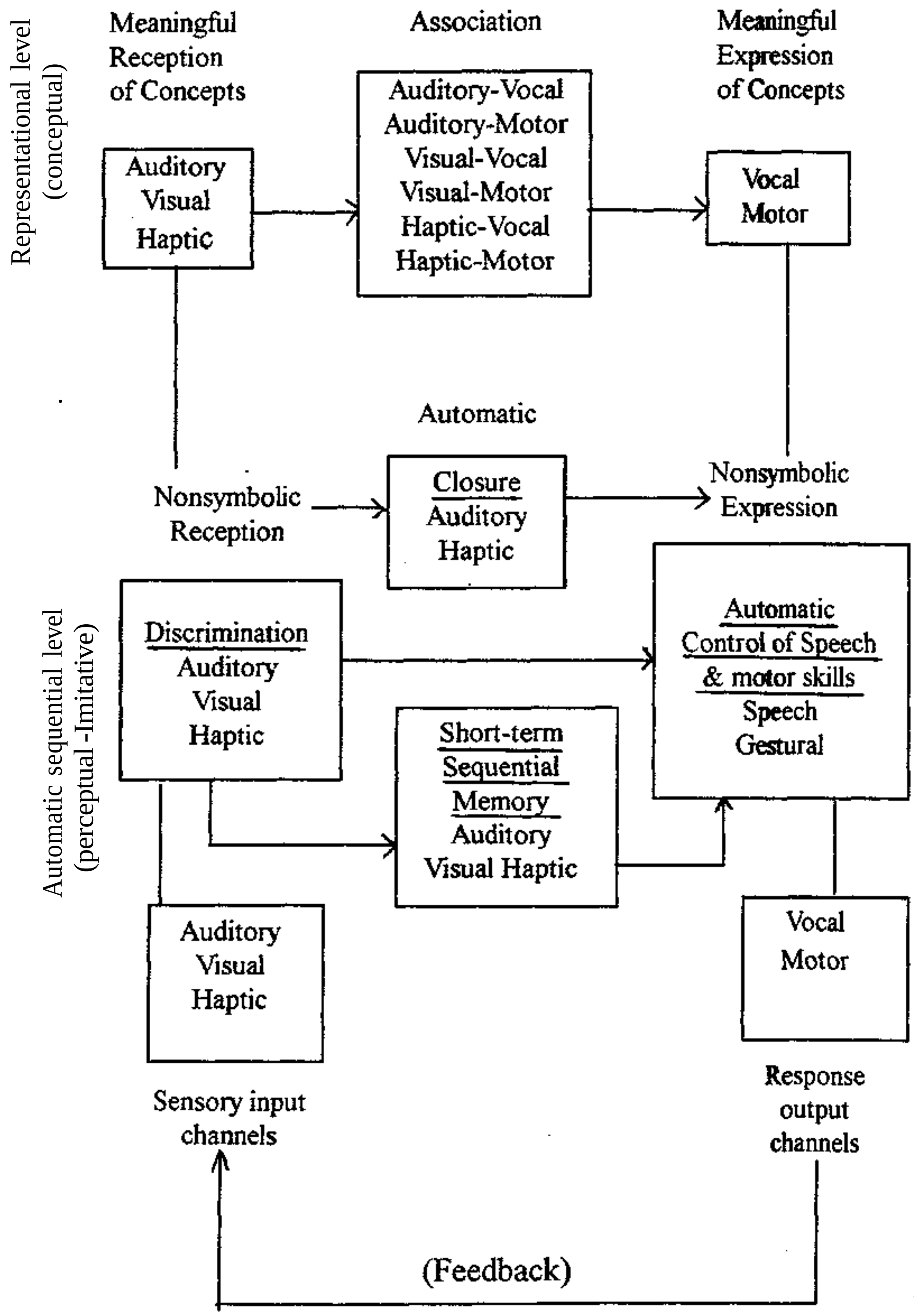
A. 14

Children who present under delayed and disorganized language often are not capable of making adequate discriminations among speech sounds. It is seen that although a correlation exists between many aspects of perceptual dysfunction and language disorders, a causal relationship may not exist.

-(Kirk and Kirk, 1971)

. . . **P.T.O.**

A14 (countd)



-(kk & Kirk, 1971)

A8

Deficit	Auditory deficits	Speech and language deficits	Behavioural problems
1. Decoding deficit	Poor phonemic representation ability, sound blending, discri-mination, retentionof phonemes.	Difficulty reading, poor speech to print skills, poor writing/spelling, vocabulary, syntax, semantic.	Difficulty understanding speech in noise,ask for repetition.
2. Integration deficit	Poor ability to recognise and utilize gestaltatterns, difficulty in integrating auditory and visual functions, poor pattern perception.	Difficulty reading, recognition, spelling and writing, use of prosodic aspects of speechis impaired.	Difficulty in multi modality tasks, difficulty in singing, dancing, music.
3. Tolerance fading memory deticit	Inability toappryfules of language to acoustic informa-tion, difficulty understanding speech in noise.	Difficulty with passive sentences, compound sentences and linguistically complex messges,has reception language deficits in vocabulary, syntax and semantics.	Poor pragmatic and social communication skills.
4. Organizational delicit	Inability to plan squence and organise responses, difficulty to act upon incoming informa-tion.	Inability to formulate the appropriate response,perseverative speech responses, poor writing and spelling.	Poor organizational skills, difficulty following instructions, reversals, poor recall and abilities poor gross and fine motor skills.

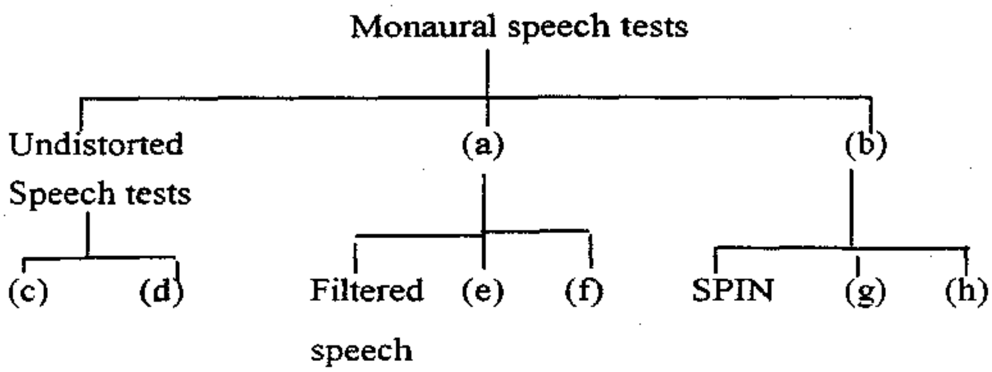
-(Bellis, 1996)

MONAURAL SPEECH TESTS

Questions

Ql. Complete the schematic representation given by Rintelmann (1992) of the different kinds of monaural speech tests.

-(Rintleman, 1992)



Q2. Known your numbers

1. What rollover index ratio separates retrocochlear from cochlear lesions with PAL PB-50 and NU-6 word lists?

2. At what intensity level are word recognition scores obtained to check the rollover index ratio?

3. Which are the cutoff frequencies used for the low pass, high pass and band pass filtered version of the NU-6 word lists?

4. What is the presentation level for low pass filtered speech and time compressed speech tests?

5. What is the most commonly used compression rate in time compressed speech tests?

6. At what message on fraction is interrupted speech test performed and what is the interruption per second used?

7. What is the reverberation time used with compressed speech for central auditory assessment to further reduce the external redundancy?

8. At what speech to noise ratio and intensity is the speech perception in noise and synthetic sentence identification with ipsilateral competing message testing done?

9. At what interruptions per second does maximum word recognition scores reach a plateau?

10. At what message-to-competition ratio does speech recognition become dramatically poorer on a monaural competing message task?

Q3. Expand these abbreviations

(l)PI-PB (2)LPFS (3) SPIN
(4)SSI-ICM (5)MCR (6) SNR (7) ips

Q4. Crossword puzzle : Answer the question and fill it into the crossword.

DOWN

1) Commonly used speech to noise ratio in speech perception in noise test.

3) Synthetic sentence identification with ipsilateral competing message is sensitive to this brainstem area

5) The commonly used rejection rate in low pass filtered speech as given in Willeford test battery.

7) Interrupted speech test detects this lesion.

9) Commonly used phonetically balanced word list in monaural low redundancy speech tests.

CROSS

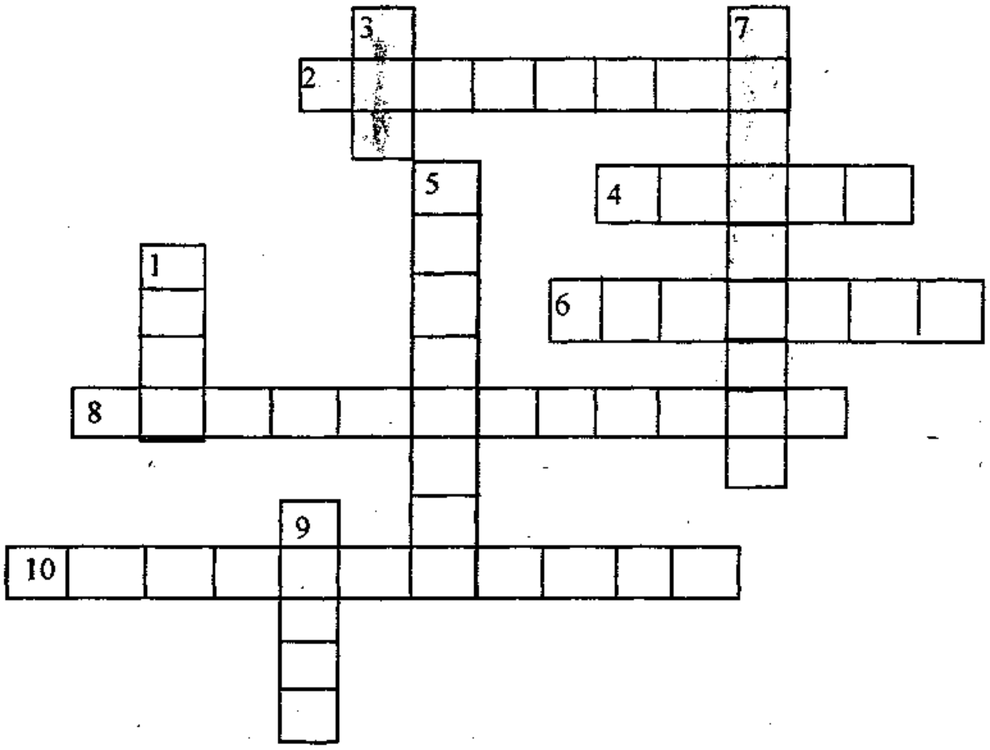
2) The index ratio obtained using the discrimination scores for phonetically balanced word list at different intensities.

4) The commonly used noise in speech perception in noise test apart from speech spectrum noise.

6) The auditory process evaluated by monaural low redundancy speech tests.

8) A term used to refer to the point in a performance intensity function at which the listener reaches 95% accuracy level for monotic representation of the stimuli.

10) The other parameter which can be altered apart from time in compressed speech tests.



Q5. Fill in the missing information about the normative data obtained for the tests in the following table.

Test	Details about subject/stimuli	Scores
1. Low pass filtered speech	8 years to adults for NU6 words	.....to .... %
2. Time compressec speech	a) 45% compression (55 dB HL) b) .... + reverberation (55 dB HL) c) .... % compression (60 dB HL) d) 65% + reverberation (60 dBHL)	a).....% b) 72.8% c) 55.5% d) .... %
3. Interruptec speech	1) For young adult normal listeners done at 35 dB SPL at a) 10 ips b) .... ips c) 4 ips	a).....% b) 95 % c) .... %
	2) 50-60 years adults at 35 dB SPL a) 7 & 10 ips b) .... ips	a) .... % b) 68.9 %
4. SSI-ICM	Normal hearing adults a) 0 MCR b) .... dB MCR c) -20 dB MCR d)......dBMCR	a) .... % b) 80 % c).....% d) 20%
5. Filtered speech	Low Pass cutoff frequency a) 1950 Hz. b) 7000 Hz c) Band pass filtered 35 dB SL at 40 dB/octave	a).... % b).....% c).....%
6. SPIN	0 dB SNR a) adults b) .... years	a).... to... % poorer scores in noise than quite b) 39 %

Q6. Compare and contrast the different monaural low redundancy tests in terms of what lesion they are sensitive to?

Q7. Represent the stimuli used, presentation levels and subject response for the following tests in a tabular column.

1) low pass filtered speech
2) time compressed speech
3) time compression + reverberation
4) interrupted speech
5) filtered speech
6) speech perception in noise
7) synthetic sentence identification with ipsilateral competing message
8)PI-PB
9) word recognition at high and low sensation levels.

Q8. Match the tests with their investigators.

1) Low pass filtered speech	a) Sinha (1959)
2) Time compressed speech	b) Bocca and Calearo (1954)
3) Interrupted speech	c) Licklider and Miller (1951)
4) Filtered speech	d) Speaks and Jerger (1965)
5) Speech in noise test	e) Jerger and Jerger (1971)
6) SSI-ICM	f) Beasley and Maki (1957)
7) PI-PB	g) Bocca (1958)
8) Time compressed with reverberation	h) Bornstein (1992)

Q9. What are the hit rates of the following tests ?

1) Low pass filtered speech in the detection of central auditory processing disorders

1) Compressed speech in the detection of:

a) brainstem lesion
b) temporal lobe lesion

3) SSI-ICM in the detection of low brainstem lesion
4) Filtered speech in the detection of:
   a) brainstem lesion
   b) temporal lobe lesion

Q10. State whether the following statements are true or false. Correct the false statements :

1) Speech in noise test scores for normal listeners at 0 dB SNR show 20 to 40% poorer scores in noise than in quite.
2) Time compressed speech can be obtained only by accelerating speaking rate.
3) Time compressed speech cannot be used on patients with sensorineural hearing loss.
4) Word recognition is inversely related to time compression ratio and directly related to sensation level.
5) Reverberation is added to speech signals in order to reduce redundancy, in addition to noise in compressed speech tests.

Answer

Al

a) low redundancy degraded speech tests.
b) competing message tests.
c) word recognition at high and low sensation levels.
d) performance intensity functions for phonetically balanced word.
e) Interrupted speech
f) Time compressed speech
g) SSI-ICM
h) combined use of PI-PB and SSI-ICM

A2:

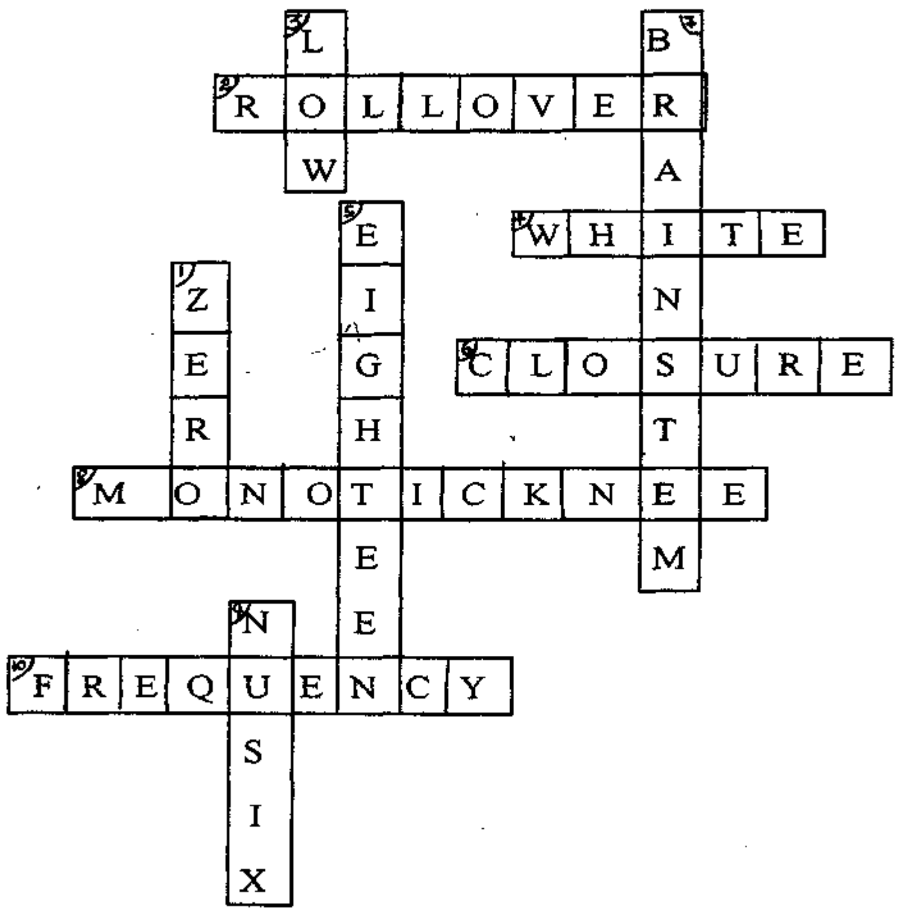
1) 0.45, 0.25 - (Jerger and Jerger, 1971)
2) 5 to 80 dB SPL or more - (Jerger et al., 1968)
3) Low pass - 500, 700, 1000 and 1500 Hz
High pass-2100 Hz
Band pass - 1500 Hz low and 2100 high pass filter
- (Wilson and Mueller, 1984)
4) 50-70 dB Hz - (Bellis, 1996)
5) 45% compression rate - (Wilson et al., 1994)
6) 50%, 1 to 40 ips - (Calearo and Antonelli, 1963)
7) 0.3 sec - (Bornstein, 1992)
8) 0 to -20 dB SNR at 40 dB SL - (Jerger, 1973)
9) slower than 3000 ips - (Licklider and Miller, 1951)
10) -10, -20, - 30 dB MCR etc. - (Jerger, 1973)

A3.

1) performance intensity functions for phonetically balanced words.
2) low pass filtered speech
3) speech perception in noise.
4) synthetic sentence identification - ipsilateral competing message.
5) message - competing ratio

6) speech-to-noise ratio.
7) interruptions per second

A4.



DOWN

1) zero - (Olsen et al., 1975)
3) low - (Jerger and Jerger, 1974)
5) eighteen - (Musiek and Geurkink, 1980)
7) brainstem - (Bocca and Calearo, 1963)
9) Nu-Six - (Bellis, 1996)

CROSS

2) Rollover - (Jerger and Jerger, 1971)
4) White - (Olsen et al., 1975)

6) Closure - (Bellis, 1996)

8) Monotic knee - (Bellis, 1996)

10) Frequency - (Beasley and Maki, 1976)

A5.

Test	Details about subject/stimuli	Scores	
1. Low pass filtered speech	8 years to adults for NU6 words	70 to 78% (Bellis,1996)	
2. Time compressec speech	a) 45% compression (55 dB HL) b) 45% + reverberation (55 dB HL) c)65 % compression (60 dB HL) d) 65% + reverberation (60 dBHL)	a) 86.5% b) 72.8% c) 55.5% d)34.9 %	(Wilson et al. 1994)
3. Interrupted speech	1) For young adult normal listeners done at 35 dB SPL at a) 10 ips b) 7 ips c) 4 ips	a)96.9 % b) 95 % c) 80.2%	(Korsan-Bengtsen, 1973)
	2) 50-60 years adults at 35 dB SPL a) 7 & 10 ips b) 4 ips	a)95 % b) 68.9 %	
4. SSI-ICM	Normal hearing adults a) 0 MCR b)-10dBMCR c) -20 dB MCR d)-30 dB MCR	a) 100 % b) 80 % c) 55 % d) 20%	(Jerger 1973)
5. Filtered speech	Low Pass cutoff frequency a) 1950 Hz. b) 7000 Hz c) Band pass filtered 35 dB SL at 40 dB/octave	a) 69 % b) 98 % c) 84 %	(Korsan-Bengtsen, 1973)
6. SPIN	0dB SNR a) adults b)9 years	a) 20 to 40% poorer scores n noise than quite b) 39 %	

A6.

Comparision

i) low pass filtered speech test, interrupted speech, (?) speech perception in noise, filtered speech, SSI-ICM tests are sensitive to low brainstem lesions.

ii) low pass filtered speech and speech perception in noise tests are sensitive to cortical lesions.

Hi) Interrupted and filtered speech tests are sensitive to temporal lobe lesions.

Contrast

i) Time compressed speech with reverberation is used with neurological population.

ii) Time compressed speech also tests diffuse pathology involving primary auditory cortex.

- (Bellis, 1996)

A 7

Test	Stimuli	PL	Subject response
1 .Low pass filtered speech	CNC words, NU6 word list	50 dB	Repeat the words heard
2. Time compressed speech	NU 6 words at 45% & 65% compression	50 dB	-do-
3. Time compressed +reverbera-tion	Same as above + reverberation	50 dB	-do-

4.1nterruptec speech	Harward PB 50, NU6, disyllabic words and sentences at messge on fraction of 50% from 1-40 ips.	50 dB	-do-
5.Filtered speech	CNS words, low pass filtered speech at rejection rate of 18 dB/ octave.	35-50 dB	-do-
6. SPIN	NU6 at SNR of 0 to -20 dB.	40 dB	-do-
7.SSI-ICM	Third order approxi-mation of English sentences at OdB SNR & -20 dB SNR	primary -30 dB com-petition between 20 & 50 dB	Select the target sentences heard from a printed list
8.PI-PB	PB words	5-80 dB SL	Repeat the words heard
9. Word recognition at high & low SL	PB words	5-40 dB	-do-

A8.

1) - (b)
2) - 00
3) - (g)
4) - (c)
5) - (a)
6) - (d)
7) - (e)
8) - (h)

A9.

Test	Sensitivity
1) Low pass filtered speech	1) 74% - (Lynn and Gilroy, 1977)
2) Compressed speech a) brainstem lesion b) temporal lobe lesion	2) a) 64% - (Karlson and b) 80% Rosenhall, 1995)
3) SSI-ICM (for low brainstem lesion)	3) 100% - (Jerger and Jerger 1974)
4) Filtered speech a) brainstem lesion b) temporal lobe lesion	4) a) 62% - (Karlson and b) 62% Rosenhal, 1995)

A10.

1) True - (Olsen et al., 1975).
2) False. It can be done even by increasing playback speed of tape recorder or chop slicing the signal - (Rintelmann, 1985)
3) False. It can be used on patients with bilaterally symmetrical sensorineurl hearing loss - (Rintelmann, 1985).
4) True - (Beasley, et al. 1972)
5) True - (Bellis, 1996)

BINAURAL INTERACTION TASKS

Questions

Ql. Fill in the blanks

1) The minimum time required for temporal interaction in normal listeners ranges from.......to. . . . . .msec.

2) The greatest release from masking for binaural threshold is in the. . . . . . .antiphasic condition.

,3) Matzker (1959) used the frequencies 500 Hz to 800 Hz for low pass filtering and .... to .... for high pass filtering in his binaural fusion testing.

4) Binaural fusion is a spectral function while rapidly alternating speech perception requires. . . . . . .of segments over time.

5) Tones of two different frequencies; when delivered to an ear, is perceived as a tone which is modulated at a rate equal to. . . . . between the tones.

6) The three variables that affect masking level difference are. . . . ., ,.and duration of the masker .

7) Masking level difference is calculated by subtracting the threshold value obtained in the. . . . .condition from that obtained in the..... condition.

8) Masking level difference is geneally administered at. . . . . . .Hz.

9) Masking level difference, binaural fusion and rapidly alternating speech perception assess the process of. . . . .

10) Simultaneous binaural medial plane lateralization does not effect lesions in the......level of the central auditory nervous system.

Q2. Multiple choice.

Choose the correct answers from the choices given below

1) The binaural fusion test uses this speech material
a) Ivey spondees
b)NU-6
c) CVC syllables
d) All of the above.

2) The condition in which speech and noise are both either in phase or out of phase is called -
a) homophasic condition
b) antiphasic condition
c) both of the above
d) none of the above

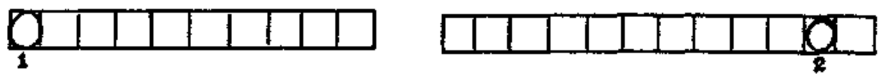
3) The duration of the alternating segments of running speech which does not interrupt intelligibility is
a) 20-500 msec.
b) 20-800 msec.
c) 1000 msec.
d) 10-300 msec.

4) The minimum Interaural Intensity Difference required for the lateralization in the contralateral ear in central involvement was
a) 1 dB
b)4dB
c)10dB
d) 3 dB

5) The antiphasic release from masking decreases in size as the Sensation Level for presentation is
a) decreased
b) kept constant
c) increased
d) doubled

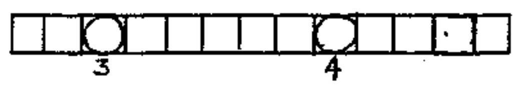
Q3. Answers the following question and fill it into the box. After answering all, form a word from the circled box and define the term

1) Another term used for binaural fusion test

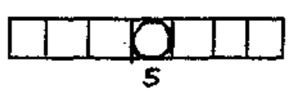


test

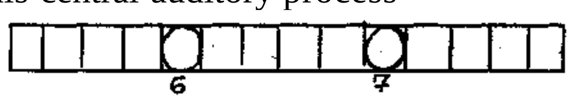
2) Smith and Resnick (1972) used this to reduce the redundancy of spondaic word in binaural fusion testing.



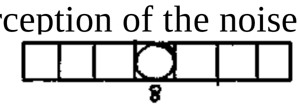
3) A person with brainstem lesion hears this kind of beats only



4) Abnormal interaural intensity difference produces an abnormality in this central auditory process

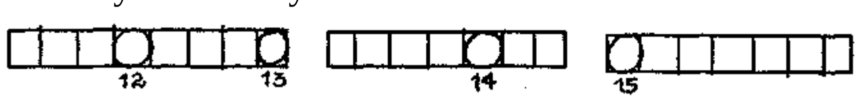


5) The noise presented in a homophasic condition results in a perception of the noise as being located in this part of the head

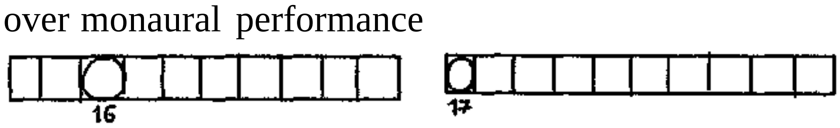


6) The term used to describe the condition in which the signal in 180 degree out of phase at the two ears and the noise in phase at both ears.

7) Masking level difference is mediated at this level of the central auditory nervous system.

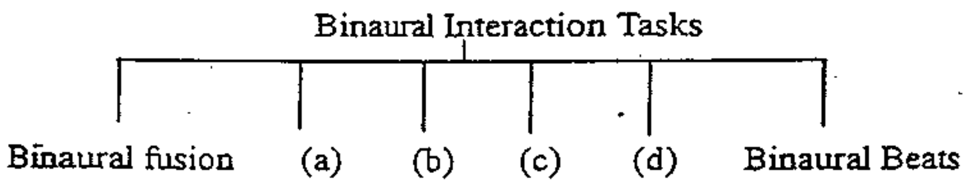


8) This term is defined as the decrease in binaural performance over monaural performance



9) This ability improves/or is better at suprathreshold levels and reaches normal performance at 10 dB SL (re. poorer ear threshold)

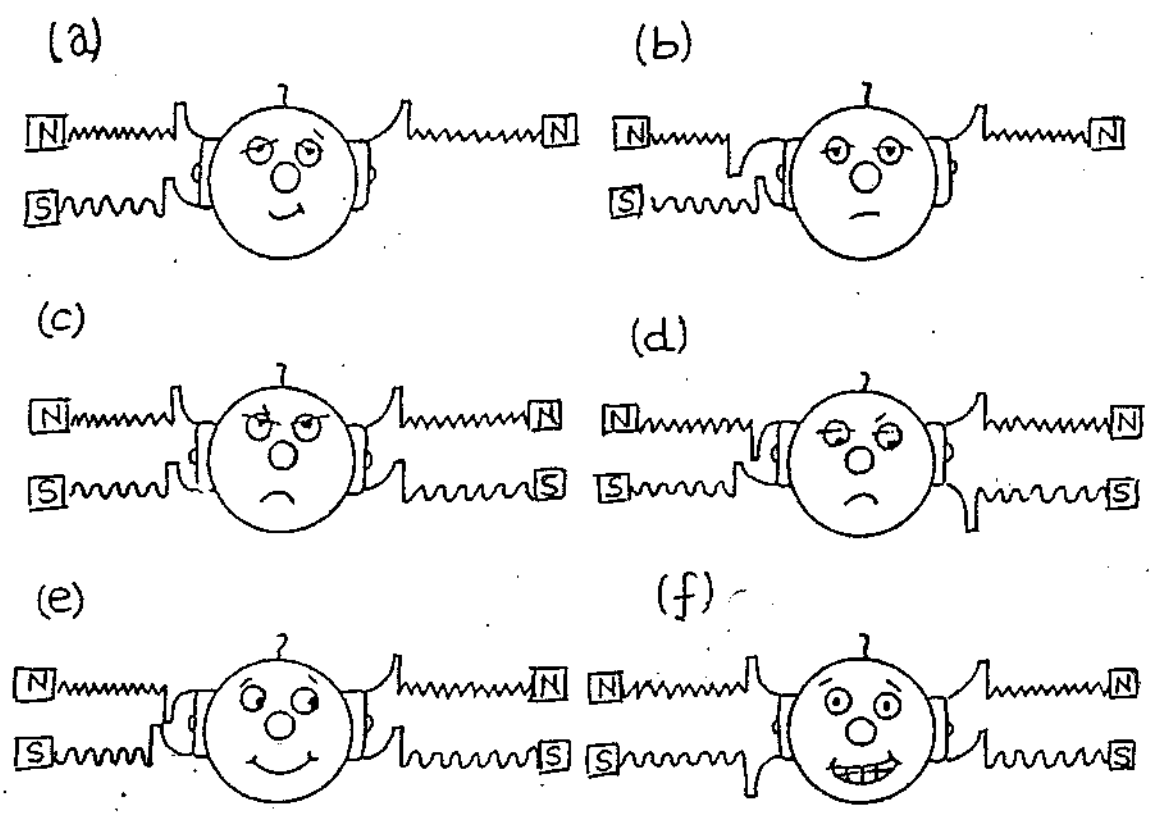
Q4. Complete the table



Q5. Expand the following term and describe them in not more than 2-3 sentences.

1)BF
2) RASP
3)HD
4)MLD
5) SBMPL
6) SWAMI

Q6. Label the diagram and indicate whether the signal or noise is in antiphase or homophase (N=noise; S=signal).



Q7. State whether true or false and correct the false statements.

1) Binaural release from masking is not affected bycochlear pathology.

2) Utilization of the antiphasic condition in which the signal delivered to the 2 ears is out of phase and the masking noise is in phase ($S_{\pi} N\varphi$) will result in the largest masking level differences

3) Masking level differences explores the cross-sectional intensity timing affects, whereas the interaural intensity differences explores the cross sectional intensity effects.

4) A masking level difference of more than 6 dB are considered abnormal for adult patients based on clinical norms.

5) Masking level difference is not affected by peripheral loss/lesions.

6) Binaural fusion relies on the integration over time of a signal and rapidly alternating speech perception taps the spectral fusion ability.

7) Localization ability is better at suprathreshold intensity levels than lower intensity levels.

8) Subjects with brainstem lesions hear monaural beats but not binaural beats.

Q8. Describe in brief the effect of the following sites of lesion on binaural interaction.

1) Temporal lesion
2) Low brainstem lesion
3) High brainstem lesion
4) Peripheral: cochlear
5) Peripheral: conductive

Q9. In a tabular column describe briefly the administration of the following tests and indicate whether they are useful in detecting a brainstem, or cortical lesion.

1) Binaural fusion
2) Masking level difference
3) Interaural intensity difference
4) Rapidly alternating speech perception
5) Simultaneous binaural medial plane lateralization
6) Segment altered *CVC* fusion
7) Binaural beats
8) Speech with alternate masking index

Q10. Complete the normative data given in the following table.

Test	Normative data
1) Binaural Fusion	
a) 25 dB SL	.... %
b) .... dB SL	62%
c) .... dB SL	81%
d) 40 dB SL	...... %
2) Masking Level Difference (on normal hearing listeners)	
a) 65 dB SPL (45 dB HL)	_dB SPL
b) 85 dB SPL (65 dB HL)	_dB SPL
3) Rapidly Alternating Speech Perception (alteration at 300 msec)	
a) monaural	0 to.....%
b) binaural	..... to ....%

Ql 1. What is the hit rate of the following tests:

1) Binaural Fusion (BF)
2) Masking Level Difference (MLD)
3) Rapidly Alternating Speech Perception (RASP)

Q12. Match the following tests with their investigators :-

(A)	(B)
1) Segment altered CVC word tests	a) Pinheiro & Tobin (1969)
2) Binaural fusion	b) Lynn & Gilroy (1977)
3) Masking level difference	c) Oster (1973)
4) Rapidly alternating speech perception	d) Matzker (1959)
5) Interaural intensity difference	e) Wilson (1994)
6) Binaural beats	f) Licklider (1948), Hirsh (1948)
7) Speech with alternate masking index	g) Jerger (1960)

Answers

A1.

1. 100 and 500 msec - (Cherry, 1953)
2. SΠN φ - (Hirsh, 1948)
3. 1815-2500 Hz - (Matzker, 1959)
4. integration - (Bellis, 1996)
5. difference in frequency - (Oster, 1973)
6. Masking level, frequency of the tone - (Townsend and Goldstein, 1972).
7. S^N^, S^N^j-(Bellis, 1996)
8. 500, 1000 and 2000 Hz-(Bellis, 1996)
9. binaural integration - (Bellis, 1996)
10. cortical - (Noffsinger, 1984).

A2.

(1) - (d) - all of the above - (Bellis, 1996)
(2) - (a) - homophasic condition - (Bellis, 1996)
(3) - (a) - 20-500 msec. - (Bellis, 1996)
(4) - (b) - 4 dB - (Pinheiro and Tobin, 1969)
(5) - (c) - increased - (Townsend and Goldstein, 1972)

A3.

1) Bilateral Resynthesis - (Matzker, 1959)
2) Monc syllables - (Smith and Resnick, 1972).
3) Monaural-(Noffsinger, 1982)
4) Lateralization - (Tobin, 1985)
5) Midline - (Licklider, 1948)
6) Antiphasic condition - (licklider, 1948)
7) Superior olivary complex - (Cranford, et al., 1975)
8) Interaural inhibition - (Licklider, 1948)
9) Localization - (Bergman, 1957)

Hidden Term - BINAURAL INTERACTION

It refers to the way in which the ears work together. This process depends primarily on the integrity of the brainstem auditory structures localization, lateralization of auditory stimuli, binaural release from masking, detection of signals in noise or binaural fusion are some function which rely on this - (Bellis, 1996).

A4.

a) Rapidly Alternating Speech Perception
b) Interaural Intensity Difference
c) Masking Level Difference
d) Simultaneous Binaural Medial Plane Lateralization

A5.

1) **Binaural fusion tests - It** involves simultaneous presentation of high pass filtered stimuli to one ear and low pass filtered stimuli to the other ear in order to assess the listener's ability to fuse the two disparate inputs into one perceptual event.

2) **Rapidly Alternating Speech Perception -** A procedure in which sentence material in switched rapidly between ears at periodic intervals, resulting in alternating presentation of unintelligible sequential bursts of information.

3) **Interaural Intensity Difference -** It evaluates the degree of intensity difference between ears needed for lateralization of a signal.

4) **Masking Level Difference -** Speech and white noise are presented to both ears at the same time while systematically varying the phase relationship between the two ears. It is the difference in binaural masked threshold for signal between the homophasic and antiphasic conditions.

5) **Simultaneous Binaural Medial Plane Lateralization-**Tones of same intensity and frequency are presented to two ears simultaneously to test lateralization.

6) **Speech With Alternate Masking Index -** A task to test the ability of **a** person to understand a speech signal while a white noise masker is altered between ears at an intensity level that is 20 dB higher.

A6a)S N φ- tone monaural, noise-binaural and in phase.

b) S NΠ - tone monaural, noise binaural and 180 degree out of phase.

c) S φN φ tone and noise binaural and out of phase i.e. homophasic condition.

d) SΠNΠ tone and noise binaural and in phase i.e. homophasic condition.

e) S φ NΠ tone binaural and in phase, noise binaural and out of phase i.e. antiphasic condition.

f) SΠ N φ tone binaural and out of phase, noise binaural and in phase i.e. antiphasic condition.

- (Bellis, 1996)

A7.

1) False - Unilateral menier's disease exhibited reduced masking level differences for 500 Hz tones and spondiac words noise induced hearing loss also exhibited reduced masking level differences for speech.

- (Hall et al., 1984)

2) True - (Olsen, Noffsinger and Carhart, 1976)

3) True - (Musiek and Geurkink, 1982)

4) False - The masking level differences should be less than 6 dB to be considered as abnormal.

- (Wilson, Zizz and Sperry, 1994)

5) False - masking level differences is reduced for 500 Hz tone and words for cochlear and middle ear pathology

- (Olsen, Noffsinger and Carhart, 1976).

6) False - Binaural fusion taps the spectral fusion and rapidly alternating speech perception relies on the integration over time of a signal.

- (Musiek and Geurkink, 1982)

7) True - (Bergman, 1957)

8) True - (Noffsinger, 1982)

A8.

1) **Temporal lesion** - Impairment of localization in contralateral auditory field, greater interaural intensity differences required in ear ipsilateral to lesion for lateralization.

2) **Low brainstem lesion** - Deficit in all binaural interaction tasks.

3) **High brainstem lesion** - no effect on masking level difference

4) **Peripheral cochlear** - Variable, possible deficit in localization and lateralization reduced masking level difference

5) **Peripheral**: conductive - reduced masking level difference, may exhibit ongoing deficit in binaural interaction tasks.

-(Bellis, 1996)

A9.

Test	Sensitive to	Stimuli	PL	Scoring
1.Binaural fusion	Low brain stem	Spondaic. NU6 words. segmented CVC words	25-35 dBSL	Repeat words
2.MLD	Low brain stem	Stimuli may be tonal or speech	Levels &S/N ratio vary.	SΠ N φ threshold minus S ΦN φ threshold
3.IID	Brain stem	Tones	20 dB SL	Detect smallest change in intensity
4. RASP	(?) Low brain stem	Sentences	40 dB SL	Repeat words
5.SBMPL	Low brain stem	Tones and noise	Supra-threshold level	Lateralize stimuli

6. Segment altered *CVC* fusion	Brain stem	CVC words	30 dB **SL**	Repeat words
7.Binaural beats	Low brain stem	Tone at two different frequencies (500, 493 Hz)	Supra-threshold level	Indicate if they hear beats.
8.SWAMI	Brain stern	PB words	PB at 50 dB5SL 0.5 noise burst 20 dB higher	Repeat words

A10.

Test Normative data

1) Binaural fusion

a) 25 dB SL	a) 35 %	
b) 30 dB SL	b) 62 %	(Linden,
c) 35 dB SL	c) 81 %	1994)
d) 40 dB SL	d) 89 %	

2) Masking level difference
(on normal hearing listeners)

a) 65 dB SPL (45 dB HL) a) 78 dB SPL

b) 85 dB SPL (65 dB HL) b) 88 dB SPL

- (Wilson, Zizz and Sperry, 1994)

3) Rapidly alternating speech perception (alteration at 300 msec)

a) monaural 0 to 10 % - (Lynn and Gilroy, 1975)
b) binaural 95 to 100 %

All.

1) MLD - 69% - (Karlson and Rosenhall, 1995)
2) BF - 30% - (Musiek and Geurikink, 1982)
3) RASP - 56% (Antonelli et al., 1987)

A12.

(A)		(B)
1.	-	e
2.	-	d
3.	-	f
4.	-	b
5.	-	a
6.	-	c
7-	-	g

SEQUENCING AND TEMPORAL ORDERING TESTS

Questions

Q1. What are the 3 kinds of temporal ordering tests?

Q2. Complete the following sentences regarding temporal ordering tasks -

1) Stimuli used in temporal ordering tasks are........
2) Temporal ordering tasks involve..........
3) Number of components used in temporal ordering tasks are

4) Duration of components are........
5) Rate of stimuli presentation is..........
6) Manner of stimuli presentation is...........
7) The ear to which the stimuli presented is........
8) Patient's response is attained through........
9) Mode of presentation of stimuli is.........
10) Psychological variables affecting the task are........

Q4. Read the following statements and find the answer in the following box of jumbled letters.

T	Y	C	N	E	U	Q	E	R	F
X	E	O	N	E	W	I	S	T	N
C	O	M	S	H	G	R	A	O	E
I	X	R	P	H	V	L	E	P	E
T	I	T	T	O	F	U	T	Y	T
O	A	M	T	H	R	E	E	T	E
H	S	A	Y	N	O	A	F	N	N
C	E	R	E	B	R	A	L	E	I
I	I	Z	B	C	D	H	G	W	N
D	D	O	M	I	N	A	N	T	J

1) A term referring to time related aspects of the acoustic signal.
2) Hemisphere that is responsible for temporal sequencing
3) Number of tone bursts used in each sequence of the adult version of pitch pattern sequence test.
4) An inter-stimulus interval at which a listener is unable to perceive the temporal order at two consecutive stimuli in central lesion.
5) In duration pattern test, the parameter that is kept constant with the duration of tone being varied from long (500 msec) to short (250 msec).
6) The mode used to present sequences of noise burst or click trains in psychoacoustic pattern discrimination test to assess discrimination of temporal changes.
7) An age below which the frequency pattern test is not an appropriate measure in children.
8) The pattern of temporal integration function found in subjects with eighth nerve pathology.
9) Pitch pattern sequence test is most sensitive to these lesions.
10) The temporal processing abilities reach mature level at this age (in years) approximately.

Q5. Choose the right answer

1) Frequency pattern test is administered. . . . .(binaurally/ monaurally)
2) Tones of low intensity......the difficulty of temporal order judgement (increase/decrease)
3) The insertion of silent intervals between successive components of a sequence or between sequences or both. . . . .the performance on temporal ordering tasks (improved/worsened).
4) Although standard, temporal integration tasks may not have much utility in the detection of cerebral lesions, evaluation of difference limen for. . . . . .may differentiate peripheral from central pathology (duration/frequency).
5) The patients with interhemispheric dysfunctions perform well in the. . . . . .condition (humming, verbal)

Q6. Known your numbers

The adult version of the pitch pattern sequence test consists of (1) ......test pattern sequences. Each sequence is made up of (2) ...... tone bursts, (3)......of one frequency and (4).......of a second frequency, arranged in *(5)*.......possible combinations. The "high" tone is (6)......Hz and "low" tone is (7)......Hz. Duration of each tone is(8)......msec, and there is a silent interval of (9) .... each sequenc is (10)......msec. The presentation level is (1.1)......dB above the (12)......Hz threshold for each ear.

Q7. Compare and contrast the 3 temporal ordering tests in terms of the processes they test and lesions they are sensitive to.

Q8. In a tabular column describe the effect of the following lesions on temporal ordering :

1) Right temporal lobe lesion
2) Left temporal lobe lesion
3) Corpus callosum lesion
4) Brainstem lesion
5) Peripheral lesion.

Q9. State whether true or false. Correct the false statement.

1) The judgement of temporal order for a tone presented before or during a noise was less difficult when the frequency of the tone was lower than the centerband frequency of the noise.

2) Temporal ordering of speech and speech like sounds are more difficult than non-speech sounds.

3) The patient with bilateral temporal lobe lesion needed 20 to 200 msec, difference in onset times of two tones in order to judge whether the first tone was high or low in pitch.

4) An inter-stimulus interval of only 2 msec, is required for the normal listener to perceive two sounds instead of only one.

5) A duration of 125 msec, for each of the contiguous components was sufficient for temporal ordering, but longer component duration were necessary when the contiguous tones were more widely spaced in frequency depending on their specific distribution within the pattern.

Q10. Write the normative data available on - (1) Pitch pattern sequence test and (2) Duration pattern test given by (Musiek, 1994).

Ql 1. What are the stimuli used, presentation levels and subject responses for (1) Duration pattern test, (2) Pitch pattern sequence test and (3) Psychoacoustic pattern discrimination tests?

Q12. Complete the hitrate data table for the following tests.

Test	Normative data
1. Pitch pattern sequence test	1.
a) Cerebral lesion	a)......%
b) Brainstem lesion	b)......%
c) Cerebral vs. cochlear lesion	c).......%
2. Duration pattern test	2.
a) Cerebral lesion	a)......%
3) Psychoacoustic pattern discrimination test	3........%

Q13. Who gave the following tests?

1) Pitch pattern sequence test (PPST)
2) Duration pattern test (DPT)
3) Psychoacoustic pattern discrimination test (PPDT)

Answers

A1.

Temporal Ordering tests

(1) Frequency pattern tests

(2) Duration pattern test

(3) Psychoacoustic pattern discrimina -tion tests

- (Musiek and Pinheiro, 1985).

A2.

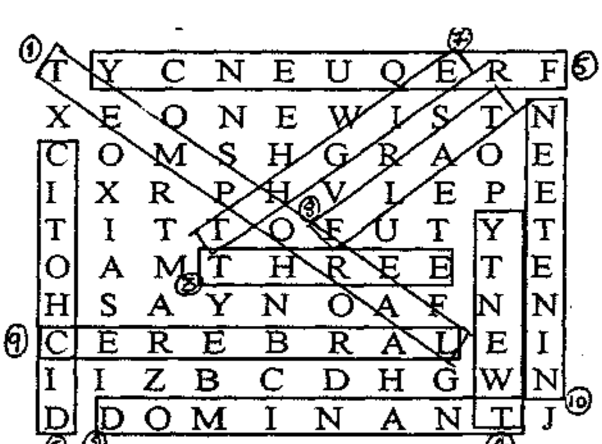
1) noise tones, clicks, speech, speech like sounds and their combination
2) detecting differences among signals in frequency, intensity or duration.
3) 2, 3, 4 or more components
4) 50 msec -700 msec.
5) usually slow rates
6) successively, contiguously
7) monaurally, binaurally dichotically, in alternating ears.
8) humming, manual and verbal
9) loudspeakers, earphones, using tape loops.
10) attention and recall

- (Musiek and Pinheiro, 1985)

A3.

1) Interstimulus interval
2) Pitch pattern sequence test
3) Duration pattern test
4) Psychoacoustic pattern discrimination test

A4.



1) Temporal - (Bellis, 1996)
2) Dominant - (Halpeiro et al., 1973)
3) Three - (Pmhiero and Musiek, 1971)
4) Twenty - (Hirsh, 1959)
5) Frequency - (Pinheiro and Musiek, 1985)
6) -:Dichotic - (Blaettner et al., 1989)
7) Eight - (Pinheiro and Musiek, 1985)
8) Flat - (Thompson and Abel, 1992)
9) Cerebral - (Musiek and Pinheiro, 1985)
10) Nineteen - (Bellis, 1996)

A5.
1) Monaurally - (Pinheiro and Musiek, 1985)
2) Increased - (Homick et al., 1969)
3) Improved - (Thomas et al., 1971)
4) Duration - (Bellis, 1996)
5) Humming - (Pinheiro and Musiek, 1985)

A6.

1. 120	7. 880
2. 3	8. 200
3.2	9. 150
4. 1	10 900
5.6	11.50
6. 1122	12. 1000

- (Pinheiro and Ptacek,1971)

A7. Comparision
(a) Processes assessed

1) Frequency pattern, duration pattern both test linguistic labeling and temporal ordering.

(b) Sensitivity
1) All 3 are sensitive to cerebral hemisphere lesions
2) Frequency and duration pattern tasks, are sensitive to interhemispheric transfer also.

Contrast

a) Processes assessed

1) Frequency pattern assess frequency discrimination.

2) Duration pattern assess duration discrimination

3) Psychoacoustic Pattern Discrimination Test assesses temporal discrimination

b) Sensitivity

1) Psychoacoustic Pattern Discrimination Test also assesses auditory association areas

- (Bellis, 1996)

A8.

Site of lesion	Effects on Temporal Processing
1. Right temporal lobe	Contralateral deficit on two tone ordering or gap detection, bilateral deficits on temporal patterning tasks involving more than two stimuli.
2. Left temporal lobe	Significant contralateral and/or bilateral effects.
3. Corpus collosum	Bilateral deficits or temporal patterning tasks involving more than two stimuli.
4. Brainstem	Variable depending upon site of lesion and type of task.
5. Peripheral	Little effect on temporal patterning performance

-(Bellis, 1996)

A9.

1) True - (Hormick et al., 1969)

2) False - (Thomas et al, 1970)

It is more easy with speech and speech like sounds.

3) False - They needed 300 to 500 msec, difference. (Jerger et al., 1969)
4) True - (Hirsh, 1959)

5) True - (Thomas and Fitzgibbons, 1971).

A10. Normative data - by Musiek (1994)

1) Frequency pattern test (on normal hearing subjects) scores obtained were :

8-9 years	42%
9-10 years	63%
10-11 years	78%
11-12 years	78%
12-adults	80%

2) Duration pattern test (on normal hearing subjects) Adults - 73%

All.

a) Stimuli used

1. Pitch pattern sequence test - 60 patterns of triads of tones differing in frequency i.e. LLL, HHH, HLH, LHL, HHL, LLH, HLL, LHH where L = 880 Hz, H = 1122 Hz.

2. Duration pattern test - 60 patterns of triads of tones differing in duration i.e. LLL, SSS, LSL, SLS, SSL, LLS, SLL, LSS where S = 250 msec. L = 500 msec.

3. Psychoacoustic pattern discrimination test - dichotically presented sequences of noise bursts or click trains.

b) Presentation levels

Pitch pattern sequence test, Duration pattern test, Psychoacoustic pattern discrimination test - 50 dB

c) Patients response

1) Pitch pattern sequence test
   - To hum or sing, gesture manually or label them verbally.
2) Duration pattern test - Same as Pitch pattern sequence test.
3) Psychoacoustic pattern discrimination test - Indicate discrimination of a monaural change in the pattern

-(Bellis, 1996)

A12.

Test	Normative data
1. Pitch pattern sequence test	1)
a) Cerebral lesion	a) 83 % (Musiek and
b) Brainstem lesion	b) 45 % -Pinheiro, 1985)
c) Cerebral vs. cochlear lesion	c) 88 %
2. Duration pattern test	2.
a) Cerebral lesion	a) 86 % (Musiek and Pinheiro, 1985)
3. Psychoacoustic pattern discrimination test	3. 86 % (Blaettner, 1989)

A13.

1) Pitch pattern sequence test - (Pinheiro and Ptacek, 1971)
2) Duration pattern test - (Pinheiro and Musiek, 1985)
3) Psychoacoustic pattern discrimination test - (Blaettner et al, 1989).

DICHOTIC SPEECH TESTS

Questions

Q1. Fill in the blanks

1. To assess cortical function with dichotic speech tasks both the .... and .... auditory pathways must be symmetrical and normal

2. The different speech stimuli used to assess binaural integration are....,....,.... and....

3. The time lags used in a dichotic CV test given by Berlin et al. (1973) are ....,...., ... and .... msec.

4. In a competing sentence test, the signal to competition ratio recommended is....

5. Staggered spondiac word test attempts to account for peripheral hearing loss by substracting.... from the raw score.

6. Among all the dichotic tests, the test using .... are the most difficult test due to the limited amount of linguistic information combined with the close temporal alignment of stimuli presentation.

7. When dichotic (competing) auditory stimuli are presented, the.... pathways are suppressed by the stronger .... pathways.

8. Patients with interhemispheric lesion (corpus callosum) are also called ,................patients.

9. An advantage of IC-CS test is that there is no.... observed in the dichotic mode.

10. Dichotic word are generally easier to recognize than CV syllables because their length allows more.....,..... and..... cues.

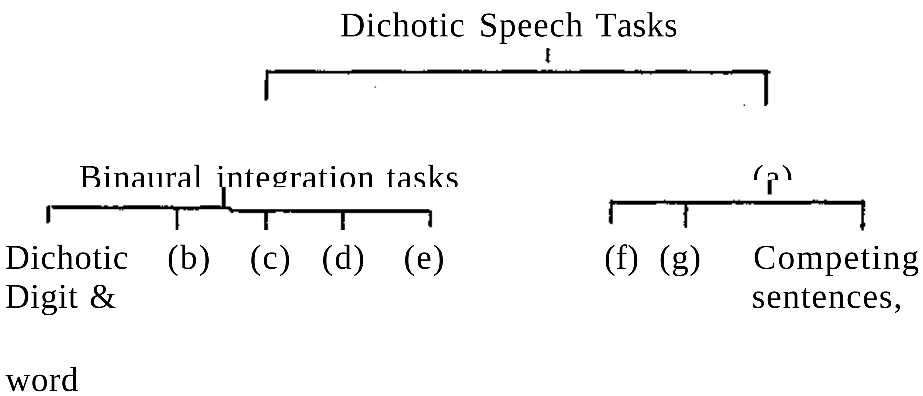
Q2. Match the following investigator with the year of their important investigation.

1. Baran and Musiek	a) 1983
2. Kimura	b) 1967
3. Katz	c) 1972
4. Musiek	d) 1961
5. Willeford	e) 1086
6. Jerger and Jerger	f) 1991
7. Berlin et al.	g) 1968
8. Keith	h) 1962
9. Olsen and Carhart	i) 1974

Q3. Expand the following abbreviations :

1) REA (2) DDT (3) SSW (4) SSI-CCM
(5)DSI (6)DRT (7)CST (8) ICCS

Q4. Complete the table



Q5. Solve the cross word puzzle

CROSS

1. In this kind of lesion, the contralateral ear scores are significantly poorer than ipsilateral ear scores for dichotic test.
3. The brainstem lesion in suspected to be on this side if the left ear scores are normal and right ear scores were severely abnormal on the staggered spondiac word test.

5. The term used when the subjects response is to repeat all the digits heard in any order in a dichotic digit test.

7. The dichotic integration tasks appears to be more sensitive to this kind of lesion than the dichotic separation tasks.

9. Dichotic sentence identification test is the modification of this test.

DOWN

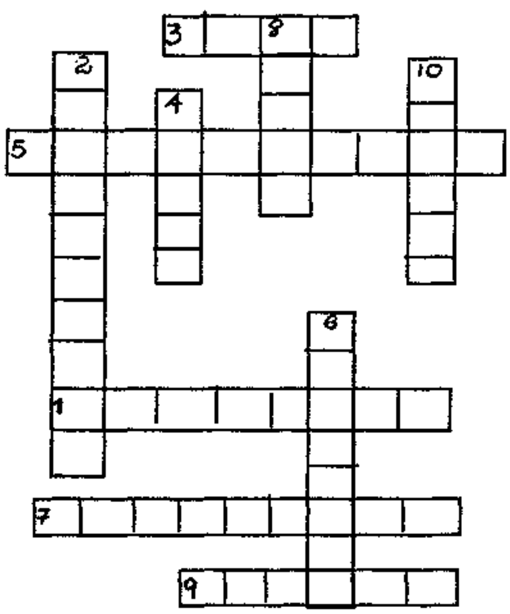
2. The term used if errors are more when stimuli in presented first to one ear in the staggered spondaic word test.

4. The digit that is not included in the dichotic digit test.

6. A term used to refer to the auditory stimuli that are presented to both ears simultaneously with the stimulus presented to each ear being different.

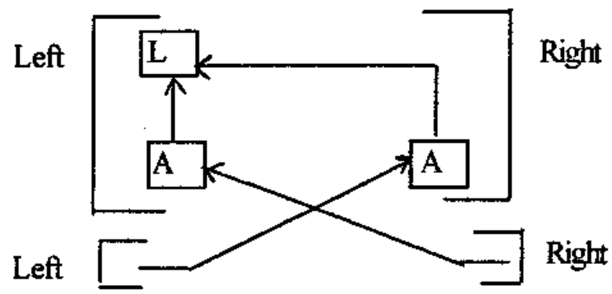
8. He developed dichotic sentence identification test in 1983.

10. A nonspeech dichotic test used for central auditory nervous system testing.



Q8. An outline of the schema for dichotic listening is given below. Study this and represent the following :

a) Right ear advantage in dichotic listening.
b) Damage to right temporal lobe
c) Damage to left temporal lobe involving the preliminary acoustic analysis area (A).
d) Damage to left temporal lobe involving linguistic area (L) and preliminary acoustic area (A).
e) Damage to hemisphere involving terminal collosal fibers.



Q9. Name the site of lesions these tests are sensitive to (that is : brainstem, cortical or others)

1. Dichotic digits tests
2. Dichotic CVs
3. Staggered spondioc test.
4. Competing sentences test
5. SSI-CCM
6. Dichotic sentence identification.
7. Dichotic rhyme test
8. Dichotic word test.

Q10. State whether the following statements are true or false and justify your answer.

1) Ipsilateral and bilateral deficits on dichotic tests are most common in brainstem lesions.

2) During dichotic presentation, there is a suppression of the ipsilateral fibers.

Q6. Identify 10 pioneers in the field of dichotic speech tests and name the test they have given.

W	E	X	L	E	R	H	A	W	L	E	S	I
D	T	A	V	P	L	I	M	N	O	K	G	H
R	S	O	B	K	I	M	U	R	A	E	F	J
O	M	N	A	A	T	R	E	T	P	K	O	N
F	I	F	E	R	S	G	Z	H	Q	M	L	P
E	K	T	M	D	R	T	S	R	T	S	D	Q
L	S	T	K	E	I	S	u	M	A	I	U	R
L	V	U	J	U	U	W	X	Z	X	B	E	C
I	B	R	O	A	D	B	E	N	T	T	U	K
W	Z	Y	L	A	T	E	N	I	L	R	E	B

Q7. Complete the term by answering the statements given below :

1) Terms used to denote that the same identical stimulus is presented to both ears simultaneously.

/ - I O - I - /

2) A term to describe the cerebral dominance effect in dichotic listening in normal right handed listeners.

/ I———E A - / A - - A - - A - E/

3) The term given for presentation of stimuli to one ear.

/ - O - O - I - /

4) The two tasks used in dichotic testing where the listener may be required to repeat everything that is heard as to direct his/her attention to one ear and repeat what is heard in that ear, are binaural:

/ I - - E - - A - IO -/ AND / - E - A - A - IO - /

5) A term used to describe when normal subjects obtained better scores for the trailing stimulus in dichotic tests when the stimuli presented to one ear was delayed in time.

/ - A - / E - - E - - /

3) A greater intensity of 20-40 dB is required for the "weak ear" (contralateral to the lesion) to perform as well as the "stronger ear" for dichotic CVs.

4) Right hemispheric lesions can easily be distinguished from corpus callosal lesion with dichotic tests such as staggered spondiac word test, competing sentence test, etc.

5) Subjects with anterior lobe lesion exhibit greater auditory deficits than posterior lobe lesions.

6) In split brain patients, the introduction of a distorted stimulus to right ear impacted left ear performance on dichotic tasks, depending on the degree of distortion.

Ql 1 .Describe in brief the stimuli and presentation levels and patients response required for the administration of the following tests :

(1) DDT (2) Dichotic CV (3) SSW (4) CST (5) SSI-CCM
(6)DSI (7)DRT (8) Dichotic word (9) IC-CS

Q12. What is the effect of the following lesion on dichotic listening :

1. Right temporal lobe
2. Left temporal lobe
3. Posterior corpus callosum
4. Anterior corpus callosum
5. Low brainstem
6. High brainstem
7. Cochlear pathology
8. Conductive pathology

Q13. What are the hit rates of the following tests in the detection of central auditory processing disorders.

1. Dichotic digit tests for (a) temporal lobe (b) brainstem lesion.
2. Dichotic CV for temporal lobe lesion

3. Staggered spondiac word test for (a) competing (b) non-competing conditions.
4. Competing sentence test for (a) temporal lobe (b) brainstem lesion.
5. SSI-CCM for temporal lobe lesions
6. Dichotic CV for temporal lobe lesions.

Q14.

Test	Subject/Stimuli	Normative data
1 .Dichotic Digit test	adults	.....%(Musiek, 1983)
2.Dichotic CV	.....percentile	56.7% (Musiek, 1983)
3.SSW	a) left ear b) right ear	a) ... % (Lynn and Gilroy b)…. % 1979)
4.CST	a) right ear b) left ear	a) ... % (Musiek, 1983) b) ... %
5.SSI-CCM	At MCR from to-40dB	... to 100% (Jerger, et al. 1968)
6.DSI	a) <39 dB poorer ear PTA. b)<… dB to>…. dB poorer ear PTA c) Without loss	a) <….% difference between ear. b) < 39% difference between ears, c) ...% or better - (Fifer et al. 1983)
7.DRT	a) right ear b) left ear	a) 30 to % b) ... to 60 % -(Musiek, 1983)
Q15. Name the dichotic tests available		in the Indian languages.

Answers

A1.

1) periphery, brainstem - (Pinheiro and Musiek, 1985).
2) digits, words, CVs and Spondees - (Pinheiro and Musiek, 1985).
3) 15, 30, 60, 90 msec- (Berlin et al., 1973).
4) higher intensity - (Willeford, 1977)
5) discrimination loss - (Katz, 1968)
6) CV segments - (Bellis, 1996)
7) ipsilateral, contralateral - (Bellis, 1996)
8) split brain - (Katz et al., 1994)
9) ear advantage - (Willeford & Burleigh, 1985)
10) acoustic, temporal, linguistic (Berlin et al., 1973).

A2.

1) - f)
2) - d)
3) - h)
4) - a)
5) - g)
6) - i)
7) - c)
8) - e)
9) - b)

- (Bellis, 1996)

A3.

1) Right ear advantage
2) Dichotic digit tests
3) Staggered spondiac word test.
4) Synthetic sentence identification with contralateral competing message.
5) Dichotic sentence identification.
6) Dichotic rhyme test
7) Competing sentence test
8) Ipsilateral - contralateral competing sentence test.

A4.

a) Binaural separation tasks

b) Staggered spondiac word test

c) Dichotic CV test

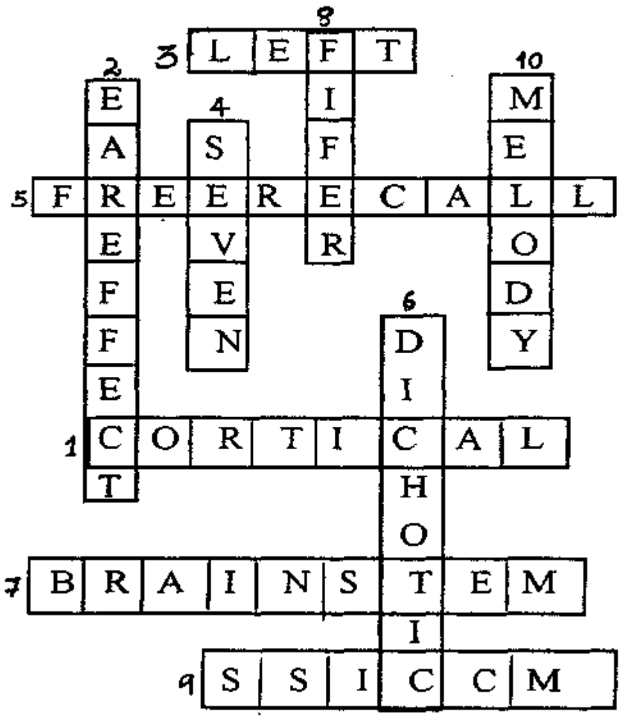
d) Dichotic sentence identification

e) Dichotic rhyme test

f) NU-20

g) SSI-CCM

A5.



Cross

1) Cortical - (Musiek, 1983)

3) Left - (Katz, 1978)

5) Freerecall - "(Musiek, 1983)

7) Brainstem - (Musiek and Pinheiro, 1985)

9) SSI-CCM - (Fifer et al, 1983).

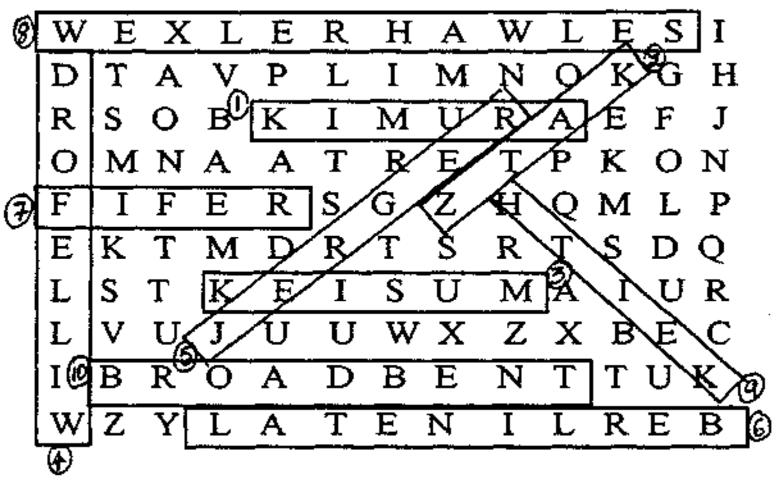
Down

2) Ear effect - (Katz, 1968)

4) Seven - (Musiek and Pinheiro, 1985)

6) Dichotic - (Bellis, 1996)
8) Fifer-(Fifer et al., 1983)
10) Melody -(Kimura, 1964).

A6.



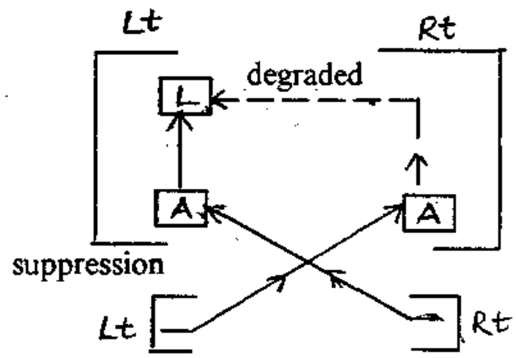
1) Kimura - Dichotic digit test using triads of digits.
2) Katz - Staggered spondiac word test.
3) Musiek - Revised dichotic digit test using diads of digits
4) Willeford - competing sentence test
5) Jerger - SSI-CCM
6) Berlin et al. Dichotic CV.
7) Fifer - Dichotic sentence identification
8) Wexler - Hawles - Dichotic rhyme test
9) Keith - SCAN
10)Broadbent - Dichotic tests.

A7.

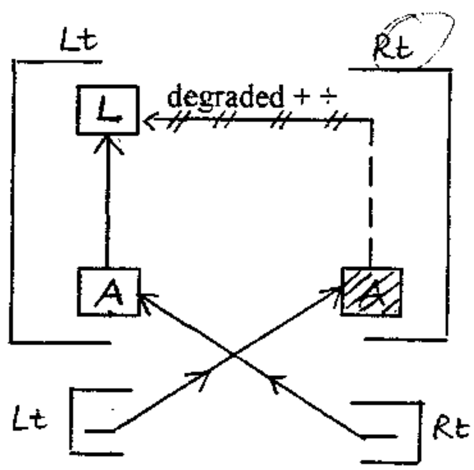
1) Diotic
2) Right ear advantage
3) Monotic
4) Integration and separation
5) Lag effect.

A8.

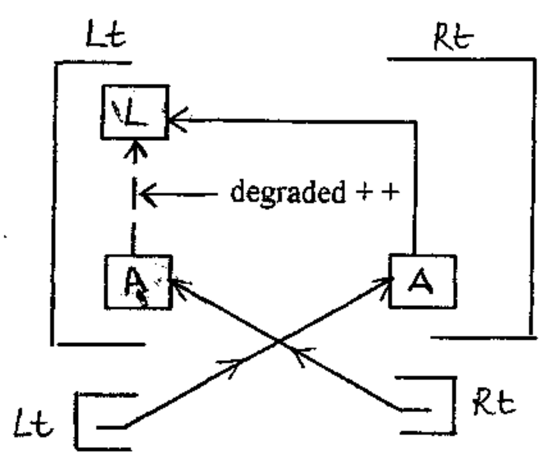
a) Model of right ear advantage during dichotic listening.



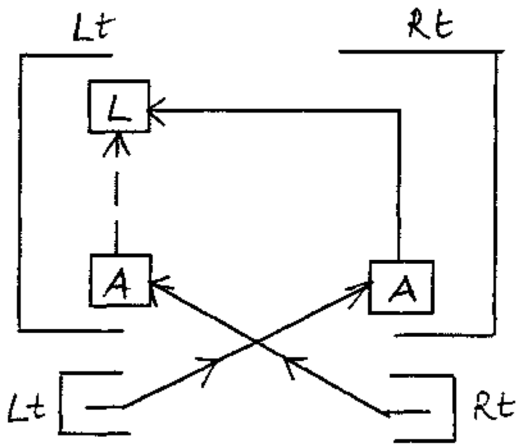
b) Ear effects in persons with damage to right temporal lobe.



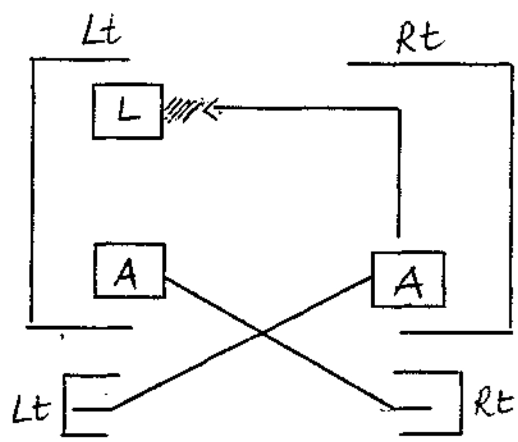
c) Ear effect in person with damage to the left temporal lobe confined to area responsible for preliminary acoustic analysis (A).



d) Ear effects in persons with damage to the linguistic area (L) and area responsible for preliminary acoustic analysis (A) in left temporal lobe.



e) Ear effects in person with damage in left hemisphere involving terminal callosal fiber.



- (Speaks, 1975).

A9.

Test	Sensitive to
1. Dichotic digit test	Brainstem, cortical, corpus - callosal lesions.
2. Dichotic CVs	Cortical lesions.
3. Staggered spondiac test	Brainstem and cortical lesions

4. Competing sentence test.	Neuromaturation and language processing.
5. SSI-CCM	Cortical lesions.
6. Dichotic sentence identification test	Brainstem and cortical lesions,
7. Dichotic rhyme test	Interhemispheric transfer
8. Dichotic word test	Brainstem and cortical lesions.

- (Bellis, 1996).

A10.

1) False : Contralateral and bilateral deficits are also commonly seen. Often extra axial lesions mimic VIII nerve lesion yielding a ipsilateral effect, while intraaxial lesion (above the cochlear nucleus) show contralateral ear effects. Lesion located lower in brainstem may be more apt to yield an ipsilateral deficit, while the higher lesion may yield a contralateral one. - (Jerger and Jerger, 1974).

2) True : The greater number of neural elements in the contralateral pathway result in this suppression. Hence in the dichotic situation the contralateral pathway dominates. - (Kimura, 1964).

3) True : Contralateral ear deficit in central auditory nervous system disorders requires much more intensity for that ear to offset the suppressive effect of the other ear. - (Berlin et al., 1972).

4) False : It is difficult to separate the classic contralateral ear effect from the actual interhemispheric transfer problem, in that both of these conditions can yield the same kind of dichotic results. - (Musiek and Sachs, 1980).

5) False: Subjects with posterior temporal lobe lesion exhibit greater auditory deficit which is consistent with placement of the primary and associative auditory areas in the more posterior aspect of the temporal lobe. - (Brunt, 1978).

6) True : Left ear extinction in split brain patient increases when the stimuli delivered to both ears are very similar and that the localization and depth of lesion significantly affects the degree - of left ear suppression/extinction. - (Sparks and Geschwind, 1968).

All.

Test	Stimulus	PL	Patient's response/ scoring
l.DDT	20 presentations of 4 digits each (2 to each ear)	50 dB	Repeat all digits in any order / % correct
2.Dichotic CV	30 pairs of CV segments/ear.	55 dB	Repeat all CVs / % correct/ear
3.SSW	Spondiac words presented in staggered format in 4 conditions - RNC, RC, LC, LNC	50dB	Repeat all words/ % of error / ear in each condition and total.
4.CST	25 sentence pairs	Target= 35 dB competing = 50dB.	Repeat target sentences / % correct / ear.
5.SSI-CCM	10 third order approximations of English sentences	Primary =30 dB compet-ing = 30-70 dB	Repeat target sentence from a list / % correct /ear.
6.DSI	Same as SSI presented dicho-tically	50 dB	Identify both sentences from a list / % correct / ear and interaural difference.

7.DRT	30 pairs of rhyming CVC words	50 dB	Repeat the words / % correct / ear.
8.Dichotic word	20 pairs of mono-syllabic words.	40dB SL	Repeat all words /% correct / ear.
9.IC-CS	5 lists (A-E) presented in contralateral and ipsilateral competition	Ipsila-teral = 45-50 dBSL. Contra-lateral= 30-50 dBSL.	Repeat all words /% correct/ear.

A12.

Site of lesion	Effects on dichotic listening
1. .Right temporal lobe	Left ear suppression/extinction
2. Left temporal lobe	Contralateral and bilateral suppression/extinction
3. Posterior corpus callosum	Marked left ear deficit/extinction, possible right ear enhancement (severe left ear deficit).
4. Anterior corpus callosum	No effect.
5. Low brainstem	Severe ipsilateral ear deficit.
6. High brainstem	Moderate contralateral and bilateral ear deficit and mild ipsilateral ear deficit.
7. Cochlear	Size and direction of ear advantage may be affected depending on task difficulty.
8. Conductive	No effect at adequate presentation levels.

%;

-(Bellis, 1996).

A13.

1. Dichotic digit Test -
a) Temporal lobe = 80% - (Musiek, 1983)
b) Brainstem lesion = 75% - (Musiek, 1983)

2) Dichotic CV (temporal lobe lesion) = 78 - 90%
- (Olsen and Kurdziel, 1978)

3) Staggered Spondiac word test
a) competing = 91% (Lynn and Gilroy, 1977)
b) noncompeting = 56%

4) Competing sentence test
a) temporal lobe lesion = 63% - (Lynn and Gilroy, 1977)
b) brainstem lesion = 50% - (Musiek, 1983)

5) SSI-CCM (Temporal lobe lesions) = 80%

- (Antonelli et al., 1987)

6) Dichotic CVs (Temporal lobe lesions) = 60% - (Olsen, 1983)

A14

Test	Subject/Stimuli	Normative data
l.Dichotic Digit test	adults	90%(Musiek, 1983)
2.DichoticCV	90th percentile	56.7% (Musiek, 1983)
3.SSW	a) left ear b) right ear	a) 98 % (Lynn and Gilroy b)98.7% 1979)
4.CST	a) right ear b) left ear	a) 97.9 % (Musiek, 1983) b) 97.8 %
5.SSI-CCM	At MCR from 0 to - 40 dB	90 to 100% (Jerger, et al. 1968)

6.DSI	a) <39 dB poorer ear PTA. b) <40 dB to >59 dB poorer ear PTA c) Without loss	a) < 16 % difference between ear. b) < 39% difference between ears. c) 75 % or better -(Fifer et al. 1983)
7.DRT	a) right ear b) left ear	a) 30 to 73 % b) 27 to 60% - (Musiek, 1983)

A15.

1) Abrol (1971) — Speech material for central auditory testing in Hindi.

2) Nagaraja (1972) — Synthetic sentence identificationin Kannada.

3) Swarnalatha (1972) — Synthetic sentence identification in English.

4) Kapur (1971) — Central auditory test in Tamil.

5)De (1973) — Central auditory test in Tamil.

6) Dayalan (1976) — PB word test in Tamil.

7) Nagaraja (1987) — Staggered paired word test in Kannada.

8) Shivashankar (1988) — Competing sentence test in Kannada.

9) Shekhar (1991) — Staggered spondiac word test in Hindi.

10) Hemalatha (1992) — Competing sentence test in Kannada.

11) Chandrashekar (1973) — Standardization of staggered spondiac word test on Indians.

12) Laxmi (1996) — Standardization of dichotic CV on Indian adults.

13) Luna (1996) — Standardization of dichotic C V on Indian children.

PHYSIOLOGICAL AND ELECTROPHYSIOLOGICAL TEST

Questions

Ql. Expand the following abbreviation

(l)AEP	(2) CM	(3)SP	(4)AP
(5)EcoG	(6)ABR	(7) SN o	(8) FFR
(9) MLR	(10)SVR	(ll)SCP	(12)P300
(13)CNV	(14)LLR	(15) SLR	(16)MMN
(17)CAEP	(18)SSP	(19) ART	(20) OAE

Q2. Know your numbers: Write the latencies at which the following auditory evoked potentials arise

1) Cochlear microphonics and summating potentials.
2. Action potentials
3. Auditory brainstem response
4. Middle latency response
5. Slow vertex potentials
6. P-300
7. Contingent negative variation
8. Mismatched negativity

Q3. Fill in the blanks

1. The three latency measures most often examined in ABR for neurodiagnosis are ....,. . . . .and. . . .

2. An interaural latency difference greater than. . . . .msec, is often considered a criteria for neurodiagnostic purpose.

3. The hit rate of auditory brainstem response for the detection of intraaxial or extra axial lesion is. . . . .to. . . . .%

4. In patients with VIII nerve or brainstem lesion, high repetition rates causes an abnormal prolongation of.....wave of the auditory brainstem response.

5. Kileny et al. (1987) reported that the amplitude of.... wave of middle latency response is diminished or absent in subjects with unilateral auditory cortex lesion.

6. "Shape ratio" amplitude for the wave IV-V complex is more sensitive to lesions such as.....

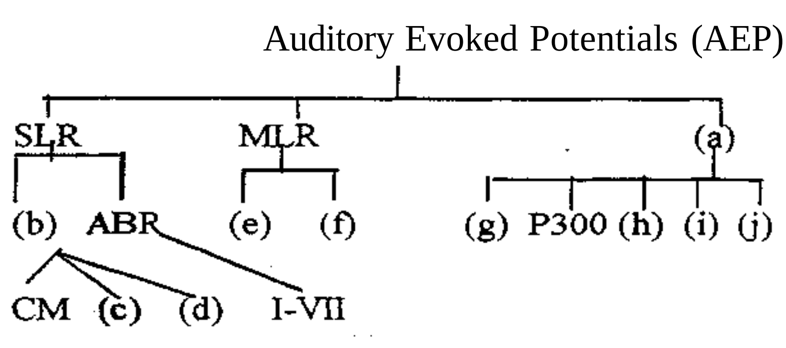
7. A physiological test which is not efficient in detecting central auditory disorders is......

8. Relaxation of the stapedius muscle during presentation of an reflex activation signal is called......

9. Responses that are dependent on subject state and/or on discrimination of some aspects of the stimulus are called.... potentials.

10. Responses that are directly dependent on stimulus characteristics and are independent whether the patient is attending, processing or discriminating the stimulus are called.....potentials.

Q4. Complete the following table



Q5. Which of the following responses are seen in cochlear, VIII nerve and brainstem lesions. Represent in tabular column.

1) No response (poor hearing)
2) No response (good hearing)
3) Wave I present only
4) Wave I and II present only

5) Wave I and III present only
6) Wave V present only (Normal latency)
7) Wave V present only (delayed latency)
8) Waves III and V present only (normal latency)
9) Waves III and V present only (delayed latency)

Q6. Name the site of generation of the following auditory evoked potentials :

1) Electrocochleography
(a) CM (b) SP (c) AP

2) Auditory brainstem responses
(a) Wave I (b) Wave II (c) Wave III (d) Wave IV (e) Wave V (f) Wave VI and VII

3) Middle latency responses
(a)Na (b)Pa

4) 40 Hz
5) Long latency responses
a) Nl (b) processing negative wave (c) P2 and N2 (d) P300 (e) N400

Q7. Descibe the test protocol used for the following tests used for differential diagnosis of auditory disorders :
1) Acoustic reflex decay
2) Auditory brainstem response
3) Middle latency response
4) Long latency response

Q8. Name the following

1) The wave which is a neurophysiologic reflection of the processing of stimulus differences especially auditory discrimination.

2) The auditory evoked potentials reflecting semantic cognitive processing and attention.

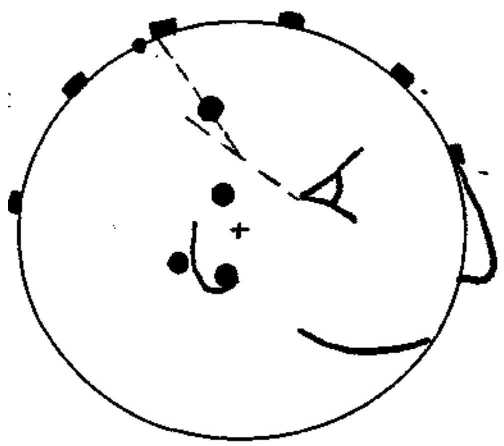
3) The auditory evoked potentials which are affected by state of arousal or consciousness.

4) A slow negative potential which usually depends upon the association between two successive stimuli.

5) The potential which reflects the semantic processing of language.

Q9. Represent the following electrode sites given by 10-20 international electrode system.

1) Fz - frontal midline
2) Fpz - Frontoproximal midline.
3) Cz - vertex
4) Nz - Nasion
5) A1/A2 - Auris
6)M1/M2 -Mastoid
7) T3/T4 - Temporal
8) Oz - occipital midline
9) C3 and C4 - Coronal.



Q10. Match the following auditory evoked potentials with their investigators.

I.EcoG	a) Davis (1938)
2. ABR	b) Gisler and Coll (1958)
3. MLR	c)Naatanen, Gaillard, Manitysalo (1979)
4. 40 Hz	d)Wever and Bray (1930)
5. LLR	e)Galambos and Coll (1981)
6. P300	f) Davis and Sutton (1965)
7. MMN	g) Jewett and Williston (1971)

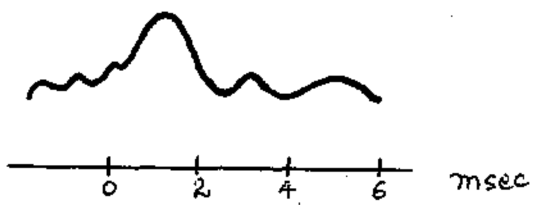
Ql 1. Draw the Jerger box pattern for acoustic reflex for subjects with normal hearing and the following lesions :

a) Intraaxial brainstem lesion

b) Extra axial brainstem lesion

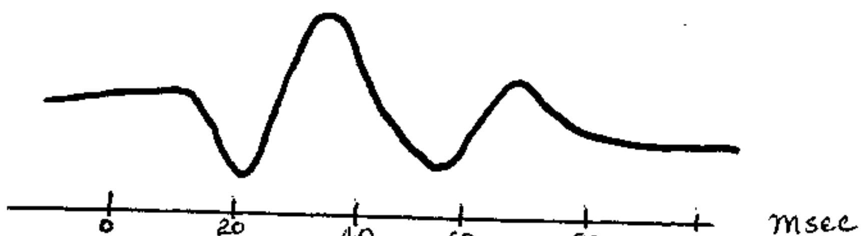
Q12. Identify and label the following waveforms,

a) Summating potential (SP), Action potential (AP)

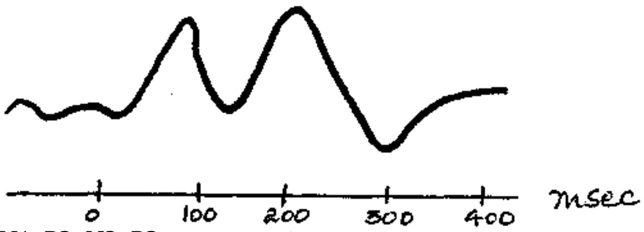


b) Waves I, II, III, IV, V

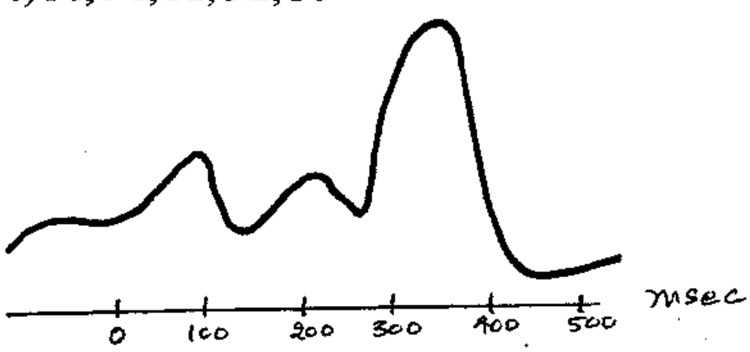
c) Po, Na, Pa, Nb, Pb



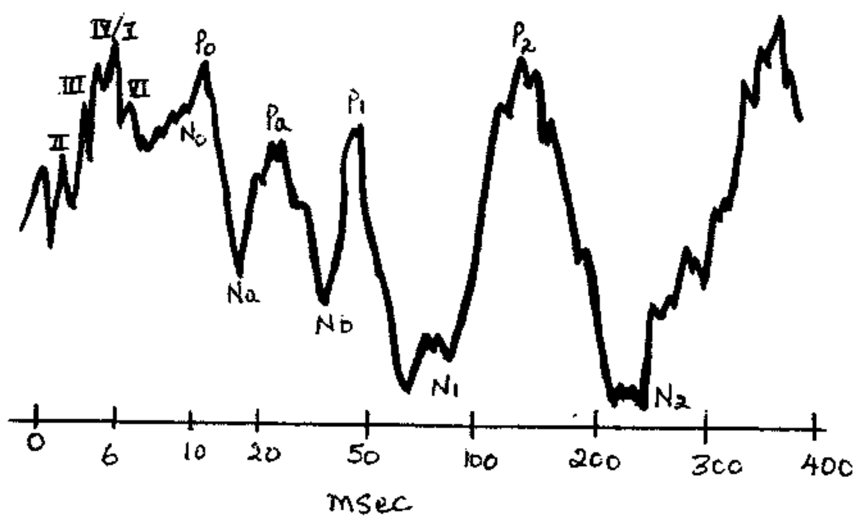
d) P1, N1, P2, N2



e) P1, N1, P2, N2, P3



f) Short latency (SLR), Middle latency (MLR), Long latency (LLR) responses.



Answer

Al

1) Auditory evoked potentials
2) Cochlear microphonics
3) Summating potential
4) Action potential
5) Electrocochleography
6) Auditory brainstem response
7) Slow negative
8) Frequency following response
9) Middle latency response
10) Slow vertex potential
11) Sustained cortical potentials
12) Late positive component
13) Contingent negative variation
14) Late latency response
15) Short latency response
16) Mismatched negativity
17) Cortical auditory evoked potential
18) Steady state potentials
19) Acoustic reflex threshold
20) Otoacoustic emission.

A2.

(1)0 msec	(2) less than 2 msec.	(3) less than 10 msec.
(4) 8-50 msec.	(5) 12-50 msec.	(6) 280-300 msec.
(7) 300 +msec.	(8) 235 msec.	

- (Hall, 1992)

A3)

1) Absolute latency of wave V, interaural latency differences between ears for wave V and interpeak latencies between waves. -(Musieketal., 1996)

2) 0.3 msec. - (Thomsen et al., 1978)
3) 92-100% - (Hall, 1992)
4) V - (Campbell and Abbas, 1987)

5) Pa-(Katz, 1994)
6) Multiple sclerosis - (Sand, 1991)
7) Otoacoustic emission - (Hall and Mueller, 1997)
8) Acoustic reflex adaptation/decay - (Fowler 1984).
9) Endogenous - (Jacobson et al., 1994)
10) Exogenous - (Jacobson et al., 1994)

A4

a) Long latency response
b) Electrocochleography
c) Summating potential
d) Action potential
e) Middle latency response
f)40Hz
g) Show vertex response
h) N 400
1) Contingent negative variation
j) Mismatched negativity.

A5

ABR pattern	Cochlear	VII nerve	Brain stem
1) No response (poor hearing)	+	+	+
2) No response (good hearing)		+	+
3) Wave I present only		+	
4) Wave I and II present only			+
5) Wave I and III present only			+
6) Wave V present only (normal latency)	+		
7) Wave V present only (delayed latency	+	+	+
8) Waves III and V present only (normal latency)	+		
9) Waves III and V present only (delayed latency)	+	+	+

- (Hall, 1992)

A6.

1) a) AC activity of outer hair cells in the basal most turn of the cochlea.
   b) DC activity reflecting the distortion product of the hair cells.
   c) Nerve fibers in the basal or high frequency region of the cochlea.

2 a) Distal portion of the VIII nerve i.e. afferent activity of the VIII nerve fibers as they leave the cochlea and they enter the internal auditory canal.

   b) Proximal portion of the VIII nerve as it enters the brainstem.

   c) Contralateral medial nucleus of the trapezoid body, second order neuron activity in or near the cochlear nucleus.

   d) Nucleus of the lateral leminiscus, also from pontine third order neurons in the superior olivary complex with contribution from the cochlear nucleus.

   e) Positive voltage from the termination of lateral leminscus fibers as they enter the inferior colliculus and negative voltage from the dendritic potentials within the inferior colliculus.

   f) Thalamic (medial geniculate body) and also inferior colliculus.

3 a) Thalamus or thalamo cortical pathway reticular formation,
   b) Primary auditory cortex, auditory radiation fibers.

4) Brainstem, thalamus, auditory cortex, reticular formation.

5) a) Superior temporal cortex.
   b) Auditory cortex - thalamus and hippocampus
   c) Frontal lobe and limbic system.
   d) Multiple subcortical sites-limbic system, hippocampus, reticular formation.
   e) Left hemisphere auditory cortex.

-(Hall, 1992)

A7

1) Acoustic Reflex Decay

Frequencies - 500 and 1000 Hz

Intensity - 10 dB above acoustic reflex threshold.

Duration of Stimulus - 10 sec.

Presentation - ipsilaterally or contralaterally

- (Anderson et al., 1970)

2) Auditory Brainstem Response

Stimulus - Broad band chick

Rate - 11 to 3 3/sec

Montage - Vertex and two mastoids earlobes

Polarity - rarefraction

Intensity - 70-95 dB

Presentation - Monaurally

- (Hall, 1992)

3) Middle Latency Response

Stimulus - monaural clicks

Rate - 1-2/sec

Montage - coronal montage with electrodes at Cz and over each temporal lobe (half way between Cz and the mastoid i.e. C5, C6, Fz, Fpz)

Polarity - alternation

Intensity - 70 dB HL

Presentation - Monaurally

-(Hall, 1992)

4) Long Latency Response

Stimulus - tone bursts/two different tones/speech stimuli

Rate-0.5 -1.0/sec

Montage - at high forehead or vertex (Fz, Fpz)

Polarity - usually alternating though it is not important.

Intensity - 70 dB

Presentation - Monarally

- (Hall, 1992)

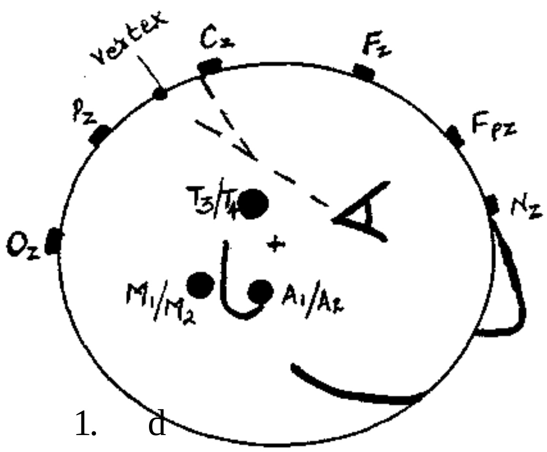
A8.

1) Mismatch negativity

2) N-400, P-300, processing negativities

3) Middle and long latency response
4) Contingent negative variation
5) N-400
- (Hall and Mueller, 1997)

A9.



- (Hall, 1992)

A10.

1. d
2- g
3. b
4. e
5. a
6. f

-(Hall, 1992)

A11.1) Intraaxial brainstem lesion

a) Horizontal

	R	*L*
C	■	■
I	□	□

2) Extra axial brainstem lesions

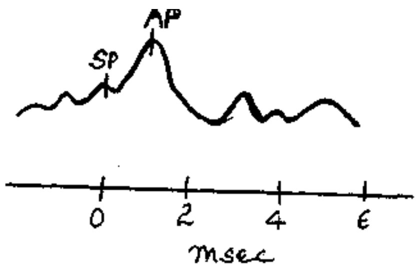
a) Uni box

	R	L
C	■	□
I	□	□

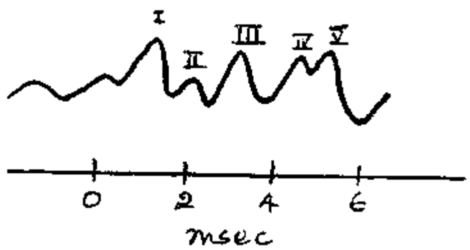
Where,
R = right ear
L = left ear
C = Contralateral stimulation
I = Ipsilateral/stimulation
□ = Normal/present,
■ = Abnormal/absent

A12.

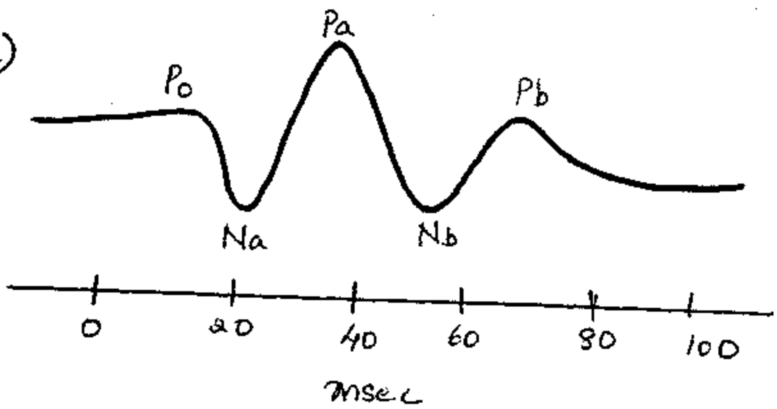
a)



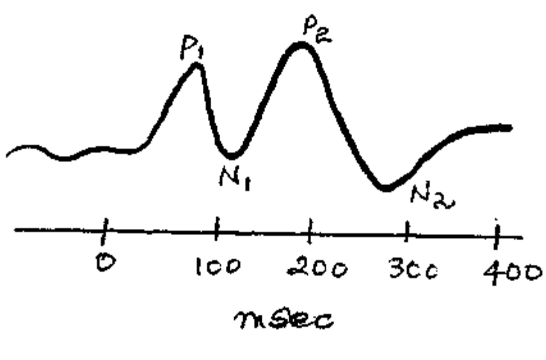
b)



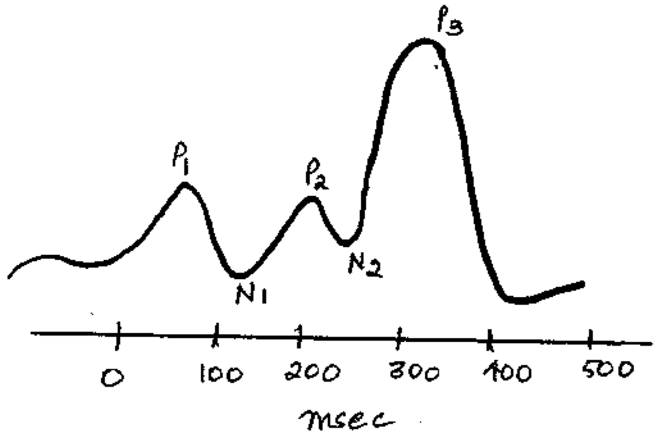
c)



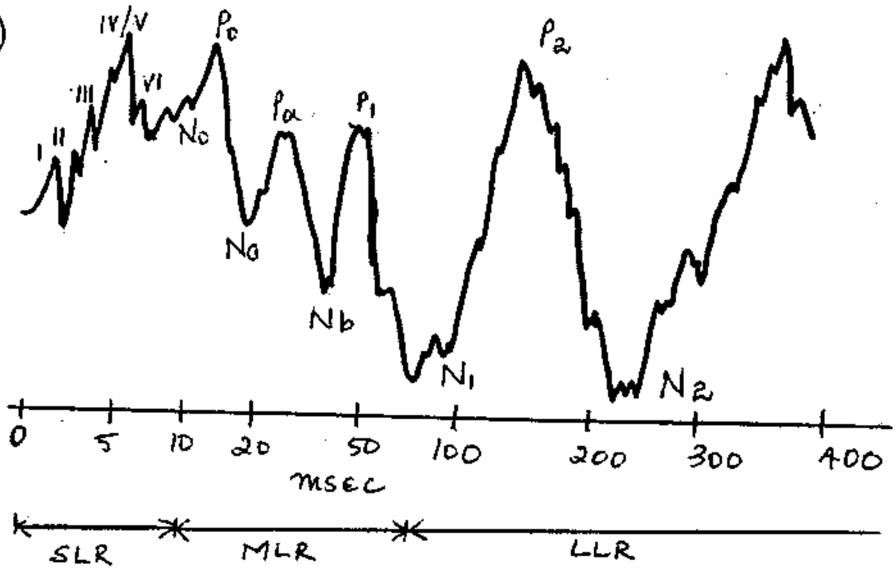
d)



e)


P3
P1
P2
N2
N1
0
100
200
300
400
500
msec

f)


IV/V
Po
P2
III
VI
Pa
P1
I II
No
Na
Nb
N1
N2
0
5
10
20
50
100
200
300
400
msec
SLR
MLR
LLR

CENTRAL AUDITORY PROCESSING DISORDERS IN CHILDREN

Questions

Ql, Expand the following abbreviations

(l)TAPS	(2)GFWB	(3) LAC	(4) ADT
(5)ITPA	(6) CCA	(7)CAPT	(8) DTLA
(9) DAPS	(10) ASMT	(11) CELF-R	(12) SCAN
(13)PSI	(14) ADD	(15) ADHD	

Q2. (a) Match the following tests with their authors.

1) DAPS	a) Kirk, McCartley & Kirk (1968)
2) Carrow auditory visual abilities test.	b) Reynolds (1987)
3) Tests of written language ability (CELF-R)	c) Butler, Hedrich & Manning (1973)
4) GFWB	d) Flowers, Costello & Small (1973)
5) DTLA	e) Reagan and Cunningham (1975)
6) TAPS	f) DiSimoni (1978)
7) ASMT	g) Woodcock (1976)
8) LAC	h) Baker & Leland (1967)
9) CCA	i) Gardner (1985)
10) ADT	j) Carrow-Woolfolk (1981)
11) CAPT	k) Semel, Wing and Secord (1987)
12)iTPA	1) Woodcock (1977)
13) Token test for children	m) Lindamood & Lindamood (1971)
14) Woodcock-Johnson Psychoeducational Battery revised	n) Wepmam and Morency (1973)
15) SCAN	o) Jerger and Jerger (1984)
16)PSI	p) Keith (1986)

(b) List which of the above tests assess the following areas

(1) Discrimination
(2) Memory/sequencing
(3) Figure ground
(4) Closure
(5) Association
(6) Language

Q3. Fill in the blanks

1. Chermak and Musiek (1997) reported that, the prevalence of central auditory processing disorders in children is. . . . . . .to .... % with a male to female ratio Of... : ....

2. Children with central auditory processing disorders experince attention deficits restricted to auditory-modality, but those with . . . . .experince attention deficit in more than one sensory modality.

3. The only audiological test to date that has been designed specifically for the purpose of screening for central auditory processing disorders is. . . . . .

4. A majority of the tests for central auditory processing disorders can be administered for children whose mental age in greater than. . . . years.

5. The frequencies used in the pitch pattern sequence test for children are. . . . .and. . . .

6. In synthetic sentence identification with ipsilateral competing message, the child is asked to.....instead of reading the item from a list.

7. The four tests, filtered speech test, binaural fusion, alternating speech and competing sentences constitute the. . . . .

8. The test that can be used for children which is based on the synthetic sentence identification concept is. . . .

9. A nonlinguistic dichotic test which was developed by Katz et al. (1992) is called. . . .

10. Ipsilateral contralateral competing sentence test did not show any right left (ear dominance effect) in the. . . . .mode with younger children.

Q4. The following characteristics are afected in children with central auditory processing disorders. In one sentence describe how they are affected.

A. Hearing difficulties :

1) ability to follow verbal commands or instructions (long and complex)
2) response to questions
3) response to auditory stimulation and auditory awareness.
4) auditory discrimination skills
5) repetition
6) listening
7) auditory localization skills
8) response to speech
9) interjections
10) verbal vs. written instructions
11) response to loud noise
12) voice use
13) response to noise
14) hearing acquity

B. Academic performance :

1) academic problems
2) intelligent quotient
3) class assignments
4) attention span
5) response to auditory or visual stimuli
6) long or short term memory

C. Behaviours :

1) Hyperctivity
2) Hypoactivity
3) Interaction with peers, younger children and adults.
4) Self concept
5) Trying new tasks
6) Attitudes
7) Social and emotional overlay

8) Environment preference
9) Parent child interaction

D. Others
1) Neurological signs
2) Coordination
3) Time concepts
4) Speech and language problems
5) Fine and gross motor skills

Q5. List the etiological factors causing central auditory processing disorders in children.

Q6. Name the tests under eachof the following categories which have been developed or modified for testing children with central auditory processing disorders
a) monotic tests
b) dichoric tests
c) binaural interaction tests
d) electrophysiological tests

Q7. Match the tests with the investigator who has developed or modified it for children.

1) Filtered speech test	a) Pinheiro (1977)
2) Compressed WIPI	b) Jerger, S (1983)
3) Pitch pattern sequence test	c) Arnst and Katz (1982)
4) SSI-ICM and CCM	d) Willeford (1978)
5) Dichotic digits	e) Musiek, Geurkink and Keitel (1982)
6) Staggered spondiac word test	f) Willeford (1976)
7) Competing sentence test	g) Beasley and Maki and Orchik (1976)
8) IC-CS	h) Katz, Kushner and Pack (1975)
9) Dichotic CV	i) Willeford and Burleigh (1985)
10) Competing environmental sounds.	j) Berlin,Huges & Lowe-Bell (1973)
11) RASP	k) Sweetow, Reddel (1975)
12) MLD	1) Willeford & Billger (1978a)

Q8. Complete the following table which gives the normative data of the central auditory tests on children.

Test	Age/stimuli	Norms
1.Willeford filtered speech	a) 6 years b). . . . years	a) ... % (Willeford and b)72% Bueleigh(1986)
2.Alternating speech	Children	.... %
3.Binaural fusion	Children	.... %
4. LPFS	Children	.... %
5. SSW	Children	75 to ... %
6. Simultaneous sentences	a) 6 years b). . . . years	a) ... % b) 100%
7. CST	Children	... %
8. PPST	a)Verbal b)….	a) ... % b) 90%
9. WIPI compressed speech	Children	... %
10.IC-CS	 a) List A b) List B c) List C d) List D e) List E	6 years and 10 years a)82%& ... % b)… %& 94% c)45%&… % d) .... % & 97% e) 87% &….%
11.RASP	a) 5 years b) 10 years	a) .... % b) .... %
12.DDT	 a) 7-8 years b) 8-9 years c) 9-10 years d) 10-11 years e) 11-12 years.	Right Left a) 70% .....% b) ... % 65% c) 80% ... % d)…% 78% e)90%. . . . %

Answers

Al

1) Test of auditory perceptual skills
2) Goldman-Fristoe-Woodoock auditory skills battery.
3) Lindamood auditory conceptualization test.
4) Auditory discrimination test.
5) Illinois test of psycholinguistic abilities.
6) Flowers - Costello tests of central auditory abilities. .
7) Composite auditory perceptual test.
8) Detroit tests of learning aptitude.
9) Differntiation of auditory perceptual skills.
10) Auditory sequential memory test.
11) Clinical evluation of langauge fundamentals - revised.
12) Screening test for auditory processing disorders.
13) Pediatric speech intelligibility test
14) Attention Deficit disorders.
15) Attention deficit hyperactivity disorder

- (Bellis, 1996)

A2(a)

I. e
2- j
3. k
4- g
5. h
6. i
7. n
8. m
9. d
10. b
II. c
12. a
13. f
14. 1
15. p
16. o

- (Bellis, 1996)
- (Willeford and Burleigh, 1985)

A2(b)

1) Discrimination
ASMT, GFWB, TAPS, LAC, ADT, CAPT, DAPS, Carrow auditory visual abilities test.

2) Memory/sequencing
ITPA, DTLA, TAPS, GFWB, LAC, ASMT, CAPT, DAPS, Carrow auditory visual abilities test.

3) Figure Ground
CAPT, CCA, GFWB, PSI, SCAN, DAPS, Woodcock Johnson Psychoeducational battery - revised.

4) Closure
ITPA, CCA(LPFS), GFWB, PSI, SCAN, Carrow auditory visual abilities test.

5) Association
ITPA, Token test for Children, Woodcock Johnson psychoeducational battery - revised.

6) Language subtests
ITPA, GFWB, Token test for children, WLA, DTLA, DAPS, CELF-R,
Woodcock Johnson psychoeducational battery - revised.

-(Bellis, 1996)
- (Willeford and Burleigh, 1985)

A3.

1) 2-3%, 2:1 - (Chermak and Musiek, 1997)
2) Attention deficit hyperactivity disorder - (Keller, 1992)
3) SCAN - (Keith, 1986)
4) 7-8 years - (Bellis, 1996)
5) 880 Hz and 1430 Hz - (Pinheiro, 1977)
6) Repeat the sentences - (Jerger, 1983)
7) Willeford test battery - (Willeford, 1985)
8) IC-CS - (Willeford and Burleigh, 1985)

9) Competing environmental sounds - (Kate et al., 1992)
10) Dichotic - (Willeford and Burleigh, 1985)

A4. A) Hearing Difficulties

1) Very poor especially multistep instructions
2) gives inappropriate responses.
3) sometimes appropraite and sometimes not, one to one conversation in better than in group.
4) poor discrimintion skills - misunderstand what is said.
5) repeatedly ask for repetition.
6) poor listener - ignores sound totally.
7) difficulty in localization.
8) sometimes responds too quickly to avoid fear of failure.
9) says what/huh:- is buying time to process or figure out what is said.
10) discrepancy in performance on this task.
11) frightened, startled or upset.
12) uses a loud voice.
13) withdraws when there is excessive noise.
14) normal hearing but behaves as if hearing loss is present.

B) Academic Performance

1) Problem with reading, spelling and writing. They are non-achievers, failures and perform below expected academic levels.
2) A discrepancy present between IQ and achievement, no correlation between IQ and CAPD. Verbal IQ scores lower than performance IQ scores.
3) Difficulty completing assignments.
4) Short attention span, fatigued easily by a long or complex activity.
5) Easily distracted by them.
6) Not able to remember information.

C) Behaviour

/ 1) high activity levels
2) passive, reserved, lethargic has trouble beginning a task.

3) mainly a 'loner' may play with younger children and adults rather than peers.
4) poor self concept.
5) reluctance to try new tasks for fear of failure.
6) has a 'don't care' attitude.
7) inadequacy, rejection, unacceptibility, depression in older child may result in delinquency.
8) seeks quite or structured environment.
9) clings to parents in active environment.

D) Others

1) may have 'soft' neurological signs.
2) incoordinated
3) difficulty with time concept.
4) obvious or subtle.
5) may be deficient.

- (Hall and Mueller, 1996)

A5.

Relationship have been proposed between neurological deficits and the following (specific or behavioural)

1) low birth weight
2) brain damage
3) lead poisoning
4) food additives
5) excessive carbohydrate ingestion
6) otitis media
7) environmental deprivation
8) delayed or arrested myelination
9) hereditary factors
10) biochemical or metabolic factors like PKU, galactocemia, glycemia, etc.
11) Trauma or injury to CANS

-(Barr, 1976).

A6. a)Monotic tests

1) Filtered speech
2) Cornpressed speech
3) Pitch pattern sequences
4) SSI-ICM
5) PI-PB
6) SPIN

b) Dichotic tests

1) Dichotic digits
2)SSW
3) SSI-CCM
4)CST
5) IC-CS
6)C-Vtest
7) Binaural fusion
8) Competing environmental sounds.

c) Binaural interction

1)RASP
2) MLD

d) Electrophysiological and physiological tests

1) Aural reflex test
2)ABR
3) Cortical evolved responses

- Willeford and Burleigh (1985)

A7.

1	d
2	g
3	a
4	b
5	e
6	c
7	f
8	i
9	j
10	h
11	1
12	k

- (Musiek & Pinheiro, 1992)

A8

Test	Age/stimuli	Norms	
1.Willeford filtered speech	a) 6 years - b) 10 years	a) 64 % b) 72%	(Willeford and Burleigh, 1986)
2.Alternating speech	Children	80 %	(Pinheiro, 1977)
3.Binaural fusion	Children	75 %	
4. LPFS	Children	70 %	
5. SSW	Children	75 to 80 %	
6.Simultaneous sentences	a) 6 years b) 10-12 years	a)70 % b)100%	
7. CST	Children	80 %	
8. PPST	a)Verbal b)hummed	a)75 % b) 90%	
9. WIPI compressed speech	Children	90 %	
10.IC-CS		6 years and 10 years	Pinheiro, 1977
	a) List A	a) 82% & 93 %	
	b)ListB	b)90%& 94%	
	c) List C	c) 45% & 70 %	
	d)ListD	d)83%& 97%	
	e) List E	e) 87% & %	
11.RASP	a) 5 years b) 10 years	a) 98 % b) 100.%	
12.DDT		Right Lef t	
	a) 7-8 years	a) 70% 55%	(Silman & Silverman, 1991)
	b) 8-9 years	b) 75 % 65%	
	c) 9-10 years	c) 80% 75 % -	
	d) 10-11 years	d)85% 78%	
	e) 11-12 years.	e) 90 % 88%	

MANAGEMENT OF CENTRAL AUDITORY PROCESSING DISORDERS

Questions

Q1. Fill in the blanks

1. The 3 categories in management of Central Auditory Processing Disorders (CAPD) in the educational setting are ....,...... and

2. ...... clues plays an important role in auditory closure activities.

3. The two approaches to phonemic training are phonemic .... and

4. Commonly used assistive listening device for management of children having central auditory processing disorders children is....

5. ...... systems are an altrnative to the sound field FM systems for personal and area listening for individuals with central auditory processing disorders.

6. The three main stratagies of central auditory processing disorder management are auditory training, ... and .... strategies.

7. ......, ... and .... skills can be used as compensatory strategies for management of central auditory processing disorders.

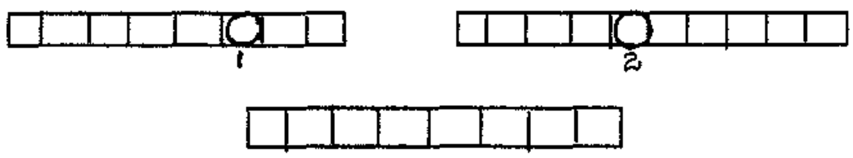
8. Recovery of function with various management strategies is more in children than when compared to adults due to...... of the brain.

9. The comprehensive management approach given by Chermak and Musiek (1997) are based on........, ... and ...... theories.

10. The two kinds of generalization strategies which are used in management of central auditory processing disorders are..... and.....

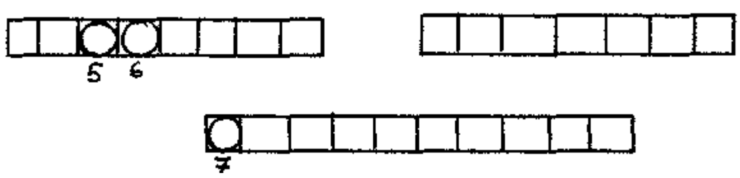
Q2. Give a terminology for the following statements and put them into the box. Form a word from the circled letters and define the term in one-two sentences :

1) These activities train the child to discriminate differences, analyze and imitate rhythmic patterns of auditory stimuli.

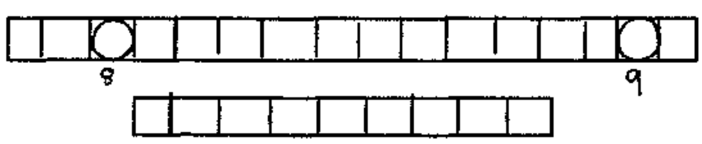


2) These activities help the child to develop accurate phonemic representation and speech-to-print skills.

3) These activities assist the child in learning to fill in missing components of a message in order to arrive at a meaningful whole.

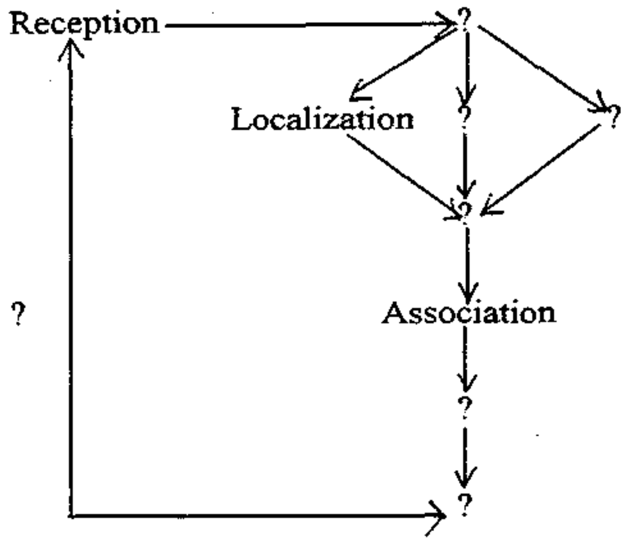


4) These activities stimulate the corpus callosum in order to improves interhemispheric transfer of information.



5) These activities help the child learn to recognize and use prosodic aspects of speech (eg. rhythm, stress, and intonation).

Q3. What general areas should be considered in the management of central auditory processing disorders and how is one related to the other? Find out by completing this schematic diagram given below :



Q4. Name a few commercially available remedial and developmental programs for working on children with central auditory processing disorder.

Q5. What parameters should be worked on in auditory training for the management of children/adults with central auditory processing disorders.

Q6. a) Explain the following techniques used for the management of central auditory processing disorders in not more than two sentences.

b) Segregate these techniques into metacognitive and metalinguistic strategies :

1) attribution training
2) vocabulary training and construction of meaning.
3) discourse cohesion devices.
4) prosody training
5) cognitive style and reasoning activities.
6) reciprocal training
7) metamemory activities
8) schema induction
9) segmentation training

Q7. What are the management strategies that can be used with children having (a) Decoding deficit (b) Integration deficit (c) Organization deficit (d) Association deficit.

Q8. a) List a few tips on environmental modification for management of central auditory processing disorders.

b) List a few modifications that can be made by the speaker/ teacher and listener in a classroom.

Q9. Give examples of the following remediation activities :

(1) Auditory closure activities
- (a) missing word exercises
- (b) missing syllable exercises
- (c) missing phoneme exercises
- (d) vocabulary building

(2) phoneme training
- (a) consonant discrimination training
- (b) associating auditory input of sound with letter symbols.

3) Prosody training
- (a) words in which change in syllabic stress changes the meaning (isolation or sentence)
- (b) sentences in which differences in prosodic features alter the meaning exaggerated or normal tone of choice
- (c) key word extraction.
- (d) reading

4) Temporal patterning training
- a) discrimination of rhythm, speed etc.
- b) stress in sentences

5) Interhemispheric exercises
- a) verbal to motor transfer
- b) music

Q10. *Give* five examples of compensatory strategies.

Ql 1. What are the suggestion for parents with children having central auditory processing disorder.

Q12. How can you modify the management strategies when working with preschoolers having central auditory processing disorder.

Q13. What techniques can be used with elderly population having central auditory processing disorder.

Q14. There are a few basic treatment principles which are used for a child with auditory processing difficulty. Can you write one sentence on the following points :

1) kind of instruction
2) guessing
3) signal detection - speaking rate
4) cues
5) presentation of speech
6) accuracy vs. efficiency
7) child's responsibility for signal detection
8) levels of linguistic structure
9) when to work on articulation
10) rate of programming management
11) success rate
12) reinforcements
13) warm up exercises
14) information about progress
15) keeping track of progress.

Q15.Briefly mention how the following theories can help in devicing management strategies for people with central auditory processing disorders :

1) cognitive neuroscience
2) systems theory
3) information processing theory

Ql 6. What kind of generalization strategies can you incorporate within the therapy sessions for central auditory processing disorder management.-

Answers

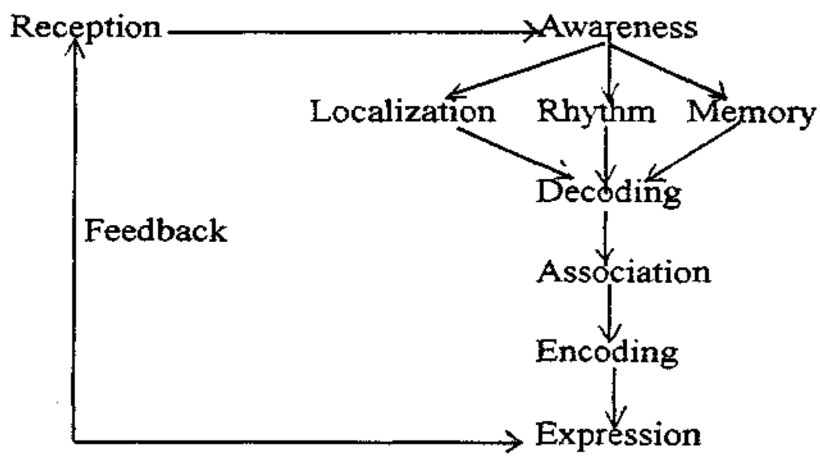
A1.
1) environmental, remediation and compensatory - (Bellis, 1996).
2) contextual - (Bellis, 1996).
3) synthesis and analysis - (Schneider, 1992)
4) FM system - (Schneider, 1992)
5) Infra red - (Chermak and Musiek, 1997)
6) metalinguistic and metacognitive - (Chermak and Musiek, 1997)
7) linguistic, metalinguistic, metacognitive - (Musiek, 1997).
8) plasticity - (Chermak and Musiek, 1997)
9) systems theory, information processing and cognitive neuroscience - (Chermak and Musiek, 1997)
10) within training and environmental support strategy - (Chermak, 1998).

A2.
1) Temporal patterning training
2) Phoneme training
3) Auditory closure activities
4) Interhemispheric exercises
5) Prosody training.

HIDDEN TERM: REMEDIATION

All the above given activities are subgroups of this 'Remediation' activities which are meant to attempt to alleviate the disorder through specific therapeutic activities. - (Bellis, 1996)

A3.



- Barr (1976)

A4. Some remedial developmental programmes are :

1) The remediation of hearing disabilities - (Valette, 1967).
2) Aids to psycholinguistic teaching - (Bush and Giles, 1969)
3) Auditory perception training - (Willette, Jackson and Peckins, 1970).
4) Auditory Discrimination in Depth - (Lindamood & Lindamood, 1969).
5) Sound/order/sense - (Semel, 1970).
6) Handbook of auditory training - (Reagan, 1973)
7) Auditory perceptual disorders and remediation - (Heasley, 1974)

A5.
1) Intensity training - eg. intensity discrimination.
2) Frequency training - eg frequency discrimination and transitions, comparing modulation rates.
3) Temporal training - Eg. discrimination of CV pairs as different (ba, da) or same (ba, ba) gap detection.
4) Dichotic speech perception training - eg. speech recognition task in various competing conditions.
5) Speech perception in competition training - listening to target words with competing 4 speaker babble - (Musiek and Schochat, 1998).

A6. A) Metalinguistic strategies

1) Discourse cohesion devices - it is used to establish relationships between ideas (eg. causal relationships). They are linguistic forms that connect proportions into more complex messages.

2) Vocabulary building and construction of meaning - use context derived vocabulary building, auditory discrimination, phonemic analysis and synthesis, and construction of meaning.

3) Prosody - working on stress, rhythm and timing, intonation.

4) Metamemory- or knowledge and awareness of one's own memory - (Flavell and Wellman, 1977).

a) Pharmacological treatment
b) Internal strategies like (Harris, 1992) mnemonic techniques like elaboration, transformation, chunking and coding eg. acronyms, rhymes, verbal mediaters, visual imagery, drawing, recasting organization etc.
c) Repetitive practice - rehearsals.
d) External aids - cognitive orthotic devices like computers.

5) Schema induction - are linguistic markers that promote cohesive and coherent messages. They organize, integrate and predict relationships across words.

6) Segmentation syllabic segmentation to recognize the coarticulation of spoken language.

B. Metacognitive strategies

(1) attribution training - for increasing motivation, self esteem through beedback (Bryan, 1991).
(2) Cognitive behaviour modification to induce self-control, through a planful, reflective processing and response style - (Lloyd, 1980).

a) Self instruction to formulate self directing verbal statements.
b) Cognitive problem solving - in a systematic process.
c) Self regulation procedures - through self control.
d) Cognitive strategy training - to help clients become more aware of their cognitive process.

3. Reciprocal teaching - alternating roles between the client and clinician (Casanova, 1986; Chermak, 1996).

4. Cognitive style and reasoning - evaluation of arguments, drawing inferences, conclusion etc. (Nickerson, 1986) along with deductive and inductive inferencing and assertiveness training. - (Chermak and Musiek, 1997).

A7.

Deficit	Management procedure
a.Decoding deficit	Consonant and vowel training speech to print skills, vocabulary building, closure activity, reduce interfering noise, preferential setting, repeat or rephrase information, preteaching new information.
b.Association deficit	Language intervention, metacognitive techniques to improve memory and recall, verbal, rehearsal, chunking, tag words, organizational aids, preteaching of new information, whole language approaches, self monitoring of learning behviour, rephrasing or paraphrasing.
c. Organization deficit	Metacognitive techniques speech and language services, rephrasing and repetition of messages, imposition of external organization.
d.Integration deficit	Improving interhemispheric transfer of information, linguistic labeling of tactile stimuli, music, singing, dance activities, following verbal instructions, prosodic activities, key word extraction, reading aloud. - (Bellis, 1996).

A8. a) Some environmental modifications in classroom set-up are:

1) Provision of lecture notes prior to class presentation.
2) Provide a notemaker ie. carbon paper to another student of the class.
3) tape record the lecture.

4) decrease background noise.
5) preferential setting - seated away from source of noise and in the front.
6) use an auditory trainer and other assistive listening devices.
7) make frequent checks for understanding after giving the child instructions.
8) provide multimodality cues matching precisely in context, timing and spoken information.
9) preteaching of new information and new vocabulary before class.
10) teacher's support and cooperation.

- (Chermak and Musiek, 1997).

A8. b) Speaker and listener modification in a classroom

1) Good audibility and visibility - reduce background noise and give preferential setting.
2) Good pacing: reduce speaking rate, insert pauses to help student "Catch up", allow more time for responding.
3) Be repetitive - Repeat key words and phrases verbatim and use paraphrase to get comprehension.
4) Keep the student informed :- tell students what you are going to talk about before you begin, make the purpose for listening known.
5) Keep sentences short - better to say things in short chunks with pauses in between.
6) Require a listening response - short active responses during or between parts of your message, keep the listener attentive and the teacher informed.
7) Use environmental cues to help convey meaning - objects, pictures, diagram, maps, overheads.
8) Monitor your own use of language - pronunciation, use of figurative language or unfamiliar vocabulary.
9) Use emphasis on key words and phrases - make them louder and longer.
10) Watch for fatigue in the student.
11) Incorporate pronunciation practice when teaching new vocabulary - practice until the student can say the word automatically.

12) Keep a visual check on comprehension; watch facial expressions indicating loss of comprehension.
13) Encourage reauditorization - encourage the student to repeat directions or instructions to her/himself upon hearing them for better retention and recall.
14) Encourage and reinforce good listening and general attentiveness.
15) Preferential seating:- make use of visual cues and facial expressions.

- (Sloan, 1998)

A9. (1) Auditory Closure Activities

a) (i) Songs and rhymes
eg.Twinkle twinkle little .... (star)

(ii) rhyming words
eg. name an animal rhyming with house. . . . .(mouse)

b) (i) sentence
eg. there are 26 letters in the alpha .... (bet)

(ii) Single words
eg. sports : base. . . . . ., ten ....
(ball) (nis)

c) (i) Sentences
eg. I like to (w)atch (t)ele(v)ision

(ii) Single words
eg. animals : (m)on(k)ey

d) eg. associate sound of word with its meaning, reading, reauditorization, contextual derivation of word meaning, immediate provision of definition.

2) Phoneme training

a) eg. using minimal contrast pairs in CV, VC words etc. like 'pet' and 'bet'

[ap] and [ab], [pa] and [ba]

b) eg. /a/ with 'A'

3) Prosody training

a) Convict vs. convict

b) He saw a snow drift by the window vs. he saw a snowdrift by the window.

c) Listen to subject, verb or objects than articles, conjunction.

d) eg. reading aloud with exaggerated prosodic features.

4) Temporal patterning training

a) Patterns of clappings, tappings, use words like tick-tack-tick as pen-pin-pen etc.

b)eg.

You are going home

You are going home

You are going home

You are going home

5) Interhemispheric exercises

a) eg. find an object with his left hand and is instructed to lable it verbally in terms of shape, texture etc.

b) eg. singing to music

- (Chermak and Musiek, 1997)

A. 10. Compensatory 'strategies.

1) Chunking - breaking of long messages into smaller component parts and grouping the concepts together.

2) Verbal rehearsals - repetition and reauditorization of a message.

3) Paraphrasing - reiterate the message in his/her own words.

4) External aids - eg. files, calculators, ALDS, etc.
5) Use and learn meaning of tag words eg. first, last, next, before, causal words like because etc.

- (Chermak and Musiek, 1997)

A11. Suggestion for parents are :

1) Do not assume he or she is purposely ignoring you as he seems to her inconsistently.
2) Greater success is assured if you communicate with your child if there are no other activities competing with you (TV or radio playing, vaccum cleaner running).
3) Provide quiet settings i.e. without noise.
4) Simplify your language level if your child does not seem to understand.
5) Slow down your rate of speech.
6) When you repeat a sentence, do it in a different way eg. use different words, etc.
7) Give the child adequate time to respond.
8) Read aloud to your child and then discuss.
9) Praise any accomplishments that represents even small improvements.
10) Provide visual cues i.e. face each other while communicating.

-(Barr, 1976; Willeford and Burleigh, 1994; Chermak and Musiek, 1997)

A12. Management of pre schoolers.

1) Phoneme training - using pictures instead of letter symbols
2) Try selective listening of target words
3) Try reading aloud.
4) Speech - to - print skills are not needed.
5) Use simpler exercises for interhemisperic exercises.
6) try games like musical chairs, "simon says, "Old McDonald" etc.
7) Try temporal patterning with body movements.
8) Try listening to stories.
9) Reduce background noise
10) Try discrimination training with pictures.

- (Chermak and Musiek, 1997)

Al 3. Management for the elderly

1) All compensatory strategies can be tried.
2) Amplification like FM systems can be very useful to reduce noise.
3) Use flexible cognitive style.
4) Do auditory discrimination in context.
5) Counselling.

- (Chermak and Musiek, 1997)

A14. Treatment Principles for auditory processing difficulty

1) Give the child direct instructions.
2) Don't allow guessing, emphasize being sure of what you hear
3) Maximize signal detection - use cues
4) Gradually withdraw cues.
5) Present speech units in contrast pairs.
6) Work until recognition or discrimination is automatic, work for accuracy first then efficiency.
7) Make the child responsible for signal detection from the start, encourage and shape self-monitoring and perceptual decision making.
8) Work on several levels of linguistic structure : sound, syllable, word, phrase, sentence.
9) Use articulation as soon as it is accurate, listen, repeat, respond.
10) Progress in very small steps, vary one element at a time.
11) Maintain a high success rate.
12) use nondistracting tangible reinforcements for good listening and correct responding.
13) Begin with a warm up (review of previous successful steps)
14) Use blocks of trials, keep the child informed of how much work has been done, how much is left to do.
15) Develop a simple system to keep track of quantitative and qualitative data, code responses for accuracy and promptness.

- (Sloan, 1998)

A15.

1) Cognitive Neuroscience - Brain plasticity may be greatest and most obvious during development, research has shown that the brain remains malleable throughout life span. Plasticity may account for the maintenance of cognitive control across many decades despite loss of neurons due to aging. The brain remaps and reorganizes itself to best meet the auditory processing demands. Stimulation enables plasticity, thereby maximizing potential for successful rehabilitative efforts through an agressive management approach.

-(Chermak, 1998)

2) Systems theory - it suggests a broad view of wholeness, which provides a conceptual framework for understanding the organization, interaction and dynamicity of elements comprising systems. Individuals are seen as parts of larger social systems. If suggests clinical practices that include induction and metacognitive interventions and supports treatment of both the individuals and the environment.

- (Chermak and Musiek, 1997)

3) Information processing - Here meaning in assigned to audible discourse based on the extraction of information through various processes or stages of cognition, including encoding, organizing, storing, retrieving, comparing and generating or reconstructing information. These stages include parallel, distributed operations involving interactions between sensory (eg. auditory processes) and central processes (eg. cognitive and linguistic processes) through feedback and feed forward loops. Intervention focus on specific processing skills as well as metacognitive training directed toward coordination and deployment of appropriate strategies.

- (Chermak and Musiek, 1997).

A16. The generalization strategies are :
A) Within training strategies.

1) Increasing length of clinical training.
2) Using real life scenarios and training vignetters.
3) Using multiple exemplars and diverse training experiences.
4) Incorporating self monitoring homework exercises.
5) Focusing on relevant and pivotal skills.
6) Adding booster sessions as follow-up to therapy.

(B) Environmental support strategies - reinforcement for skills learned in treatment to natural settings.

- (Guevremont, 1990)

CENTRAL AUDITORY PROCESSING DISORDERS IN A NUTSHELL

NOW, LET US SEE HOW MUCH YOU HAVE LEARNT AND HOW MUCH YOU CAN INTEGRATE THEM ALL INTO A "NUTSHELL".

I Bonus questions

Q1. Group the following tests according to the site of lesion they are sensitive to i.e. a) auditory nerve, (b) high or low brainstem (c) auditory hemisphere (d) corpus callosum (e) non-auditory area.

a) Dichotic tests
(1) DDT (2) Dichotic CV (3) SSW (4) CST (5) SSI-CCM (6) DSI (7) DRT.

b) Temporal ordering tests
(1)PPST(2) DPT(3)PPDT

c) Monaural low redundancy tests
(1) LPFS (2) PIPB (3) Time compressed (4) SSI-ICM (5) SPIN (6) Speech discrimination scores (SDS) (7) PTA

d) Binaural interaction tests
(1) RASP (2) BF (3) IID (4) MLD (5) SBMPL

e) Electrophysiological and physiological tests
(1) ABR (2) ECoG (3) MLR (4) LLR (5) P300 (6) ART (7) RDT.

Q2. List the behavioural tests that can be used to detect central auditory processing disorders in the presence of peripheral hearing loss.

Q3. What central auditory tests are sensitive to the following central auditory processing disorders (Katz et al., 1992).

1) Decoding deficit
2) Integration deficit
3) Tolerance fading memory deficit
4) Organization deficit

A1

(a) Auditory nerve	(b) Brainstem Low	(b) Brainstem High	(C) Hemisphere
SDS ABR ART PTA TDT ECoG RDT	MLD ART ABR SSI-ICM SBMPL Binaural beats DDT ABLB SPIN Binaural fusion RASP IID LPFS RDT	SSW DDT Dichotic CV SPIN SSI-CCM MLR PI-PB ABLB Binaural fusion DSI LPFS IID PPST	CST DDT Dichotic CV Compressed speech SSW P300 MLR LLR PPST SSICCM SPIN SBMPL SISI PPDT DSI LPFS Interrupted speech

(d) Corpus Callosum	(e) Non-auditory areas
PPST DDT Dichotic CV DRT CST	SSW P-300 LLR

A2. 1)DDT (2) SSW (3) DSI (4) PPST (5) DPT (6) CVC fusion -(Bellis, 1996)

A3.

1. Decoding deficit — Poor performance on monaural low redundancy speech tests and speech perception in noise.

2. Integration deficit	Left ear deficit on dichotic speech tests combined with bilateral deficits on tests of temporal patterning requiring verbal report.
3. Tolerance fading memory deficit	Bilateral deficits on dichotic speech tasks, poor word recognition skills.
4. Organization deficit	Difficulty on any task requiring report of more than 2 critical elements (i.e. DPT, FPPT, DDT, CST, SSW) - (Katz etal, 1992)

II Mega Bonus Questions

Ql. Answer the questions and follow the instructions:

1. The classification of the central tests into four categories i.e. dichotic speech, temporal ordering, monaural low redundancy and binaural interaction tests was given by:

   a) Ptacek and Pinheiro (1971) - GO TO 13
   b) Baran and Musiek (1991) - GO TO 7
   c) Katz (1994)-GO TO 16

2. Wrong Other tests like masking level difference, dichotic tests etc. are more sensitive to brainstem tumors. Try again.
   - BACK TO 3

3. TEOAEs along with auditory brainstem response and acoustic reflex threshold are used to diagnose.

   a) VIII nerve tumors - GO TO 29
   b) Brainstem rumors - GO TO 2
   c) Cerebral rumors - GO TO 2 1

4. Right. IT is a test of cochlear function. Studies have shown some abnormal findings in some cases of bramstem and temporal lobe lesions.

-GOTO 17

5. Wrong ! Masking level difference is sensitive to only low brainstem lesion. Try again.

- BACK TO 8

6. No ! This electrophysiological measure of VIII cranial nerve and auditory brainstem function was discovered by Jewett and Williston in 1971.

- GO BACK TO 24

7. Way to go ! Thats correct. These include all behavioral assessments of the central auditory nervous system. Good .' Try the next one.

- GO TO 3

8. This test does not differentiate between brainstem versus cerebral auditory dysfunction.

a) Masking level difference - GO TO 5
b)SSI-ICM-GOTO25
c) Staggered spondaic word test - GO TO 19
d) Rapid alternating speech perception - GO TO 9

9. Wrong ! It is sensitive to low brainstem lesion only.

- GO BACK TO 8

10. Wrong This was developed after staggered spondaic word test in 1983. Musiek used two rather than three digits.

- GO DOWN TO 17

11 Wrong! It is a test of retrocochlear function. Studies have shown it to be abnormal in few cases of brainstem and temporal lobe lesion.

-GO TO 12

12. Name a test which was conventionally used in diagnosis of cochlear pathology but has also been used in assessment of CAPD?

a) Alternate binaural loudness balance - GO TO 4
b) High level short increment sensitivity index - GO TO 27
c) Tone decay test - GO TO 11.

13. Wrong start! They investigated that intensity or sensation level at which the auditory sequences are presented may also influence temporal ordering results. Try again.

- BACK TO 1

14. Wrong again ! This electrophysiological measure of primary auditory cortex function was discovered by Geisler, Frishkoff and Rosenblith in 1958.

- BACK TO 24

15. Wrong again. It gives rise to digestive and respiratory systems. Try again.

- GO TO 26

16. Wrong start ! He classified the auditory processing disorders based on the staggered spondiac word test performance. Try again.

-GO BACK TO 1

17. Staggered spondiac word test is a unique modification of which test

a) Dichotic digit test (Kimura, 1961) - GO TO 22
b) Dichotic digit test (Musiek, 1983) - GO TO 10
c) Competing sentence test (Willeford, 1968) - GO TO 28

18. Correct! This electrophysiological measure of dendritic, neural activity of the auditory cortex was discovered by Davis in 1939.

You have come to the last question.

- SO GO TO 26

19. Absolutely right! This is because staggered spondiac word test is sensitive to both brainstem and hemispheric/cerebral lesions. Try the next question.

- GO TO 12

20. Wrong ! This gives rise to skeleton, including bony structures of the middle ear, the circulatory system and the reproductive organs.

- GO DOWN TO 26

21. Bad luck! staggered spondiac word test, competing sentence and dichotic tests are sensitive to cortical/hemispheric lesions.

- BACK TO 3

22. Right! He used triads of digits presented simultaneously to each ear. Staggered spondiac word test was given by Katz (1962). Good Going !

- GO TO 24

23. Bad luck ! This electrophysiological measure of hippocampal and auditory cortex function was discovered by Sutton et al in 1967.

-GO TO 24

24. Which of these potentials was the first to be discovered.
   a) auditory brainstem response - GO TO 6
   b) auditory middle latency response - GO TO 14
   c) auditory long latency response - GO TO 18
   d) P300 - GO TO 23

25. False alarm ! SSI-ICM in sensitive to only low brainstem lesions. Bad luck ! try again.

- GO TO 8

26. Which germinal layer does central auditory nervous system develop from?
   a) ectoderm - GO TO 30
   b) mesoderm - GO TO 20
   c) endoderm - GO TO 15

27. Wrong ! It is a test of retrocochlear function. Studies have shown it to be abnormal in some cases of temporal lobe lesions.

-GO BACK TO 12

28. Absolutely not! He also developed a children version competing sentence test which is widely being used. Try again.

-BACK UP TO 17

29. Correct! A combination of tests always help in more accurate diagnosis.

- GO TO 8

30. Correct! Good ending. It gives rise to outer skin, nervous system and also inner and outer ears.

You have come to the end. Good guessing !

III CASE REPORTS

Study the following case reports and identify the site of lesion based on the history and audiological findings. Justify your answer.

Ql. History : A 9 year old girl had hypernasality due to poor velopharyngeal closure. She also had facial weakness, resulting in inability to close her eyes or lips tightly. The symptoms were apparent for a few months before we saw the patient reported to the speech and hearing clinic. There had been no other symptoms or concerns.

Audiological findings :-

1) Puretone audiogram:- normal hearing sensitivity bilaterally.

2) Speech recognition:-

a) Right = 96%, Left = 96%

b) No roll over seen for high intensities for either ears.

3) Immittance - Normal tympanograms bilaterally and normal ipsilateral reflexes at 500 Hz to 2 kHz for both ears. Contralateral reflexes were absent for 500 Hz to 4 kHz bilaterally.

4) Auditory brainstem response.

Left : Normal latencies of waves I, II and III J-III interval is 2.46 msec. Waves IV and V were absent.

Right : Waves I, II and III was normal. Wave V was present but reduced in amplitude to less than one half that of wave I. Wave V was not detectable at the high repetition rate. It was difficult to read the waves.

5) Central auditory tests

a) Dichotic rhyme:- Left = 27%, right = 67%
b) Dichotic digit:- left = 70%, right = 80%

6) Click evoked otoacoustic emissions : It showed a robust response . for the spectrum range of 600 or 700 Hz to 4500 Hz bilaterally. The level was in excess of 20 dB SPL and correlation was more than 90% bilaterally and was considered bilaterally normal

Q2.

History :-

A 71 year old patient had severe, right sided headache and he woke up with left hemiparesis, dysarthria and left facial droop. A diagnosis of right cerebrovascular accident was rendered. The patient who had a longstanding hearing loss, complained of increased hearing difficulty.

Audiological findings :-

1) Puretone audiometry:- mild to moderately severe bilaterally symmetrical sensorineural hearing loss.

2) Speech recognition:- right = 96%, left = 92%.

3) Central auditory tests

a) dichotic rhyme:

Right = 55%, left = 15%

b) low pass filtered speech
Right = 45%, left = 34%
c) compressed speech
Right = 65%, Left = 42%
d) duration pattern test
Right= 10%, Left =10%
e) frequency pattern test
Right= 46%, Left = 38%
f) dichotic digits
Right=90%, Left = 10%

Q3.
History
A 24 years old male reported with a history of non-convulsive seizure activity which began at 7 years. At 10 years of age he was diagnosed to have left temporal astrocytoma and partial resection was done. She continued to experience non-convulsive seizures and at 20 years had "drop attacks" where she fell backwards and as a result had "slurred" speech and memory problem. Moderate deficits were noted on attention and concentration and mild deficits were noted bilaterally on manual dexterity and speed measures.

Audiological findings
1) pure tone thresholds:- normal
2) speech recognition:- right = 98%, left — 100%
3) Central auditory findings
a) Dichotic rhyme test:- right = 32%, left = 48%.
b) Dichotic digit test:- right = 70%, left = 80%
c) Duration pattern tests:- right = 10%, left = 15%
4) Late auditory evoked potentials

Right : Well defined Nl and P2 tracings were seen for C3 and C4 electrode sites.

Left : Nl and P2 response amplitudes were reduced and not as well defined at C3 and C4 sites. The latencies of Nl were abnormal and latencies of P2 were borderline normal (slightly delayed) for both ears at both sites.

An attempt was made to derive P-300 but patient was not able to keep an accurate count of the rare stimuli.

Q4

History:-

A 11 year old child suffering from seizures came with symptoms of severe retroorbital and parietal headaches, occasional parasthesia of left hand and foot. Seizures were of three types (1) absence of seizures (staring spells) (2) dysarthria and lip smacking followed by postictal aphasia (3) major motor seizures characterized by thrashing movement of the whole body.

Audiological findings :-

1) Puretone thresholds - normal bilaterally except depressed thresholds at 8 KHz in both ears.
2) Speech recognition - normal bilaterally.
3) Central test findings

a) Dichotic digit tests : Right = 70%, Left = 45%

b) Staggered spondiac word test:
Right = 50%, Left = 35%

c) Low pass filtered speech
Right = 60%, Left = 90%

d) Competing sentence test
Right = 60%, Left = 75%

e) Frequency pattern test:
Right = 10%, Left = 5%

f) Masking level difference = of 6 dB was obtained

4) P300:- It showed bilaterally prolonged latencies for both recording sites (C3 and C4). These waveforms were noisy. The Nl and P2 peaks "were identifiable and repeatable for the right ear at C4. The P2 was repeatable for left ear at C3.

Q5.

History

A 69 year old woman came with some right sided motor problems intermittent dizziness for 2 years and occipital headaches for 3 years.

She had trouble locating sounds and difficulty hearing soft speech but could not report the exact onset. She also experienced a fullness sensation in the left ear for several years. She also had progressive left arm and leg weakness, some confusion and memory loss. Multiple sclerosis or a tumorous growth was suspected.

Audiological findings :

1) Puretone thresholds :- bilaterally symmetrical moderate to severe sensorineural hearing loss.

2) Speech recognition :- right = 98%, left - 100%

3) Auditory brainstem response :
Right = normal findings
Left = Normal waves I and II with wave III delayed and an absence of the IV-V complex.

4) Acoustic reflexes:- Contralateral reflexes were present at normal levels bilaterally for frequencies 500 Hz through 4 kHz.

5) Middle latency responses : Noisy and poor responses seen. T3 (left temporal) electrode, showed no repeatable response or at best a meager response. The T4 electrode (right temporal) showed a response to right ear stimulation (Na, Pa, Nb, Pb), but a non-replicable response to left ear stimulation.

6) Central auditory test
a) Dichotic digit test :Left = 76%, right = 96%
b) Competing sentence test: Left = 100%, Right = 68%
c) Compressed speech test: Left = 40%, Right = 78%
d) Low pass filtered speech : Left = 28%, Right = 18%
e) Frequency pattern test :Left = 96%, Right = 98%

Q6.
History :-
A 39 year old male has a history of multiple sclerosis, characterized by weakness in all extrimities especially lower limbs, intermitent

diplopia, fatigue and liable emotion. His speech was difficult to understand but appeared to be accurate and appropriate. He also had a history of right sided tinnitus since youth, which he attributed to a gun shot close to his. He had difficulty in swallowing. Medical history revealed internuclear opathalomoplagia, blurred vision, ataxia, intention tremor, nystagmus, hyperflexia of certain deep tendon reflexes and upgoing toes.

Audiological findings:-

1) Puretone threshold - normal bilaterally
2) Speech recognition- right - 92%, left - 94%
3) Tympanograms - Normal bilaterally contralateral acoustic reflexes were present at normal levels with the stimuluspresented to the left ear for frequencies 500 Hz - 4000 Hz, but about at all frequencies with the stimulus presented to the right ear.
4) Central test findings :-
a) Masking level difference:- of 4 dB was measured with a pulsed 500 Hz stimuli.
b) Low pass filtered speech:- right = 80%, left - 80%
c) Dichotic digit tests:- right = 55%, left = 95%
d) Staggered spondiac word test:- right = 68%, left = 82%.
e) Frequency pattern test- right = 70%, left ~ 55%

5) Auditory brainstem response :- It was derived at 80 dB nHL at two stimulus rates in each ear (15.7 and 80.7)

Left : Wave I was evident at normal latencies for both stimuli rates. Wave in was also present at normal absolute latencies and the I to m interwave latencies were also normal. The presence of wave V could not be determined for any of the waveforms.

Right: Wave I was again identifiable but no other waves cpuld be observed.

Q7

History :-

The patient was 13 years when she was diagnosed to have herpes encephalitis. Her initial symptoms were severe headaches, numbeness of both hands. Later they were accompanied by vomiting, fever, right sided facial twitching, nonsensical talk, bizarre, behaviors, babbling etc. At the time of admission, her temperature was 40 degree C. She was combative, did not recognize her family and was not responsive to commands. Testing showed increased intracranial pressure. Next month, she developed left eye ptosis, alternating, exotropia, attentional problems, disorganized thinking and speech. She was auditorily irresponsive, though she could read and write. In the next few months her behavior improved, speech improved but she lost intonation.

Audiological findings:

Earlier reports : No behavioural responses to puretone stimuli.

Testing done later :-

1) Puretone threshold:- profound hearing loss for mid frequencies. She responded for vibrations in case of low frequency at high intensities. High frequencies showed unreliable or no responses.

2) Acoustic reflex:- contralateral reflexes were present at normal intensity levels at 500-4 KHz for each ear, with ipsilateral reflexes present at normal levels at 500 through 2 KHz bilaterally and absent at 4 KHz bilaterally.

Two months later:

1) Puretone thresholds:- right ear thresholds improved to within normal limits at 500 through 3 KHz and mild loss at high frequencies. Left ear thresholds improved to 20-30 dB HL at 250 through 1 KHz and a mild to moderate loss for the higher frequencies.

After 3 years

1) Same puretone results were obtained with generally poorer thresholds in the left ear.
2) Speech audiometry - speech detection threshold was done.
3) Auditory brainstem response:- It showed normal absolute and interwave interval bilaterally. A response was traced at 25 dB HL bilaterally.
4) Middle latency response - repeatable responses for either ear at any electrode site was not obtained. Responses were noisy.
5) Click evoked otoacoustic emissions :- were normal bilaterally. The levels, correlation and spectrum responses were essentially within normal ranges bilaterally.
6) Difference limen for intensity:- Using a modified SISI test at 70 dB HL for 1000 Hz the patient could not reach a 50% performance for 5 dB increments. This was done for rightear only.

The patient has recently begun to recognize one or two phonemes presented auditorily and shows awareness to environmental sounds like telephone ringing and music. Can you also suggest a management plan which can be worked upon with this child.

Q8. History

This patient was a healthy 61 year old male. He had a hearing loss in his right ear and slight momentary imbalance on turning quickly. He reported an occasional high pitched tinnitus in the right ear. His most noticeable problem was the inability to hear over the phone when it was held to his right ear. These symptoms had appeared to be progressive during the year before his evaluations. The patient initially sought help for his hearing problem by contacting a hearing aid dealer who referred him to audiologic consultation. There was no history of noise exposure.

Audiological findings :-

1) Pure tone thresholds:- right : moderate to severe sensorineural hearing loss, left: mild to severe sensorineural loss commencing at 2 kHz.

2) Speech - spondee thresholds were established with difficulty and the patient could not recognize monosyllabic words from the NU-6 lists at any of several intensity levels tested at the right ear. The left ear showed a good speech recognition score.

3) Immittance - Contralateral acoustic reflex were present at normal intensity levels for the left ear (stimulus ear) at test frequencies of 500 Hz, 1 kHz and 2 kHz. The right ear (stimulus ear) reflexes were elevated at 500 Hz and 1 kHz and absent at 2 kHz.

4) Auditory brainstem response : No repeatable tracings at high intensities for right ear was obtained. Left ear demonstrated abnormal absolute latencies for waves III and V i.e. delayed latencies. Wave I could not be identified.

Q9. History

The child was classified as learning disabled early in his school career. He came for central auditory processing disorder assessment at 13 years of age. The child was highly distractible, having trouble hearing in noise, having difficulty following directions and often asking people to repeat what they had said. Sound localization was also a problem but occasionally lost his temper and became unruly. He was making reasonably good progress in school, with reading as his major problem and his reading level being about one grade level below expectations. He had normal overall intelligence. He did not have any balance problem, but was occasionally clumsy.

Audiological findings

1) Puretone thresholds - normal sensitivity in left ear. Right ear showed moderate to severe high frequency sensorineural hearing loss.

2) Speech recognition
Left = 100% at 30 dB SL
Right = 36% at 30 dB SL, 72% at 70 dB SL.

3) Auditory brainstem response:- Normal for left ear. Right ear shows waveform consistent with cochlear involvement i.e. prolonged wave V and unidentifiable wave I and III.

4) Central auditory tests :-
a) Staggered spondiac word test :-
Right = 35%, left = 40%
b) Low pass filtered speech :-
Right = 14%, Left = 68%

5) Middle latency response:- It was obtained using 500 Hz tone pips with a 4 msec, rise/fall and 2 msec, plateau time (used to avoid influence of cochlear hearing loss). The waves were identifiable at this time. After one year, late potentials and P300 were obtained. N2 and P2 demonstrated severely reduced amplitudes for right and moderately reduced responses for left at both C3 and C4 recording sites. For right, Nl responses were delayed. P300 using. 500 and 750 Hz showed poor morphology for right than left stimulation. Latencies were grossly within the normal range for both ears.

After 6 years

1) Puretone and speech recognition:- scores unchanged bilaterally.
2) Auditory brainstem response:- unchanged bilaterally.
3) Middle latency responses - delayed in latency (for 500 Hz tone pip) with Pa, Na and Pb waves observed for both ears, late potentials were also markedly improved in amplitude for both ears and recording sites. The P300 for right showed a marked increased in amplitude and slight decrease in latency.
4) Central auditory tests :-
a) Staggered spondiac word test :-
Right = 50% left = 100%
b) Filtered speech test
Right = 16%, Left = 88%

Q10. J was a 10 year old male who was exhibiting significant difficulties in the classroom. His teacher report that he had difficulty following directions, appears confused much of the time, and exhibits difficulty in noisy situations. Upon central auditory assessment. He exhibited a left ear deficit ear on Dichotic digits and a more pronounced left ear suppression on competing sentences. In addition, his performance on the frequency patterns test indicated a bilateral depression when verbal report was required; however the scores revert to within normal limits when he was asked to hum his responses. His performance on low pass filtered speech was within normal limits for his age.

Is it likely that he exhibits a CAPD and, if so what underlying processes to be dysfunctional ? What kind of CAPD type does he exhibit characteristics of ? Design a management program based on his specific deficits.

Ql 1. M was a 12 years old female with difficulty understanding speech in noise although she was in the 6th grade, she reads at a second to third grade level, and her word attach skills are significantly depressed. Upon central testing, scored within the normal range for her age on dichotic digits, dichotic CVs, the SSW and frequency patterns, however, her performance on low pass filtered speech was abnormally low bilaterally. When a compressed speech test was administered. M scored just above the chance level for both ears.

Is it likely that she exhibits a CAPD and, if so what underlying processes are likely to be dysfunctional? What kind of CAPD type does Mary exhibit characteristics of? Design a management program for her.

Q12. History :-

A 50 year old woman came with a complaint of bilateral high pitched tinnitus of 1 year duration with a pulsatile character in the left ear. She also had 6 months history of progressive right sided hearing loss, slight imbalance and intolerance to motion. 10 years previously she had experienced time episodes of vertigo with vomiting, however so these resolved spontaneously without recurrence. She had no other complaints at this time.

Audiological findings :-

1) Puretone thresholds :- normal hearing sensitivity in the left ear with a moderate to severe high frequency sensorineural loss in the right ear.
2) Speech recognition :- right = 96%, Left -100%
3) Auditory brainstem response :-
Left - absolute latency for wave V was 7.03 msec. III-V interwave interval was 2.77 msec. I-V interwave interval was 5.25 msec, at 80 dB nHL I-III interval was 2.48 msec.
Right - I-V interval was 5.64 msec, at 90 dB nHL. Wave III was not identifiable.

Answers

A1. The audiological findings were consistent with brainstem involvement for the following reasons:

Normal audiogram and speech recognition scores are unusual in acoustic tumors, not totally unexpected;

Auditory brainstem response showed normal latency and well defined wave II bilaterally. Because this wave is present, normal and generated by the medial aspect of the auditory nerve, it is unlikely that an acoustic tumor is present. The absence and/or reduced amplitude of the late waves with normal early waves strongly suggests brainstem involvement. The bilateral involvement of the late waves is also consistent with brainstem dysfunction.

Central auditory tests showed mild abnormality for a 9 year old child for both tests.

* A case of brainstem involvement.

A2. The symmetry of the puretone thresholds and speech recognition scores permits a reasonable interpretations of the central test results, even though there is a peripheral hearing loss.

The central tests show left ear deficits on all the tests and right ear deficits on a few (low pass filtered speech, compressed speech, duration and frequency pattern tests). A marked difference was noted between the ear on few of the tests (dichotic rhymes, low pass filtered speech and dichotic digits).

The interpretation of the central test findings needs to be based on ear differences. That is, if central test results were bilaterally similar and abnormal, then one could argue this is due to peripheral involvement. Major differences in ear scores cannot be attributed to peripheral hearing loss. The differential deficit noted on the central tests could be related to the compromise of auditory fibers coursing through the internal capsule that interrupts connections to Heschl's gyri and other cortical areas. The central deficit could also be associated with damage to the auditory region of the insula.

* A case of subcortical and insular involvement.

A3. The case demonstrated the presence of a contralateral ear deficit on dichotic speech tests. Mild deficits were seen bilaterally in dichotic rhyme test, Right ear performance was poorer than left ear for dichotic digit test and duration pattern tests showed severe bilateral deficits.

"Ear effect" for late potentials were observed. Responses were poorer when the right ear (ear contralateral to the lesion) was stimulated.

The P2 responses were delayed for both ears at both recording sites. P300 responses could not be obtained because the patient was unable to perform the relatively simple task of counting the rare stimuli i.e. he was unable to discriminate large frequency differences or unable to attend the task. In either case cerebral involvement is suspected i.e. lesion in the cortex.

* A case of auditory cortex involvement.

A4. This case shows a combination of effects - those of left cortex and callosal involvement, that can be differentiated by the test battery administered. Central test findings show bilateral abnormal scores on all dichotic speech tests and on the frequency patterns test. Low pass filtered speech was abnormal only for right ear, where as masking level differences are normal. The bilateral deficits on dichotic speech tests can be either due to contralateral ear effect or compromise of corpus callosum resulting in decreased left ear performance when a verbal response is required.

The frequency patterns are bilaterally decreased because the cortex or the corpus callosum is compromised. Filtered speech test shows only the contralateral ear deficit. This indicates left but not right hemisphere involvement, hence, the left ear deficits on dichotic tests is probably not from right hemispheric involvement but from callosal compromise. Filtered speech is not sensitive to callosal dysfunction but hemispheric lesions.

P300 findings show bi-hemispheric abnormalities from a single lesion site.

* A case with involvement of the auditory areas of corpus callosum.

A5. The auditory brainstem responses showed the late waves are affected on the left side which indicate that the upper pons would have had been comprised, which was not likely. The acoustic reflex test results were normal or consistent with cochlear pathology and this indicates the low pons encompassing the circuitry was intact and also may indicate the auditory brainstem response abnormality was related to the structures in the upper pons. However, there could have been indirect pressure transfer to the pons. Central auditory tests indicate a left ear deficit on dichotic digits, competing sentences, and compressed speech tests and bilaterally suppressed filtered speech scores.

The involvement of the medial geniculate body and the surrounding areas are consistent with the abnormal findings on the middle latency response and central tests. The presence of multiple sclerosis would explain the left ear auditory brainstem response results.

The hearing loss was probably related to the patient's age and was not influenced by the tumor.

* A case of brainstem involvement.

A6. The acoustic reflex and auditory brainstem response comparision can be done in this case with longstanding multiple sclerosis. The better brainstem responses is from the left ear (I, II, III waves), that is also the ear showing normal acoustic reflexes. The poorer brainstem responses (only wave I) was from the right ear, which did not show any reflexes. The binaural masking level differences was also abnormal indicating abnormality in the low pons as did the acoustic reflex and auditory brainstem response test results.

The central tests could also be reflecting the brainstem abnormality or could be indicating a problem in the white matter of the corpus callosum, because of the left ear deficits on dichotic tests. Frequency pattern and masking level difference shows abnormal scores on both ears and normal scores on filtered speech test.

* A case of multiple sclerosis affecting the brainstem.

A7. The patient's hearing sensitivity improved after a few months as seen in the improvement of audiogram responses.

Since she has begin to respond to recognise 1 or 2 phonemes when presented auditorily and other environmental sounds, this profile is consistent with pure word deafness. Extremely poor frequency and intensity discrimination was present which could influence appropriate speech perception.

Puretone deficits were the greatest at the high frequencies which was in the ear opposite the hemisphere with the most damage. Therefore hearing loss may be based in the cortex (? pure word deafness) and not the periphery.

Otoacoustic emission findings also support this which showed spectral responses in the high frequency range - an indication that the cochlea (the outer hair cells) was intact for the high frequencies.

The auditory brainstem responses further supports it, as their thresholds were better than the puretone thresholds at 4000 Hz.

* A case of central deafness - pur word deafness

Management',

Approaches to aid in auditory feedback and monitoring can be initiated by amplifying the patients own voice while she is speaking. This is to develop a sense of intensity/frequency changes.

Speech reading can be emphasized especially the use of gestural and situational cues for understanding speech. Signs can also be taught.

Binaural input can be emphasized like dichotic speech signals under phones to achieve maximal recognition, as speech in one ear and noise in the other.

Localization tasks could be worked upon informally in a quite room and to track individuals as they moved while speaking, lateralization could be done under earphones, varying in intensity of tonal and speech signals to the two ears.

Prosody can be worked upon by asking the patient to determine if sentences said to her were declarative, interrogative or exclamatory based on prosodic features and also intensity frequency and duration.

A8. This is a classic case of VIII nerve involvement i.e. with a progressive hearing loss on one side, with tinnitus and a vestibular problems. Audiological results show a greater sensitivity loss and poor recognition on that side. Acoustic reflexes were absent or elevated for stimuli presented to the right ear and the auditory brainstem response were absent on the right side even at 80 to 90 dB nHL. It is possible that the hearing loss is great enough on the right to disallow acoustic reflexes or a readable auditory brainstem response, however these findings combined with the patients history suggests a possible acoustic nerve lesion. Prolonged III-V latency also supports it.

* A case of auditory nerve involvement

A9. Before 6 years

Middle latency responses revealed bilateral ear deficits. Speech recognition scores in right ear reveals reduced speech recognition but no roll over at high intensities. Staggered spondiac word test reveal bilateral deficits. Low pass filtered speech also shows abnormal scores in right and normal scores for left ear. On the staggered spondiac word test one could expect a right ear deficit because of hearing loss. But the left ear deficit was probably related to the right hemisphere lesion. Middle latency responses done after one year showed no response and as the frequencies used were not affected by the patients hearing loss, it implicates central auditory nervous system involvement.

After 6 years

A change in morphology of the brain with corresponding auditory involvement argues for this as an example of plasticity of the brain. The staggered spondiac word test and filtered speech tests showed improvement in left ear. Improvement is seen even in the evoked potentials. Because the right ear pure tone deficit did not change with these, other changes, it seems doubtful if it is/or was related to the lesion. This is supported by staggered spondiac word test results, which showed a similar deficit as previously for the right ear, but improved left ear performance. This is consistent with the morphological change of the brain.

* A case of central auditory processing disorder/learning disability.

A10. J appears to exhibit the characteristics of deficits in the areas of binaural separation and integration, and interhemispheric transfer. His performance pattern suggests a neuromaturational delay, and he fits the description of the integration deficit subprofile. A management program appropriate for him would include classroom based • modifications such as provision on a note taker and placement with an animated teacher, remediation activities such as prosody training and interhemispheric exercises, and compensatory strategies designed to aid in sequencing information, such as verbal rehearsal and chunking.

A11. M exhibits a deficit in the process of auditory closure and appears to fit the profile of auditory decoding deficit. Management for Mary would include environmental modifications designed to improve acoustical clarity of the spoken message, while decreasing background noise, and use of an FM auditory trainer might be considered. Phoneme training, including speech to print skills, would be appropriate in order to help Mary develop accurate phonemic representation, and auditory closure activities, including vocabulary building, may be indicated. Compensatory strategies appropriate for Mary would include methods of increasing internal motivation and self monitoring of her own comprehension, as well as methods of identifying difficult listening situations and developing problem solving strategies to overcome those difficulties.

A12. Auditory brainstem responses show extended absolute Wave V latency, abnormal III-V and I-V interwave interval in the left ear and abnormal I-DI interval. Right ear showed extended I-V interval at 90 dBnHL.

With these findings there is a confusion that, is there an VIII nerve or brainstem lesion on the right. Because only waves I and V are present, a brainstem-auditory nerve differentiation cannot be made. The left ear findings are consistent with a brainstem lesion in the pons. Therefore it is possible that there could be an acoustic tumor on the right and a brainstem lesion affecting the left auditory brainstem response.

Another possibility is that the brainstem is being compressed or displaced by a large lesion in the right cerebellopontine angle, such as an acoustic tumor or meningioma. The progressive high frequency loss on the right side implicates the presence of an acoustic tumor rather than a single brainstem lesion.

The right brainstem response is consistent with VIII nerve lesion (or a brainstem lesion). As wave III is missing for the right ear thus a differentiation cannot be made between the two. The left ear responses showed normal I-III interval (2.48 msecs) and an extended III-V interval (2.77 msec) which contributes to extended I-V (5.25 msec).

This pattern is consistent with brainstem involvement in most cases and suggests a left sided lesion in the brainstem in the region of the cerebellopontine angle. Also an abnormal I-III on the left is consistent with an acoustic tumor. The I-III interval is abnormal with the lesion located in the region of the cochlear nucleus, which is thought to be a generator of wave III.

* A case of auditory nerve/brainstem differential diagnosis.

REFERENCES

Abel, S.M. (1972). Discrimination of Temporal Gaps. Journal of the Acoustical Society of America, 52, 519-524.

Abrol (1971). Cited in Shekhar, S.S. (1991). Standardization of Spondee Words to be Used in the SSW test. Journal of the All India institute of Speech and Hearing, 22, 95-97.

Aitkin, L. (1990). The Auditory Cortex. London : Chapman and Hall.

Amerman, J.F. & Parnall, M.M. (1980). The Staggered Spondiac Word Test : A Normative Investigation of Older Adults. Ear and Hearing, 1, 42-45.

Anderson, H., Barr, B. & Wendenberg, E. (1970). Early Detection of Acoustic Tumors by the Stapedius Reflex Tests. Acta Otolaryngologica, Suppl. 263, 232-237.

Antonelli, A.R., Bellolte, R. & Grandori, F. (1987). Audiologic Diagnosis of Central vs. VIII Nerve and Cochlear Auditory Impairment. Audiology, 26, 209-226.

Antonelli, A. & Calearo, C. (1968). Further Investigation on Cortical Deafness. Acta Otolaryngology (Stockholm), 66, 97-100.

Arnst, D. & Katz, J. (1982). Cited in Willeford, J.A. (1985). Assessment of Central Auditory Disorders in Children. In M.L.Pinheiro & F.E.Musiek (Eds). Assessment of Central Auditory Dysfunction : Foundations and Clinical Correlates. 239-255, Baltimore : Williams and Wilkins.

Baran, J. A. & Musiek, F.E. (1991). Behavioral Assessment of Central Auditory Nervous System. In W.F.Rintlemann (Ed). Hearing Assessment. 549-602, Massachusetts : PRO-Ed. Inc.

Baran J.A. & Musiek, F.E. (1994). Cited in Hall, J. & Mueller, H.G. (1997). Central Auditory Processing Disorders. In Audiologist's Desk Reference : Diagnostic Audiology Principles, Procedures and Protocols-I. 485-564, San Diego : Singular Publishing Group, Inc.

Barr, D.R (1976). Auditory Perceptual Disorders. Illinois : Thomas Books.

Beasley, D. & Maki, J. (1976). Cited in Musiek, RE., & Baran, J.A. (1987). Central Auditory Assessment : Thirty Years of Challenge and Change. Ear and Hearing, 8, Suppl 22S-35S.

Beasley, D., Maki, J. & Orchik, D. (1976). Children's Perception of Time Compressed Speech Using Two Measures of Speech Discrimination. Journal of Speech and Hearing Disorders, 41,216-226.

Beasley, D.S., Schnimmer, S. & Rintelmann, W.R (1972). Intelligibility of Time Compressed CNC Monosyllables. Journal of Speech and Hearing Research, 15, 340-350.

Bellis, T. J. (1996). Assessment and Management of Central Auditory Processing Disorders in the Educational Setting : From Science to Practice. San Diego : Angular Publishing Group, Inc.

Bergman, M. (1957). Cited in Bellis, T.J. (1996). Assessment and Management of Central Auditory Processing Disorders in the Educational Setting : From Science to Practice. 113-139. San Diego : Singular Publishing Group, Inc.

Bergman, M., Hirsch, S. & Solzi, P. (1987). Behavioural Techniques in Audiology and Otology: Interhemispheric Suppression. A Test of Central Auditory Function. Ear and Hearing, 8, 87-91.

Berlin, C, Huges, L. & Lowe-Bell, S. (1973). Cited in Willeford, J.A. and Burleigh, J.M. (1985). In Handbook of Central Auditory Processing Disorders in Children. Orlando, FL: Grune and Stratton.

Berlin, C, Lowe-Bell, S., Cullen, J. Thompson, L. & Stafford, M. (1972). Is Speech Special? Perhaps the Temporal Lobectomy Patient Can Tell Us. Journal of the Acoustical Society of America, 52, 702-705.

Berlin, C, Lowe-Bell, S., Cullen, J. Jr. Thompson, S., Looms, C. (1973). Dichotic Speech Perception : An Interpretation of Right Ear Advantage and Temporal Offset Effects. Journal of the Acoustical Society of America, 53, 699-709.

Blaettner, L.J., Murphy, K.P.S.J., & Pockett, S. (1989). Diagnosis of Unilateral Telencephalic Hearing Disorders : Evaluation of Simple Psychoacoustic Pattern Discrimination Test. Brain, 112, 177-195.

Blaettner, U., Scherg, M. & Von Cramon, D. (1989). Diagnosis of Unilateral Telencephalic Hearing Disorders : Evaluation of a Simple Psychoacoustic Pattern Discrimination Test. Brain, 112, 177-195.

Bocca, E. (1958). Cited in Musiek, F.E. & Baran, J.A. (1987). Central Auditory Assessment Thirty Years of Challenge and Change. Ear and Hearing, 8, Supple. 22S-35S.

Bocca, E. & Calearo, C. (1963). Central Hearing Processes. In Jerger, J. (Ed). Modem Developments in Audiology (Eds.), New York : Academic Press.

Bocca, E., Calearo, C. & Cassinari, V (1954). Cited in Musiek, F.E. & Baran, J.A. (1987). Central Auditory Assessment: Thirty Years of Challenge and Change. Ear and Hearing, 8 (Supplement), 22S-35S.

Bornstein, S.P. (1994). Cited in Bellis, TJ. (1996). In Assessment and Management of Central Auditory Processing Disorders in the Educational Setting: From Science to Practice. San Diego : Angular Publishing Group, Inc.

Brunt, M. (1978). The Staggered Spondaic Word Test. In J.Katz (Ed.). Handbook of Clinical Audiology, 262-275. Baltimore : Williams and Wilkins.

Bryan, T. (1991). Cited in Chermak and Musiek (1997). In Central Auditory Processing Disorders: New Perspectives. London: Singular Publishing Group, Inc.

Buser. P. & Imbert, M. (1992). Audition. London : The MIT Press.

Bush, W.J. & Giles, M.T. (1969). Cited in Barr, D.F. (1976). Auditory Perceptual Disorders. Illinois : Charles C Thomas.

Calearo, C. & Antonelli, A.R. (1963). Cited in Rintleman (1985). Monaural Speech Tests in the Detection of Central Auditory Disorders. In M.L. Pinheiro & F.E.Musiek (Eds). Assessment of Central Auditory Dysfunction: Principles and Clinical Correlates. 173-200, Baltimore : Williams and Wilkins.

Calearo, C. & Antonelli, A. (1968). Audiometric Findings in Brainstem Lesions. Acta Otolaryngology (Stockholm), 66, 305-319.

Calearo, C. & Lazzaroni, A. (1957). Cited in Rintelmann, W.F. (1985). Monaural Speech Tests in the Detection of Central Auditory Disorders. In MX.Pinheiro & F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunction : Foundation and Clinical Correlates. 173-200, Baltimore : Williams and Wilkins.

Campbell, K. & Abbas, P. (1987). The Effect of Stimulus Repetion Rate on the Auditory Brainstem Response in Tumor and Nontumor Patients. Journal of Speech and Hearing Research, 30, 494-502.

Carner, W.F. (1978). Loudness Balance Procedures. In J.Katz (Ed.). Handbook of Clinical Audiology. 164-178. Baltimore : Williams and Wilkins.

Casanova, U. (1989). Cited in Chermak, G.D. & Musiek, F.E. (1997). Centrl Auditory Processing Disorders : New Perspectives. London : Singular Publishing Group, Inc.

Chandrashekhar, S.S. (1973). An Exploratory Study of the Performance of Normal Indian Listeners on the SS W Test Developed in English for Indian Population. Unpublished Masters Dissertation, University of Mysore, Mysore.

Chermak, G.D. (1981). Handbook of Audiological Rehabilitation . Illinois : Charles C Thomas.

Chermak, G.D. (1998). Managing Central Auditory Processing Disorders : Metalinguistic and Metacognitive Approaches. Seminars in Hearing, 19, 379-392.

Chermak, G.D. & Musiek, F.E. (1997). Central Auditory Processing Disorders: New Perspectives (Eds.). San Diego : Singular Publishing Group, Inc.

Cherry, E.C. (1953). Cited in Tobin, H. (1985). Binaural Interaction Tasks. In M.L.Pinheiro & F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunction : Foundations and Clinical Correlates. 155-171, Baltimore : Williams and Wilkins.

Clemis, J.D. & Sarno, C.N. (1980). The Acoustic Reflex Latency Test Clinical Applications. Laryngoscope, 90, 601-611.

Colletti, V. (1975). Stapedius Reflex Abnormalities in Multiple Sclerosis. Audiology, 14, 63-71.

Cox, R.M., Alexander, G.C. & Gilmore, C. (1987). Development of the Connected Speech Test (CST). Ear and Hearing, Suppl. 8,119S-126S.

Cranford, J.L., Stramler, J., Igarashi, M. (1978). Cited in Tobin, H. (1985). Binaural Interaction Tasks. In MX.Pinheiro & F.E.Musiek, (Eds.). Assessment of Central Auditory Dyfunctions, Foundations and Clinical Correlates. 155-172, Baltimore : Williams and Wilkins.

Cranford, J., Boose, M., Moore, C. (1990). Tests of the Precedence Effect in Sound Localization Reveal Abnormalities in Multiple Sclerosis. Ear and Hearing, 11, 282-288.

Davis, P. (1939). Cited in Hall, J.W. (1992). Handbook of Auditory Evoked Responses. Massachusetts : Allyn and Bacon.

Dayal, V.S., Tarantino, L. & Swisher, L.P. (1966). Cited in Rintelmann, W.F. (1985). Monaural Speech tests in the Detection of Central Auditory Disorders. In M.L.Pinheiro & F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunction : Foundations and Clinical Correlates, 173-200.Baltimore : Williams and Wilkins.

Dayalan, J.S. (1976). Development and Standardization of Phonetically Balanced Test Materials in Tamil Language. Unpublished Master's Dissertation, University of Mysore, Mysore.

De, N.A. (1973). Cited in Shekhar, S.S. (1991). Standardization of Spondee Words to be Used in the SSW Test. Journal of All India Institute of Speech and Hearing, 22, 95-97.

Dirks, D., Kamm, C, Bower, D., Betsworth, A. (1977). Use of Peformance - Intensity Functions for Diagnosis. Journal of Speech and Hearing Disorders, 42, 408-415

Farrer, S.M. & Keith, R.W. (1981). Clinical Note : Filtered Word Listing in the Asessment of Children's Central Auditory Abilities. Ear and Hearing, 2, 267-269.

Fifer, R.C., Jerger, J.F., Berlin, C.I., Tobey, E.A. & Campbell, J.C. (1983). Development of a Dichotic Sentence Identification Test for Hearing Impaired Adults. Ear and Hearing, 4, 300-305.

Flavell, J.H. & Wellman, H.M. (1977). Cited in Chermak, G.D. & Musiek, F.E. (1997). Central Auditory Procesing Disorders : New Perspectives. London : Singular Publishing Group, Inc.

Fletcher, H. (1953). Cited in Tobin, H. (1985). Binaural Interaction Tasks. In M.L Pinheiro & F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunctions : Foundations and Clinical Correlates. 155-171, Baltimore : Williams and Wilkins.

Fowler, C.G. & Wilson, R.H. (1984). Adaptation of the Acoustic Reflex. Ear and Hearing, 5, 281-288.

Geisler, C.D., Frishkopf, L.S. & Rosenblith, W.A. (1958). Cited in Kraus, N., Kileny, P. & McGee, T. (1994). Middle Latency Auditory Evoked Potentials. In J.Katz (Ed). Handbook of Clinical Audiology, 387-405, Baltimore : Williams and Wilkins.

Green, D.S. (1963). The Modified Tone Decay Test (MTDT) as a Screening Procedure for Eighth Nerve Lesion. Journal of Speech and Hearing Disorders, 28, 31-36.

Green, D.S. (1978). Tone Decay. In J.Katz (1978). Handbook of Clinical Audiology (Ed.). 128-200, Baltimore : Williams and Wilkins.

Green, J. (1969). Diagnostic Value of Lateralization Ability for Dichotic Time Differences. Acta Otolaryngology, 67, 326-332.

Grimers, A.M., Mueller, H.G. & Williams, D.L. (1984). Clinical Considerations in the Use of Time Compressed Speech. Ear and Hearing, 5, 114-117.

Guevremont, D. (1990). Cited in Chermak, G.D. & Musiek, F.E. (1997). Central Auditory Processing Disorders. New Perspectives. London : Singular Publishing Group, Inc.

Hall, J.W. (1979). Classic Site-of-Lesion Tests : Foundations of Diagnostic Audiology. In W.F.Rintelmann (1979). Hearing Assessment (Ed.). 653-677. Massachusetts : PRO-Ed. Inc.

Hall, J.W. (1992). Handbook of Auditory Evoked Responses. Massachusetts : Allyn and Bacon.

Hall, J. & Mueller, H.G. (1997). Audiologists Desk Reference : Diagnostic Audiology Principles, Procedures and Protocols : I. San Diego : Singular Publishing Group, Inc.

Hall, J.W., Taylor, R.S. & Fernandez, M.A. (1984). Factors Influencing the Masking Time Difference in Cochlear Hearing Impaired and Normal Hearing Listeners. Journal of Speech and Hearing Research, 27, 145-154.

Hallpike, C.S. & Hood, J.D. (1951). Cited in Green, D.S. (1978). Tone Decay. In J.Katz (Ed) Handbook of Clinical Audiology, 188-200. Baltimore : Williams and Wilkins.

Halpiro, Y., Maclishon, I., Carmon, A. (1973). A Shift of Ear Superiority in Dichotic Listening to Temporally Patterned Non-Verbal Stimuli. Journal of the Acoustical Society of America, 53, 46-50.

Harris, J.E. (1992). Cited in Chermak, G.E. & Musiek, F.E. (1997). Central Auditory Processing Disorders : New Perspectives. London : Singular Publishing Group, Inc.

Heasley, B.E. (1980). Auditory Processing Disorders and Remediation. Illinois : Charles C Thomas.

Heasley, B.E. (1974). Cited in Barr, D.F. (1976). In Auditory Perceptual Disorders. Illinois : Charles C Thomas.

Hemalatha, R. (1982). Development and Standardization of a Competing Sentence Test in Kannada. Unpublished Masters Dissertation, University of Mysore, Mysore.

Hirsh, I.J. (1948). Cited in Tobin, H. (1985). Binaural Interaction Tasks. In M.L.Pinheiro & F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunction : Foundations and Clinical Correlates. 155-172, Baltimore : Williams and Wilkins.

Hirsh, I.J. (1959). Cited in Pinheiro, M.L.. & Musiek, F.E. (1985). Sequencing and Temporal Ordering in the Auditory System. In M.L.Pinheiro & F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunction: Foundations and Clinical Correlates. 219-238, Baltimore : Williams and Wilkins.

Homick, IX., Elfher, L.F. & Bothe, G.G. (1969). Auditory Temporal Masking and the Perception of Order. Journal of the Acoustical Society of America, 45, 712-718.

Huges,RX. & Johnson, E.W. (1978). Bekesy Audiometry. In J.Katz, (Ed). Handbook of Clinical Audiology, 201 -217, Baltimore : Williams and Wilkins.

Hynd, G.W., Cohen, M. & Obrzut, J.E. (1983). Dichotic CV in the Diagnosis of Learning Disabilities in Children. Ear and Hearing, 4, 283-286.

Jacobson, J.T. (1994). Principles and Applications in Auditory Evoked Potentials. (Ed.). Massachusetts : Allyn and Bacon.

Jacobson, G.D., Jacobson, J.T., Ramadan, N. & Hyde, MX. (1994). Auditory Brainstem Response Measurement in Auditory Nerve and Brainstem Diseases. In J.T. Jacobson (Ed). Principles and Applications in Auditory Evoked Potentials. 387-426, Massachusetts : Allyn and Bacon.

Jerger, J. (1960). Cited in Rintleman (1985). Monaural Speech Tests in the Detection of Central Auditory Disorders. In M.L.Pinheiro and F.E.Musiek (Eds.). Assessment of Central Auditory Dsyfunction : Foundations and Clinical Correlates. 173-200, Baltimore : Williams and Wilkins.

Jerger, J. (1960a). Observation on Auditory Behaviors in Lesions of the Central Auditory Pathways. Archieves of Otolaryngology, 71, 797-806.

Jerger, J. (1960b). Cited in Raghunath, M. (1990). Testing, Interpreting and Reporting Procedures in Special Audiological Tests - Part A (Eds.). Indian Speech, Language and Hearing Tests. 54-78, The ISHA Battery.

Jerger, J. (1963). Modern Developments in Audiology. (Ed). New York : Academic Press.

Jerger, J. (1973). Cited in Rintleman, W.F. (1985). Monaural Speech Tests in the Detection of Central Auditory Disorders. In M.L.Pinheiro, and F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunction: Principles and Clinical Correlates. 173-200, Baltimore : Williams and Wilkins.

Jerger, J. (1980). Diagnostic Application of Impedance Audiometry in Central Auditory Disorders. In J.Jerger & J.L.Northern (Eds). Clinical Impedance Audiometry. 128- 140, M.A : American Electromedics.

Jerger, S. (1983). Speech Audiology in Young Children. Ear and Hearing, 4, 56-66.

Jerger, J. (1998). Controversial Issues in Central Auditory Processing Disorders. Seminars in Hearing, 19, 393-398.

Jerger, J. & Jerger, S. (1966). Critical Off Time in VIII Nerve Disorders. Journal of Speech and Hearing Research, 9, 573-583.

Jerger, J. & Jerger, S. (1971). Diagnostic Significance of PB Word Functions. Archives of Otolaryngology, 103,216-222.

Jerger, J. & Jerger, S. (1974). Auditory Findings in Brainstem Disorders. Archives of Otolaryngology, 99,324-350.

Jerger, J. & Jerger, S. (1975). Clinical Validity of Central Auditory Tests. Scandinavian Audiology, 4, 147-163.

Jerger, S. & Jerger, J. (1977). Diagnostic Value of Crossed Versus Uncrossed Acoustic Reflexes. Archives of Otolaryngologica, 103, 445-449.

Jerger, S., Martin, R. & Jerger, J. (1987). Specific Auditory Perceptual Dysfunction in a Learning Disabled Child. Ear and Hearing, 8, 78-86.

Jerger, J., Shedd, J. & Harford, E. (1989). On the Detection of Extremely Small Changes in Sound Intensity. Archives of Otolaryngology, 69, 200-211.

Jerger, J., Speaks, C. & Trammell, J. (1968). A New Approach to Speech Audiometry. Journal of Speech and Hearing Disorders, 33, 318-328.

Jerger, J., Weikers, N.J., Sharbough, F.W. m & Jerger, S. (1969). Bilateral Lesions of Temporal Lobe. Acta Otolaryngologica, Suppl. (Stockholm), 258, 1-51.

Jewett, D.L. & Williston, J.S. (1971). Auditory Evoked Far Fields Averaged From the Scalp of Humans. Brain, 94, 681-696.

Jiang, Z.D. (1991). Intensity Effects on Amplitude of Auditory Brainstem Responses in Humans. Scandinavian Audiology, 20,41-47.

Johnson, D.W., Enfield, M.L. & Sherman, R.E. (1981). The use of Staggered Spondaic Word and the Competing Environmental Sounds Test in the Evaluation of Central Auditory Function of Learning Disabled Children. Ear and Hearing, 2, 70-77.

Kapur, Y.P. (1971). Cited in Shekhar, S.S. (1991). Standardization of Spondee Words to be Used in the SSW Test. Journal of the All India Institute of Speech and Hearing, 22, 95-97.

Karlsson, A. & Rosenhall, U. (1995). Clinical Application of Distorted Speech Audiometry. Scandinavian Audiology, 24, 155-160.

Katz, J. (1962). Cited in Musiek, F.E. & Baran, J.A. (1987). Central Auditory Assessment: Thirty Years of Challenge and Change. Ear and Hearing, 8 Supplement, 22S-35S.

Katz, J. (1968). The SSW Test an Interim Report. Journal of Speech and Hearing Disorders, 33, 25-38.

Katz, J., Kushner, D. & Pack, D. (1975). Cited in Willeford, J.A. & Burleigh, J.M. (1985). Handbook of Central Auditory Procesing Disorders in Children. 87-120. Orlando, F.L : Grime and Stratton.

Katz, J. (1978). Handbook of Clinical Audiology (Ed.). Baltimore : Williams and Wilkins.

Katz, J. (1985). Handbook of Clinical Audiology (Ed.). Baltimore : Williams and Wilkins.

Katz, J. (1992). Classification of Auditory Processing Disorders. In J.Katz, N.Stecker, D.Henderson (1992). Central Auditory Processing : A Transdisciplinary View (Eds.), 81 -91, St.Louis : Mosby-Year Book, Inc.

Katz, J. (1994). Handbook of Clinical Audiology (Ed.). Baltimore : Williams and Wilkins.

Keith, R W. (1977). Central Auditory Dysfunction (Ed.). New York : Grune and Stratton.

Keith, R.W. (1983). Interpretation of Staggered Spondee Word (SSW) Test. Ear and Hearing, 4, 287-292.

Keith, R.W. (1986). Cited in Bellis, T.J. (1996). Assessment and Management of Central Auditory Processing Disorders in the Educational Setting: From Science to Practice. San Diego : Singular Publishing Group, Inc.

Keith, R.W. (1986a). Cited in Hall, J.W. & Mueller, H.G. (1997). Audiologists Desk Reference I. London: Singular Publishing Group, Inc.

Keller, W.D. (1992). Auditory Processing Disorder or Attention-Deficit Disorder? In J.Katz, N.A.Stecker & D.Henderson (Eds). Central Auditory Processing : A Transdisciplinary View. 107-114, St.Louis : Mosby Year Book

Keith, R.W. (1994). Cited in Auditory Procesing Dysfunction and Remediation. In Chermak, G.D. (1981). Handbook of Audiological Rehabilitation. 139-181, Illinois : Charles C Thomas.

Kimura (1961). Cited in Musiek, F.E. & Pinherio, M.L. (1985) Dichotic Speech Tests in Detection of Central Auditory Dysfunction. In M.L.Pinherio & F.E.Musiek (Eds). Assessment of Central Auditory Dysfunction: Foundation and Clinical Correlates. 210-217, Baltimore : Williams and Wilkins.

Kimura (1964). Cited in Musiek, F.E. & Pinheiro, F.E. (1985). Dichotic Speech Tests in Detection of Central Auditory Dysfunction. In M.L.Pinherio & F.E.Musiek (Eds). Assessment of Central Auditory Dysfunction : Foundation and Clinical Correlates. 210-217, Baltimore : Williams and Wilkins.

Kirk, S. & Kirk, W. (1971). Cited in Chermak, G.D. (1981). Handbook of Audiological Rehabilitation. 139-181, Illinois : Charles C Thomas.

Korsan-Bengten, M. (1973). Distorted Speech Audiometry : A Methodological and Clinical Study. Acta Otolaryngologica (Supplement) (Stockholm), 310, 7-75.

Kraus, N.,Kileny,P. & McGee, T. (1994). Middle Latency Auditory Evoked Potentials. In J.Katz(Ed.). Handbook of Clinical Audiology. 387-405, Baltimore : Williams and Wilkins.

Kraus, N. & McGee, T. (1994). Auditory Event Related Potentials. In J.Katz (1994). Handbook of Clinical Audiology. 406-423 Baltimore : Williams and Wilkins.

Laxmi, R. (1996). Dichotic CV Test : Normative Data on Adults. Unpublished Masters Dissertation, University of Mysore, Mysore.

Licklider, J.C.R. (1948). Cited in Tobin, H. (1985). Binaural Interaction Tasks. In M.L.Pinheiro & F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunction: Foundations and Clinical Correlates. 155-171, Baltimore : Williams and Wilkins.

Licklider, J.C.R. & Miller, G.A. (1951). The Perception of Speech. In Stevens, S.S. (1966). Handbook of Experimental Psychology (Ed.), 1040-1074, New York : Wiley.

Lindamood, C. & Lindamood, P. (1969). Cited in Barr, D.F. (1976). Therapeutic Considerations. In Auditory Perceptual Disorders. 82-96, Illinois : Charles C Thomas.

Linden, A. (1964). Cited in Tobin, H. (1985). Binaural Interaction Tasks. In M.L.Pinheiro & F.E.Musiek (Eds.). Asessment of Central Auditory Dysfunction : Foundtion and Clinical Correlates. 155-172, Baltimore : Williams and Wilkins.

Lloyd, J. (1980). Cited in Chermak, G.D. & Musiek, F.E. (1997). Central Auditory Processing Disorders : New Perspectives (Eds.). 135-235, London : Singular Publishing Group, Inc.

Luna, G. (1996). Dichotic CV Test : Normative Data on Children. Unpublished Masters Dissertation, University of Mysore, Mysore.

Lynn, G.E. & Gilroy, J. (1975). Cited in Silman, S. & Silverman, C.A. (1991). In Auditory Diagnosis : Principles and Application. San Diego : Academic Press.

Lynn, G.E. & Gilroy, J. (1977). Cited in Silman, S. & Silverman, C.A. (1991). Auditory Diagnosis : Principles and Application. San Diego : Academic Press.

Martin, EN. (1978). The SISI Test In J.Katz (1978). Handbook of Clinical Audiology (Ed.). 179-190, Baltimore: Williams and Wilkins.

Matzker, J. (1959). Cited in Tobin, H. (1985). Binaural Interaction Task. In M.L.Pinheiro & F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunction, Foundations and Clinical Correlates. 155-171, Baltimore : Williams and Wilkins.

Miller, G.A. & Licklider, J.C.R. (1950). Cited in Rintelmann, W.F. (1985). Monaural Speech Tests in the Detection of Central Auditory Disorders. In Pinheiro & F.E, Musiek (Eds). Assessment of Central Auditory Dysfunction : Foundations and Clinical Corrleates. 173-200, Baltimore : Williams and Wilkins.

Moller, A.R. (1983). Auditory Physiology (Eds.). New York : Academic Press, Inc.

Moore, B.C.J. (1973). Frequency Difference Limens for Short Duration Tones. Journal of the Acoustical Society of America, 54, 610-619.

Moore, B.C. J. (1982). An Introduction to the Psychology of Hearing (Eds.). London : Academic Press Inc.

Morales-Gracia, C. & Poole, T.U. (1972). Masked Speech Audiometry in Central Deafness. Acta Otolaryngology (Stockholm), 74,307-316.

Mueller, H., Beck, W, Sedge, R. (1987). Comparison of Efficiency of Cortical Level Speech Tests. Seminars in Hearing, 8, 279-298.

Murdoch, B.E. (1990). Acquired Speech and Language Disorders : A Neuroanatomical and Functional Neurological Approach. 1-59, London : Chapman and Hall.

Musiek, F.E. (1986a). Neuroanatomy, Neurophysiology and Central Auditory Assessment. Part II: The Cerebrum. Ear and Hearing, 7, 283-294.

Musiek, F.E. (1986b). Neuroanatomy, Neurophysiology and Central Auditory Assessment. Part HI : Corpus Callosum and Efferent Pathways. Ear and Hearing, 7, 349-358.

Musiek, F.E., Geurkink, N. & Keitel, S. (1982). Test Battery Assessment of Auditory Perceptual Dysfunction in Children. Laryngoscope, 92, 251-257.

Musiek, F.E. (1983). Assessment of Central Auditory Dysfunction. The Dichotic Digit Test Revisited. Ear and Hearing, *4,* 79-83.

Musiek, F.E. (1994). Cited in Bellis, T.J. (1996). Assessment and Management of Central Auditory Processing Disorders in the Educational Setting From Science to Practice. SanDiego : Singular Publishing Group, Inc.

Musiek, F.E. & Baran, J.A. (1986). Neuroanatomy, Neurophysiology and Central Auditory Assessment. Part I: Brainstem. Ear and Hearing, 7,207-219.

Musiek, F.E. & Baran, J.A. (1987b). Central Auditory Assessment: Thirty Years of Challenge and Change. Ear and Hearing, 8, Supplement, 22S-35S.

Musiek, F.E. & Baran, J.A. & Pinheiro, MX. (1990). Duration Pattern Recognition in Normal Subjects and Patients With Cerebral and Cochlear Lesion. Audiology, 29, 304-313.

Musiek, F.E. & Baran, J.A. & Pinheiro, M.L. (1994). Neuroaudiology : Case Studies. California : Singular Publishing Group, Inc.

Musiek, F.E., Borenstein, S.P., Hall, J.N. & Schuiaber, M.K. (1994). Auditory Brainstem Response : Neurodiagnostic and Intraoperative Applications. In J.Katz(Ed). Handbook of Clinical Audiology (Eds.). 351 -374, Baltimore : Williams and Wilkins.

Musiek, F.E. & Geurkink, N.A. (1982). Auditory Brainstem Rsponse and Central Auditory Test Findings for Patinets With Brainstem Lesions : A Preliminary Report. Laryngoscope, 92, 891-900.

Musiek, F.E., Kibbe, K., Rackliffe, L. & Weider, D. (1984). The Auditory Brainstem Response I-V Amplitude Ratio in Normal, Cochlear and Retrocochlear Ears. Ear and Hearing, 5, 52-55.

Musiek, F.E. , Kurdziel-Schwan, S., Kibbe, K.S., Gollegly, K.M., Bararu J.A. & Rintelmann, W.F. (1989). The Dichotic Rhyme Task-Results in Split Brain Patients. Ear and Hearing, 10, 33-39.

Musiek, F.E. & Pinheiro, M.L. (1985). Dichotic Speech Tests in Detection of Central Auditory Dysfunction. In M.L.Pinheiro & F.E.Musiek (Eds). Assessment of Central Auditory Dysfunction : Foundation Clinical Correlates. 201-217, Baltimore : Williams and Wilkins.

Musiek, F. & Sachs, E. Jr. (1980). Reversible Neuroaudiologic Findings in a Case of Right Frontal Lobe Abcess With Recovery. Archieves of Otolaryngology, 106, 280-283.

Musiek, F.E. & Schochat, E. (1998). Auditory Training and Central Auditory Processing Disorders : A Case Study. Seminars in Hearing, 19,351-366.

Musiek, F. & Wilson, D.H. (1979). SSW and Dichotic Digit Results Pre and Post Commissurotomy : A Case Report. Journal of Speech and Hearing Disorders, 44, 528-533.

Musiek, F.E., Wilson, D.H. , Pinheiro, MX. (1979). Audiological Manifestations *in* "Split Brain" Patients. Journal of the Acoustical Society of America, 5, 25-29.

Nagaraja, M.N. (1972). Development of a Synthetic Speech Identification Test in Kannada Language. Journal of All India Institute of Speech and Hearing, 8, 11-18.

Nagaraja, M.N. (1987). Cited in Shekhar, S.S. (1991). Standardization of Spondee Words to be Used in the SS W Test. Journal of All India Institute of Speech and Hearing, 22, 95-97.

Niccum, N., Speaks, C, Kasturi-Nakamura, J. & Van Tassell, D. (1987). Effects of Stimulated Conductive Hearing Loss on Dichotic Listening Performance for Digits. Journal of Speech and Hearing Disorders, 52, 313-318.

Nickerson, R.S. (1986). Cited in Chermak, G.D. & Musiek, RE. (1997). Central Auditory Processing Disorders : New Perspectives London : Singular Publishing Group, Inc.

Noffsinger, D. (1982). Clinical Applications of Selected Binaural Effects. Scandinavian Audiology (Supplement), 15, 157-165.

Noffsinger, D., Martinez, C. & Schaefer, A. (1982). Auditory Brainstem Responses and Masking Level Differences From Persons With Brainstem Lesions. Scandinavian Audiology, 15, 81-93.

Noffsinger, D., Martinez, CD. & Schaefer, A.B. (1985). Puretone Techniques in Evaluation of Central Auditory Function. In J.Katz (1994). Handbook of Clinical Audiology. (Ed .). 337-354, Baltimore : William and Wilkins.

Noffsinger, D., Schaefer, A.B. & Martinez, CD. (1984). Cited in Bellis, T. J. (1996). Assessment and Management of Central Auditory Processing Disorders in the Educational Setting. : From Science to Practice. San Diego : Singular Publishing Group Inc.

Olsen, W.O. (1983). Dichotic Test Results for Normal Subjects and for Temporal Lobectomy Patients. Ear and Hearing, 4, 324-330.

Olsen, W.O. (1987). Brief Bone Audiometry : A Review. Ear and Hearing Supplement, 8, 13S-18S.

Olsen, N., Noffsinger, D. & Carhart, R. (1976). Masking Level Differences Encountered in Clinical Populations, Audiology, 15,287-301.

Olsen, W.O., Noffsinger, D. & Kurdzeil, S. (1975). Speech Discrimination in Quite and White Noise by patients With Peripheral and Central Lesions. Acta Otolaryngologica (Stock), 80, 375-382.

Olsen, C. (1998). Management of Auditory Processing Difficulties : A Perspective From Speech Language Pathology. Seminars in Hearing, 19, 367-378.

Olsen,W.,Kurdziel, S. (1978). Cited in Musiek,F.E. and Pinheiro, M.L. (1985). Dichotic Speech Tests in the Detection of Central Auditory Dysfunction. In M.L.Pinheiro and F.E. Musiek (Eds.). Central Auditory Dysfunction : Foundation and Clinical Correlates. 201-217, Baltimore : Williams and Wilkins.

Oster (1973). Cited in Stevens, J.H. (1978). Monosyllabic Speech Tests. In Katz, J.(Eds.). Handbook of Clinical Audiology. 244-251, Baltimore : Williams and Wilkins.

Pickles, J.O. (1982). An Introduction to the Physiology of Hearing. New York : Academic Press Inc.

Pinheiro, M.L. (1977). Cited in Willeford, J.A. (1985). Assessment of Central Auditory Disorders in Children. In Pinheiro, & F. E. Musiek, S.(Eds.). Asessment of Central Auditory Dysfunction : Founation and Clinical Correlates,. 239-255, Baltimore : Williams and Wilkins.

Pinheiro, M.L. & Musiek, M.E. (1985). Sequencing and Temporal Ordering in the Auditory System. In M.L.Pinheiro & F.E.Musiek, (Eds.). Assessment of Central Auditory Dysfunction, Foundations and Clinical Correlation. 219-238, Baltimore: Williams and Wilkins.

Pinheiro, M.L. & Musiek, F.E. (1985). Assessemnt of Central Auditory Processing Dysfunction : Foundations and Clinical Correlates (Eds.) Baltimore : Williams and Wilkins.

Pinheiro, M.L. & Ptacek, PH. (1971). Reversals in the Perception of Noise and Tone Patterns. Journal of the Acoustical Society of America, 49, 1778-1782.

Pinheiro, M.L. & Tobin, H. (1969). Interaural Intensity Difference for Intracranial Lateralization. Journal of the Acoustical Society of America, 46, 1482-1487.

Phillips, D.P. (1998). Sensory Representations, the Auditory Cortex and Speech Perception. Seminars in Hearing, 19, 319-344.

Reagan, C.L. (1973). Cited in Barr,D.F. (1976). Auditory Perceptual Disorders. Charles C Thomas.

Rintelmann, W.F. (1979). Hearing Assessment (Ed.). Massachusetts : PRO-Ed, Inc.

Rintelmann, W.F. (1985). Monaural Speech Tests in the Detction of Central Auditory Disorders. In M.L.Pinheiro & F.E.Musiek (Ed.). Assessment of Central Auditory Dysfunction ; Foundations and Clinical Correlates. 173-200, Baltimore : Williams and Wilkins.

Rose, D.E. & Rittmanic, P.A. (1986). Evokved Response Tests With Mentally Retarded. Archives of Otolaryngology, 88, 495-498.

Rosenhall, V., Hedner, M. & Bjorkman, G. (1981). ABR and Brainstem Lesions. Scandinavian Audiology, Supplement, 13, 117-123.

Rosenhamer, H. (1981). The Auditory Evoked Brainstem Electric Response (ABR) in Cochlear Hearing Loss. Scandinavian Audiology, Supplement, 13, 83-93.

Roeser, R.J. (1996). Audiology Desk Refernce : A Guide to the Practice of Audiology. New York : Thieme Medical Publishers, Inc.

Roeser, R.J., Johns, D.F. & Price, L.L. (1972). Effects of Intensity on Dichotically Presented Digits. Journal of Auditory Research, 12, 184-186.

Sand, T. (1991). The Clinical ABR Click Polarity and Amplitude Variables in Multiple Sclerosis Patients. Scandinavian Audiology, 20, 75-80.

Schneider, D. (1992). Audiologic Management of Central Auditory Processing Disorders. In J.Katz, N.Stecker & D.Henderson (Eds.). Central Auditory Processing : A Transdisciplinary View. 161-168. St.Louis : Mosby Year Book, Inc.

Semel, E. (1970). Cited in Barr, D.F. (1976). Therapeutic Considerations. In Auditory Perceptual Disorders. 82-96, Illinois : Charles C Thomas.

Shaw, G.M., Tardine, C.A. & Fridjhon, P. (1996). A Pilot Investigation of High Frequency Audiometry in Obscure Auditory Dysfunction (OAD). British Journal of Audiology, 30, 233-237.

Shekhar, S.S. (1991). Standardization of Spondee word to be Used in the SS W Test. Journal of All India Institute of Speech and Hearing, 22,95-97.

Shiriman, M.J. & Arnst, D.J. (1980). Pl-PB Rollover in a Group of Aged Listeners. Ear and Hearing, 1, 50-53.

Shivashankar, N. (1988). Cited in Shekhar, S.S. (1991). Standardization of Spondee Words to be Used in the SSW Test. Journal of All India Institute of Speech and Hearing, 22, 95-97.

Silman, S. & Silverman, C.A. (1991). Auditory Diagnosis : Principles and Applications. San Diego : Academic Press.

Sinha, S.O. (1959). Cited in Musiek, F.E. & Baran, J.A. (1987). Central Auditory Assessment: Thirty Years of Challenge and Change. Ear and Hearing, 8 (Supplement), 22S-35S.

Smith, B.B., Resnick, D.M. (1972). An Auditory Test for Assessing Brain Stem Integrity : Preliminary Report. Laryngoscope, 82, 414-424

Sloan, C. (1998). Management of Auditory Processing Difficulties : A Perspective From Speech Langauge Pathology. Seminars in Hearing, 19, 367-378.

Spark, R & Geshwind, N. (1968). Cited in Musiek, F.E. & Pinheiro, M.L. (1985). Dichotic Speech Tests in the Detection of Central Auditory Dysfunction. In M.L.Pinheiro & F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunction: Foundation and Clinical Correlates. 201-217, Baltimore : Williams and Wilkins.

Speaks, C.E. (1975). Cited in Silman,S. & Silverman, C.A. (1991). Auditory Diagnosis : Principles and Applications. San Diego : Academic Press, Inc.

Spitzer, J.B. (1983). Discussion Paper :A Central Auditory Evaluation Protocol: A Guide for Training and Diagnosis ofLesions of the Central System. Ear and Hearing, 4, 221-231.

Stevens, J.H. (1978). Monosyllabic Speech Tests. In J.Katz (Ed.). Handbook of Clinical Audiology. 244-251, Baltimore : Williams and Wilkins.

Sutton, S., Tueting, P., Zubin, J. & John, E.R. (1967). Cited in Kraus, N. & McGee, T. (1994). Auditory Event Related Potentials. In J.Katz (Ed.). Handbook of Clinical Audiology, 402-423, Baltimore : Williams and Wilkins.

Swarnalatha (1972). The Development of Standarization of Speech Material in English for Indians. Unpublished Master's Dissertation, University of Mysore, Mysore.

Sweetow, R. & Reddell, R. (1978). Cited in Willeford, J.A. & Burleign, J.M. (1985). In Handbook of Central Auditory Processing Disorders in Children. . Orlando, F.L: Grune and Stratton.

Swisher, L. & Hirsh, I.J. (1972). Cited in Musiek, F.E. & Baran, J.A. (1987). Central Auditory Assessment: Thirty Years of Challenge and Change. Ear and Hearing, 8 (Supplement), 22S-35S.

Thomas, I.B., Chetti, R.D. & Chase, P.W. (1970). Effect of Silent Intervals on the Perception of Temporal Order for Vowels. Journal of Acoustical Society of America, 49 : 85-89.

Thomas, I.B. & Fitzgibbons, P.J. (1971). Temporal Order and Perceptual Classes. Journal of the Acoustical Society of America, 50, 86-87.

Thompson, M.E. & Abel, S.M. (1992a). Indices of Hearing in Patients With Cental Auditory Pathology - I : Detection and Discrimination. Scandinavian Audiology, 21 (Supplement 35), 3-15.

Thompson, M.E. & Abel, S.M (1992b). Indices of Hearing in Patients With Cental Auditory Pathology - II Choice Response Time. Scandinavian Audiology, 21 (Supplement 35), 17-22.

Thomson, J., Terkildsen, K. & Osterhammel, P. (1978). Auditory Brainstem Response in Practice With Acoustic Tumor. Scandinavian Audiology,7, 179-184.

Tobin, H. (1985). Binaural Interaction Tasks. In M.L.Pinheiro & F.E.Musiek (Eds.). Assesment of Central Auditory Dysfunction : Foundation and Clinical Correlates. 155-172, Baltimore : Williams and Wilkins.

Townsend, T.H. & Goldstein, D.P. (1972). Suprthreshold Binaural Unmasking. Journal of the Acoustical Society of America, 51, 621-624.

Valett, R.E. (1967). Cited in Barr, D.F. (1976). Therapeutic Consideration. In Auditory Perceptual Disorders, 82-96. Illinois : Charles C Thomas.

Vivion, H.C. Hirsh, J.E., Frye-Osier, H. & Goldstein, R. (1980). Effects of Stimulus Rise-Fall Time and Equivalent Duration on Middle Components of AER. Scandinavian Audiology, 28, 360-267.

Weber, B. (1986). Assessing Low Frequency Hearing Using Auditory Evoked Potentials. Ear and Hearing, Supplement, 8, 49S-54S.

Willeford, J.A. (1976). Cited in Willeford, J. (1985). Assessment of Central Auditory Disorders in Children. In M.L.Pinheiro . & F.E.Musiek (Eds.). Assessment of Central Auditory Dysfunction : Foundations and Clinical Correlates. 239-255, Baltimore : Williams and Wilkins.

Willeford, J. (1968). Cited in Willeford, J. (1977). Assessing Central Auditory Behviour in Children : A Test Battery Approach. In R.Keith, (Ed.). Central Auditory Dysfunction. 43-73, New York: Grune and Stratton.

Willeford, J. (1977). Assessing Central Auditory Behviour in Children : A Test Battery Approach. In Keith (Ed .). Central Auditory Dysfunction. 43-73, New York : Grune and Stratton.

Willeford, J. (1978). Sentence Test of Central Auditory Function. In J.Katz (Ed.). Handbook of Clinical Audiology. 252-261, Baltimore : Williams and Wilkins.

Willeford, J. & Billger, J. (1978a). Auditory Perception in Children With Learning Disabilities. In Katz (Ed .). Handbook of Clinical Audiology,. 410-425, Baltimore : Williams and Wilkins.

Willeford, J.A. & Burleigh, J.M. (1985). Handbook of Central Auditory Processing Disorders in Children. Orlando, F.L : Grune and Stratton.

Willetle, R., Jackson, B. & Peckins, I. (1970). Cited in Barr, D.F. (1976). Therapeutic Considerations. In Auditory Perceptual Disorders, 82-96, Charles C Thomas.

Wilson, R. (1994). Cited in Chermak, G.D. & Musiek, F.E. (1997). Central Auditory Processing Disorders : A New Perspectives, San Diego : Singular Publishing Group, Inc.

Wilson, R.H. & Margolis, R.H. (1979). Acoustic Reflex Measurements. In W.F.Rintelmann (Eds). Hearing Assessment. 247-320, Massachusetts : PRO-ED, Inc.

Wilson, L. & Mueller, H.G. (1984). Cited in Bellis, T.J. (1996). In Assessment and Management ofCentral Auditory Processing Disorders in the Educational Setting From Science to Practice. San Diego : Singular Publishing Group, Inc.

W3son, R.H., Preece, J.P., Salamon, D.L., Sperry, J.L. & Bornstein, S.P. (1994). Cited in Bellis, T.J. (1996). Assessment of Central Auditory Processing Disorders in the Educational Setting : From Science to Practice. San Diego : Singular Publishing Group, Inc.

Wilson, R.H., Zizz, G.A. & Sperry, J.L. (1994). Cited in Bellis, T.J. (1996). Assessment and Management of Central Auditory Processing Disorder in the Eucational Setting: From Science to Practice. San Diego : Singular Publishing Group, Inc.

Wright, H.N. (1978). Brief Tone Audiometry. In J.Katz (Ed.). Handbook of Clinical Audiology. 218-232, Baltimore: Williams and Wilkins.

Zemlin, W.R. (1988). Speech and Hearing Science. Anatomy and Physiology (Ed.). New Jerse: Prentice-Hall, Inc.