DOCUMENT RESUME

ED 302 809 CS 009 456

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TITLE Frequency-Specific, Binaural Stimulation of Students with Reading and Spelling Difficulties.
PUB DATE 88
NOTE 14p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Auditory Discrimination; Auditory Evaluation; *Auditory Tests; Case Studies; Dyslexia; Elementary Education; Foreign Countries; *Hearing Impairments; *Hearing Therapy; Junior High Schools; Language Research; *Learning Disabilities; *Phonology; *Reading Difficulties; Spelling

ABSTRACT

A study examined the hearing of learning disabled students (such as dyslexics) in an attempt to classify, identify, and design auditory stimulation procedures. Subjects, 40 students from seventh-grade classes and 40 volunteers (ages 9 to 23) with reading and spelling difficulties, were given listening tests. Results indicated that many of the learning disabled students had a left ear advantage while many of the control group had right ear advantage. Additionally, left-handed students were more likely to have learning disabilities than right-hande. students. A case study involved an 11-year-old female reading several years below age level. The subject underwent daily 10- to 15-minute auditory stimulation in an attempt to alter ear advantage from left to right. After 18 months, the subject advanced from a second-grade level to a sixth-grade level. (Twenty-five references are attached.) (RS)

FREQUENCY-SPECIFIC, BINAURAL STIMULATION OF STUDENTS WITH READING AND SPELLING DIFFICULTIES

Kjeld Johansen, Ph.D.

Various researchers have documented during recent years that children with both early and long-lasting hearing problems develop language difficulties.
Besides language, the ability to learn, to read, and to spell "at normal time and to a normal degree" is also reduced. (Dalby, 1986; Kavanagh, 1986).

Researchers have spent little time researching whether frequently repetitive or long-lasting hearing loss in only one ear is more of or less of a heavy strain for linguistic development than two-sided hearing loss. Minimal attention has been devoted to studying whether one-sided hearing loss in the right ear, for example, is more or less of a strain for linguistic development than a corresponding one-sided hearing loss in the left ear.

Finally, no researcher has, to the best of my knowledge, heretofore attempted to see any greater relationship between hearing loss, linguistic development, and cerebral laterality, even though it would appear to be an obvious and stimulating subject for research.

C.G. Watson (1975) has documented how double-sided sensorineural hearing loss influences linguistic development including both vocabulary and reading ability.
Children with even slight hearing losses over the entire frequency range or for the highest frequencies had delayed reading development and were as much as three years behind age-matched peers.

Stillman (1980) is of the opinion that binaural hearing problems result in subsequent reading problems.

Sak and Ruben (1982) compared siblings both with and without repeated cases of otitis media before their fourth year. The study showed that early cases of otitis media result in poorer verbal abilities, poorer auditory decoding and spelling problems.

Webster and Webster (1977) have, by means of experiments with animals, documented a relationship between early conductive hearing loss and morphological changes in certain neurons in the brain stem's auditory system.
Or in other words, banal hearing losses in certain situations could be imagined to result in neural degeneration supposedly caused by lack of auditory stimulation.

This seems to fit in well with research during recent years concerning the importance of stimulation for the development of dendrites and synapses in the cerebral cortex (Diamond, 1984).

A number of studies all document the same conclusion that children from the age of four already have right ear advantage for language (Witelson, 1977; Woods, 1980).

Since stimuli perceived by way of the right ear influence the auditory terminal area in the left hemisphere earlier and more strongly than stimuli perceived by way of the left ear, right ear advantage is presumably related to general linguistic dominance of the left hemisphere.
Nevertheless, the majority of studies made have overlooked a group of factors which could prove valuable to consider along with the others.

It is a common assumption that the two cerebral hemispheres function according to different principles. While the left hemisphere principally works sequentially or digitally, the right hemisphere works simultaneously or analogously. To be more specific, decoding pictures or gestalts is a task for the right hemisphere while decoding sequential stimuli (sounds or letters in succession, for example) is a task for the left hemisphere.

It has long been known that children with reading difficulties also have problems with sequences in general for such tasks as naming months and the days of the week, ordering pictures in their proper sequence, etc. (Levine, 1987).
Reading disabled (RD's) often have difficulty perceiving and remembering a long message. Many have difficulty learning to tell time. Their rhythmic sense is often lacking. Some have difficulty hearing the difference between phonemes and pronouncing words.

It would be quite natural to consider whether or not these factors were related to one another.

In the holistically-oriented sciences, one of the phenomena dealt with is based upon the idea that identical principles recur throughout the same area on large and small scales, a quality of self-similarity (see Gleick, 1988).
For instance, if the left hemisphere primarily functions sequentially, then according to the holistic viewpoint, it will also do so at all levels whether it be perception of pure tones, which collectively comprise cognitive linguistic sound (a phoneme) for decoding letter combinations (graphemes to phonemes), decoding word sequences (cognitive expressions) or continuity.

Insufficient sequential-information processing associated with the left hemisphere seems to be precisely the root of many difficulties for large groups of dyslexics.

It appears, as well, that degeneration in certain areas of the cerebral cortex in the left hemisphere has been established for some children with severe cases of developmental dyslexia (Geschwind & Galaburda, 1984).

Geschwind's work was based on the hypothesis that these changes are hereditary or are caused by maternal hormonal conditions during pregnancy.

To the best of my knowledge, no researchers have ever seriously considered whether corresponding degenerative changes in neurons in the auditory terminal area's marginal zone in the left hemisphere's temporal lobe (the so-called Wernicke area) are due to lack of stimulation during the first years of a child's life. Nevertheless, there are indications that Geschwind could have had such thoughts shortly before his death in 1984 (Geschwind, 1985; Katz, 1985).

During various forms of dichotic listening (Hugdahl & Andersson, 1986) and binaural audiometry (described in the following), it can be established that a large group of RD's have definite or predominant left ear advantage for language sounds (meaningless syllables) as well as pure tones, contrary to normal readers who demonstrate right ear advantage for corresponding stimuli. (It should be emphasized that both research and control groups were exclusively made up of right-handed subjects.)

While various forms of dichotic listening are often described during recent years (Hugdahl & Andersson, 1986; Katz, 1985; Rasmussen et al., 1987; Hugdahl, 1988), no dyslexia researchers have, to the best of my knowledge, described the utilization of binaural, pure-tone audiometry as a possible aid for sub-group classification of dyslexics.

A general screening-audiometer with a simultaneous R and L signal can be used.
The binaural test consists of two rounds. First a test at 20 dB and then at the binaural hearing threshold.

The subject sits in front of the researcher with his back facing him. The following message is given: "You will now hear a tone. Sometimes in your right ear, sometimes in your left ear and sometimes in both ears simultaneously. Raise one or both hands to show on which side you hear the tone."

The researcher can carry out random shifts between L, R, and both ears simultaneously (L+R), or be satisfied with double-sided stimulation. Only reactions from double-sided stimulation are recorded. The entire frequency range is tested at 20 dB.

In the second round, the same message is given to the subject. The audiometer is set at -10 dB. The strength is increased in steps of 5 dB. Each level is held for 3 seconds. The subject's primary, spontaneous reaction is recorded as previously.

For the tests referred to here, an audiometer of the type Danplex, AS60 Portable Screening Audiometer, fulfilling the specifications in the IEC publication no. 178 "Pure Tone Screening Audiometers" is used. It furthermore meets the requirements in the Danish Health Department's regulations from August 8, 1972 and is calibrated in agreement with ISO standards R-389, 1964.

Tests are carried out at 20 dB and at the binaural thresholds for the following frequencies: 125 Hz, 250 Hz, 500 Hz, 750 Hz, 1000 Hz, 1500 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz and 8000 Hz.

Therefore each subject will require at least twenty-two and at most forty-four recordings (the latter if all stimuli are recorded for both sides).

A recording can appear as follows:

(X=L, 0=R, 0=both)

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Advantage at 20 dB:          X  X  X  X  X  O  O  Ø  Ø  X  X
                             |--+--+--+--+--+--+--+--+--+--|
                       125 Hz                               8000 Hz
Advantage at threshold:      Ø  X  X  X  X  O  O  O  X  X  X
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In this case there are 25 recorded reactions of which 17 or 68% are for the left ear (XLEA).

I have chosen to divide the subjects into five ear-advantage groups as follows:

80 - 100% to L. ear:	LEA	(Left Ear Advantage)
60 - 80% to L. ear:	XLEA	(Unsure, primarily L.)
40 - 60% to L. ear:	XEA	(Unsure ear advantage)
20 - 40% to L. ear:	XREA	(Unsure, primarily R.)
0 - 20% to L. ear:	REA	(Right Ear Advantage)

From a study of eighty persons (forty volunteers with reading and spelling difficulties from the ages of nine to twenty-three years and forty student from two seventh grade classes) the following advantages were found:

	RD's		Control group	
LEA	15	(1, 13, 1)	3	(0, 3, 0)
XLEA	6	(1, 4, 1)	5	(1, 4, 0)
XEA	8	(2, 6, 0)	10	(0, 10, 0)
XREA	10	(2, 8, 0)	6	(1, 5, 0)
REA	1	(1, 0, 0)	16	(2, 12, 2)

The figures in parentheses indicate handedness (L, R, ambidextrous). Five students from the control groups receive or have received remedial reading instruction: two right-handed students from the XLEA group, one right-handed student from the XEA group and both left-handed students from the REA group.

Notice that there were seven left-handed RD's as opposed to only four in the control group. Notice, too, that the two ambidextrous subjects with difficulties have LEA and XLEA while two ambidextrous without difficulties have REA. Finally, the two left-handed subjects with right ear advantage (REA) from the control group have reading and spelling difficulties.

There seem to be significant differences between ear advantages in the two groups. A difference which other researchers have discovered using dichotic-listening tests.

Mamen (1987), who is interested in the correlation between conditions of advantage and of reading development, provides yet another reason to take the advantage problems seriously. According to Mamen, a considerable number of early readers have sight, hearing, and motor-function advantages on the same side.

In an article in Nordisk Tidsskrift for Spesialpedagogikk 2/88, I have concerned myself with advantage and lateralization regarding motor function, sight and hearing (Johansen, 1988).

Analyses of the individual audiograms of the subjects, which in addition to the aforementioned binaural test also include measurement of monaural thresholds, reveal some general differences between the majority of RD's and the control group of normal readers.
As a result, RD's most often have much greater divergences between their thresholds than those of the control group. Furthermore, the hearing of the left ear in the RD group is more often than not the most sensitive.
Phoneme discrimination is physically speaking a complicated process in which the auditory system seems to differentiate between language sounds in pure tones (Fourier analysis).

The likelihood of disturbing this complicated analysis process seems great if some of the phoneme's frequencies are perceived primarily through the right ear while others are perceived through the left ear, which audiometer measurements reveal must be the case.

At a general sound level of 50 dB, the volume for the left ear must be increased by only 5 dB in order for an established right ear advantage to shift to the left ear (Berlin, 1977). At lower sound levels, presumably even smaller increases are necessary to achieve the same result. Everyday vocal speech communication rarely supercedes 50 dB. A whispering voice level is approximately 20 dB.

It is precisely this discrepancy in sensitivity of 5 dB in the left ear's favor over a more or less limited frequency range which seems to be characteristic for many RD's.

Besides being frequency-dependent, ear advantage also seems to be volume-dependent for some children. In other words at any given frequency, the ear advantage at 20 dB isn't the same as it is at the hearing threshold for binaurally prescribed pure tones. I have discovered this relationship applying to students with great reading difficulties.

An audiometer examination describes the actual hearing situation. Through an extensive utilization of questionnaires with the subjects' parents, I feel I have been able to document how early hearing losses play a significant role in the development of the inappropriate (left-sided) ear advantage.

It seems to have been documented that ear advantage is an important factor in connection with general language development. Right ear advantage for all frequencies can prove to be a necessary prerequisite for optimal development of the ability to sequentially process language stimuli.

An attempt at establishing right ear advantage for those frequencies at which an RD subject shows left ear advantage would seem to be appropriate.

Experiments with cats and rats have more than sufficiently documented how sensory deprivation has a degenerative neural effect and how environments rich with stimuli have the opposite (positive) effect (Diamond, 1984).

Therefore, for several years I have attempted to provide frequency-specific, auditory stimulation as a supplement to remedial instruction of reading and spelling disabled children and adults.

The following is a description of the progress with one student whose teachers and parents were actively involved in the project and made sure that listening exercises were done every day.
I have experienced a number of corresponding cases, but as a "hobby researcher" without research funding and materials, I have no possibilities to carry out proper, controlled experimental treatments. The Danish Public School System's Development Council rejected an application for funding for such an experiment at Vestermarie School on Bornholm where several successful pilot projects have already been carried out.

WHY COULDN'T WINNIE READ?

Winnie, eleven years old, was a small, resigned girl in the fifth grade when I met her for the first time in October, 1985. Her parents had, through the school, asked me to make a hearing examination and, if I deemed it necessary, to carry out a sound stimulation program to supplement her normal remedial education.

For the following eighteen months, Winnie was stimulated every day for ten minutes with specifically recorded music and sounds in an attempt to shift her ear advantage and, in so doing, improve her possibilities for language acquisition.

In October, 1985, Winnie's reading level corresponded to that of an average second grader. By August, 1986, her reading level corresponded with her fellow classmates in the sixth grade.

The results from a range of oral reading tests are as follows:

Date	Lix index	Reading aloud words/minute	Mistakes
10-07-85	21	38	10
12-18-85	20	47	8
05-30-86	22	66	6
10-20-86	22	87	4
04-10-87	31	80	1

At her initial hearing examination in October, 1985, a number of significant divergences were discovered between the hearing thresholds for her right and left ears, especially under 1000 Hz. At 20 dB, ear advantage was unsure. The advantage at hearing thresholds was not tested.
By May, 1986, divergences under 1000 Hz had decreased considerably, but binaural examinations showed definite left ear advantage both at 20 dB and at hearing thresholds.
By April, 1987, the thresholds were congruent under 1000 Hz and the binaural examination showed definite right ear advantage in the same frequency range.
Winnie has right-sided motor functioning advantage (hand and foot), but left eye advantage.

The teachers had the following (written) comments to her developments during these eighteen months:

Starting in August, 1984 when Winnie began the fourth grade, I became Winnie's remedial reading teacher. She was a very poor reader who only could read a text with a LIX index of 7 fluently.
Starting on October 7, 1985, she was stimulated at home every day for ten minutes with sound therapy. After a month, her parents noticed progress, and in school we saw a more open-minded girl who developed rapidly.
Today, in June 1987, she reads as well as her classmates.

G.A., teacher

If one didn't know that Winnie has had reading difficulties, one wouldn't have noticed any problems in English class. Her conversation corresponds with that of her classmates and there are no problems with reading aloud. Written English is still difficult for her, since Winnie has great problems with spelling.

K.D., principal

PRINCIPLES FOR BINAURAL SOUND STIMULATION

On the basis of the audiogram for each individual, a stimulation program of ten to fifteen minutes is composed for daily use.
Some are treated with a standard program, so that for the first six to eight weeks, the ranges 125-250 Hz and 2000-4000 Hz are stimulated so as to primarily stimulate the right ear.
During the ensuing four to six months, the entire frequency range is stimulated, for the most part still concentrating on the right ear.
It should be noted here that some left-handed individuals present some very great problems which are most difficult to grapple with.

During the preceding six months, I have attempted to use individual stimulation tapes for a group of subjects. The principle used here is that new recordings of the standard tape are made with the help of an equalizer so that the individual frequency ranges are strengthened or weakened relatively according to how the hearing thresholds for each ear differentiate from the hearing curve which the French ear physician, A.A. Tomatis characterizes as optimal. (Manasi, 1982). It looks as though more rapid results are reached with this method (lessening the difference between thresholds and shifting the advantage to the right ear for all tested frequencies, 125 Hz - 8000 Hz).

CLOSING COMMENTS

There should hardly be any doubt that when a child is learning to read phonemic languages, he or she relies on the phonological aspects of the words themselves. In addition, it has been documented how some sub-groups of RD's (perhaps all groups?) have difficulties with the phonological aspect of language itself.
The prerequisite for optimal development of phonological awareness is that the child must be able to hear the sounds of language and discriminate between them.
Simple measurements can show how various RD's perceive auditory stimuli significantly differently than the average normal reader.
Throughout the most recent years, brain researchers have described how intensive, modal-specific stimulation provokes visible morphological changes in the perception areas of the brain.
By means of intensive, auditory stimulation over a period of some months, the ear's sensitivity and ear advantage is changed, which can be demonstrated afterwards through monaural and binaural audiometry.
Quite a number of the children treated with sound therapy feel they can actually acquire the written language more easily.
In my opinion, this should be made into the subject of serious research.

It is relatively unknown that in a number of locations throughout the world serious work is being done with specific auditory stimulation to supplement other forms of treatment of both children and adults with various forms of difficulties and to increase the possibilities of learning for the normal functioning individual as well.

Many refer to Marian Diamond's research through more than twenty-five years (Diamond, 1984) and a growing number mean they are able to find explanations of ascertained effects in theories of such experts as David Bohm, Karl Pribram and Ilya Prigogine concerning implicate and explicate order, holographic memory and sensory and dissipative structures.

Interested readers can become thoroughly shaken by (and perhaps caught up in) Michael Hutchison's book, Megabrain: New Tools and Techniques for Brain Growth and Mind Expansion, (Hutchison, 1986). Auditory stimulation and research carried out at the Monroe Institute in Faber, Virginia is covered in depth in chapter 12. At the institute, sound therapy is carried out in a comprehensive research area.

Patricia Joudry (Joudry, 1984) has in Sound Therapy for the Walk Man described her form of auditory stimulation. Also the French ear physician, Guy Bérard, has contributed to enlightenment of sound therapy's possibilities with his book, Audition égale comportement, (Bérard, 1982).

That one can stimulate hearing specifically in frequency ranges where it is relatively impaired and that one can afterwards objectively measure shifts after some months of sound therapy simultaneously that the child or adult seems more able to function linguistically is naturally thought provoking to those of us who have for decades practiced educational and/or psychological techniques when working with learning and development.
We suddenly find ourselves, like adherents of Lozanov's method, suggestopedy or suggestology (Lozanov, 1978) and of Colin Lane's ARROW method (Lane, 1987), in a realm not defined by traditional concepts of education, psychology and physiology .

The author, Kjeld Johansen, received his teaching certificate in 1963 and became a vice principal in 1972. In 1984 he received a Ph.D. in Education.

Translated by Stuart Goodale

BIBLIOGRAPHY

Bérard, Guy, Audition Égale Comportement, Maisonneuve, 1982.

Berlin, C.J., "Hemispheric asymmetry in auditory tasks," in Lateralization in the Nervous System, S. Harnad, R. Doty, L. Goldstein, J. Jaynes and G. Krauthamer, eds., N.Y. · Academic Press, 1977.

Dalby, M.A., "Early Diagnosis of Reading Disabilities and Learning Disorders," in Aspects in Reading Processes, K. Trondhjem, ed., København: The Danavox Jubilee Foundation, 1986.

Diamond, Marian C., "Age, Sex and Environmental Influence," in Cerebral Dominance: The Biological Foundations, N. Geschwind and A.M. Galaburda, eds., Harvard University Press, 1984.

Geschwind, Norman, "The Biology of Dyslexia: The Unfinished Manuscript," in Biobehavioral Measures of Dyslexia, David B. Gray and James F. Kavanagh, eds., York Press, Inc., 1985.

Gleick, James, Chaos: Making a New Science, London: Cardinal Sphere Books Ltd., 1988.

Hugdahl, K. and L. Andersson, "The Forced-Attention Paradigm in Dichotic Listening to CV-syllables: A comparison between adults and children," Cortex 22: 417.432, 1986.

Hugdahl, K., ed., Handbook of Dichotic Listening: Theory, Methods and Research, Chichester: John Wiley and Sons, 1988.

Johansen, Kjeld, "Hørelsen som en overset faktor i relation til dysleksi," Nordisk Tidsskrift for Spesialpedagogikk, June 1988.

Joudry, Patricia, Sound Therapy for the Walk Man, Muenster, Sask. Canada: Steele & Steele, 1984.

Katz, Jack, ed., Handbook of Clinical Audiology, Third Edition, Williams & Wilkins, 1985.

Kavanagh, James F., ed., Otitis Media and Child Development, Parkton, Maryland: York Press, 1986.

Lane, Colin, "The Improvement of Non-Verbal Listening with Hearing-Impaired Children using ARROW", Journal British Assoc. Teachers of the Deaf, 5:151-154, 1981.

Levine, Melvin D., Developmental Variation and Learning Disorders, Cambridge, MA: Educators Publishing Service, 1987.

Lozanov, Georgi, Suggestology and Outlines in Suggestopedy (Psychic Studies), Gordon & Breach, 1978.

Mamen, Maggie, "Laterality Patterns in Young Fluent Readers," Brain and Language, 30, 1987, pp. 81-92.

Manassi, Sabina, "Beziehung Ohr-Körper-Sprache. Pädagogik des Hörens. Eine Einführung in die Tomatis-Methode," Zürich, 1982.

Rasmussen, Inge Lise, et al., "Rapport om dikotisk lytnings anvendelighed til valg af læsemetode," Randers Kommune, 1987.

Sak, R. and R. Ruben, "Effects of recurrent middle ear effusion in preschool years on language and learning," Journal of Developmental and Behavioral Pediatrics, 3: 7-12. 1982.

Stillman, R., "Auditory Brain Mechanisms," in Auditory Processing and Language: Clinical and Research Perspectives, P.J. Levinson and C. Sloan, eds., N.Y.: Grune & Stratton, 1980.

Watson, C.G., "A Study of Short Term Visual Memory Skills and Relationship to Certain Aspects of Language in Selected Groups of Hearing Impaired Children," Doctoral Thesis, Northwestern University, Evanston, Illinois, 1975.

Webster, D. and M. Webster, "Neonatal sound deprivation affects brain stem auditory nuclei," Archives of Otolaryngology, 103: 392-406, 1977.

Witelson, S.F., "Early hemispheric specialization and interhemispheric plasticity: An empirical and theoretical review," in Language Development and Neurological Theory, S.J. Segalowitz and F.A. Gruber, eds., N.Y.: Academic Press, 1977.

Woods, B.T., "Observation on the neurological basis for initial language acquisition," in Biological Studies of Mental Processes, D. Caplan, ed., MIT Press, 1980.