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ABSTRACT

The study investigated the task performance of cerebral palsied children under conditions of reduced auditory input and under normal auditory conditions. A non-cerebral palsied group was studied in a similar manner. Results indicated that cerebral palsied children showed some positive change in performance, under conditions of reduced auditory input, on a recall of missing picture test and an attention test and on certain parts of a learning test and digit span test. They showed no change in performance on visual-perceptual or perceptual-motor tasks. The non-cerebral palsied children showed no significant change in performance under conditions of reduced auditory input. However, since the difference scores of the non-cerebral palsied group did move in a positive direction, a comparison of the performance of the cerebral palsied and the non-cerebral palsied children did not show a statistical difference in the amount of positive change exhibited by the two groups. (Author)

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This study investigated the task performance of cerebral palsied children under conditions of reduced auditory input and under normal auditory conditions. A non-cerebral palsied group was studied in a similar manner. Results indicated that cerebral palsied children showed some positive change in performance, under conditions of reduced auditory input, on a recall of missing picture test and an attention test and on certain parts of a learning test and digit span test. They showed no change in performance on visual-perceptual or perceptual-motor tasks. The non-cerebral palsied children showed no significant change in performance under conditions of reduced auditory input. However, since the difference scores of the non-cerebral palsied group did move in a positive direction, a comparison of the performance of the cerebral palsied and the non-cerebral palsied children did not show a statistical difference in the amount of positive change exhibited by the two groups.

PERFORMANCE OF CEREBRAL PALSIED CHILDREN UNDER CONDITIONS OF REDUCED AUDITORY INPUT ON SELECTED INTELLECTUAL COGNITIVE AND PERCEPTUAL TASKS[1,2]

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The literature about brain-damaged and cerebral palsied children often suggests that they are easily distracted by auditory and visual stimuli (Werner and Strauss, 1941; Cruickshank, Bentzer, Ratzeburg and Tanhausser, 1961). Although a considerable amount of research has been done in varying the visual stimuli to which such children are exposed, very little has been done involving a change or manipulation of the auditory environment.

Cerebral palsied children are children who suffer from brain-injury and motor impairment. Current definitions, however, include mention of a variety of other disorders that are frequently associated with cerebral palsy and brain-injury, i.e., intellectual retardation, learning disturbances, visuo-motor and cognitive disorders, restlessness, failure of concentration, and emotional lability, as well as convulsive disorders and disorders in speech and hearing (Nielsen, 1966).

A particular emphasis on distractibility and figure-background disturbances appears in the literature concerned with cerebral palsied and brain-injured children. For example, Eisenberg (1964, p. 64) has described such children as being easily distracted by the trivial and the transient. Herbert Birch (Birch and Lefford, 1964) suggests that brain-injured and cerebral palsied

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children apparently fail to outgrow the initial chaos of infancy, or what William James referred to as "one great blooming, buzzing confusion" (James, 1890, p. 488). Similarly, Werner and Strauss (1941) have suggested that a proper integration of relevant stimuli may be difficult for brain-injured children to achieve because of continuous interference from stimuli extraneous to the task at hand.

In view of such reported distractibility, the present investigation was designed in order to examine the possibility that cerebral palsied children with normal auditory acuity may, in fact, be so satiated with the sensory stimulation received through their own auditory channels that this stimulation, or their response to it, or their incapacity to deal with it, may in some way be interfering with their intellectual, cognitive and perceptual functioning.

The area of sensory psychology and the field of hearing and audiology offered additional support for the logic upon which the present investigation has been formulated. There is, for example, a considerable amount of evidence from the field of sensory psychology indicating that a change in stimuli received through one sense modality may affect performance or behavior involving other modalities. The sensory-tonic field theory of perception (Werner and Wapner, 1956), the theory of intersensory synthesis (Birch and Lefford, 1964) and the concentration of energy theory (Stern, 1938, p. 476; Hernandez-Peon and Donoso, 1959) all offer cogent evidence supporting this possibility. In addition, there is some provocative evidence beginning to accumulate indicating that a period of selective sensory deprivation can produce facilitating as well as detrimental effects on performance and/or behavior (Duda and Zubek, 1965; Smith, Meyers and Murphy, 1967; Ohkubo and Kitamura, 1965).

In the auditory field, there is widespread agreement that some noises are annoying to almost all people, and that any particular noise is annoying to some person. There is also agreement that noise reduction does reduce annoyance even though that annoyance may be produced by very faint sounds (Broadbent, 1957). The effect on performance of such annoyance is much less clear, although factors such as individual variation, distractibility, and fatigue are frequently mentioned.

Considering the brain-injured child and his reaction to auditory stimuli, several comments in the literature indicate the possibility that auditory stimuli may, in fact, play a more prominent role in the lives of many brain-damaged and cerebral palsied children than such stimuli do for normal children. For example, Ram (1962) has commented that to some of these children, sound frequently conveys so much more meaning than vision that visual stimuli are partially ignored. Similarly, Cruickshank, Bentzer, Ratzeburg and Tanhausser (1961, p. 4) have commented that the brain-injured child frequently exhibits an apparent hyper-awareness of the auditory stimuli within his perceptual field.

Accordingly, in order to consider the possibility that cerebral palsied children might be able to function at a higher intellectual, cognitive and perceptual level while under conditions of reduced auditory input, and to be able to compare the task performance of cerebral palsied children under conditions of reduced auditory input with the task performance of non-handicapped children under such conditions, the following hypotheses were formulated:

Hypothesis 1a. There will be a positive change in the performance of normal hearing cerebral palsied children on selected tasks of memory, attention, learning and perceptual abilities under conditions of reduced auditory input.

Hypothesis 1b. There will be a positive change in the performance of normal hearing non-handicapped children on selected tasks of memory, attention, learning and perceptual abilities under conditions of reduced auditory input.

Hypothesis 2. Normal hearing cerebral palsied children will show a greater amount of positive change on selected tasks of memory, attention, learning and perceptual abilities under conditions of reduced auditory input than the amount of positive change exhibited by normal hearing children who are not cerebral palsied.

METHOD

Subjects

Two groups of subjects were used in this study. One group consisted of thirty cerebral palsied children with normal auditory acuity, ranging in age from approximately six to 13 years and in Peabody Picture Vocabulary Test IQ score (Dunn, 1965) from 70 to 136, all of whom could relate to the examiner and attempt the tasks required in the study. The second group consisted of 35 children with normal auditory acuity who were not cerebral palsied (sometimes referred to in this study as the non-handicapped group), all of whom could relate to the examiner and attempt the tasks required in the study. Table 1 summarizes the descriptive statistics of the two groups and indicates that the groups are comparable in chronological age, mental age and IQ. The ratio of males to females is approximately the same in each group.

Setting and Procedure

The major purpose of this study was to ascertain if a reduction in auditory input in the usual environment to which the child was exposed would result in an increase in performance on selected tasks. It was decided, therefore, to keep the setting as natural as possible so that the child could be observed while functioning in his customary milieu.

Both groups of Ss received a series of tasks, administered on an individual basis, under two different auditory conditions, i.e., normal auditory environment and reduced auditory input. Tasks were administered in an empty classroom with the door remaining open during the testing session. There was an interval of one week's time between the two testing sessions. In addition, a counter-balancing procedure was introduced concerning the order in which the auditory conditions were presented, so that 1/2 of all Ss were tested first under normal auditory conditions and the remaining Ss were tested first under conditions of reduced auditory input.

The condition of reduced auditory input was established by placing a set of ear protectors on the S and allowing him to proceed with his usual routine. Ear protectors are designed to block out a certain amount of auditory stimuli. They consist of a muff-type protection for the ears, which is attached to an adjustable vinyl head band. Attenuation data at various frequencies for the ear protectors used in the present investigation are presented in Figure 1.

Ss wore the ear protectors for one hour before the actual testing occurred and during the entire testing session. Previous pilot work had shown that children could hear and understand task instructions while wearing the ear protectors so that pantomime or other unusual techniques were not required during the testing session.

The condition of normal auditory input included the introduction of a placebo mechanism that did not block out auditory stimuli which was worn prior to and during the testing session being administered under conditions of normal auditory environment.

Task Selection and Administration

Tasks administered in this study are described below:

Learning test. This test consists of 15 pictures of common objects. Pictures were selected from the easy pages of the Peabody Picture Vocabulary Test (Dunn, 1965). The complete series of pictures was shown to the child, one by one. Pictures were presented at one-second intervals, each picture covering the preceding one, and each object being named by the examiner as it was shown. When all 15 pictures were shown, the pile was removed and the child was asked to name all objects he could remember. Replies were recorded. The child was shown the same series for three separate trials. The score for each trial was the total number of objects remembered on that trial. Two different sets of pictures, of similar vocabulary difficulty, were used for this test. One set was used at the first testing session and the second set was used at the second testing session.

In order to obtain reliability data, this test was administered to 30 fifth graders in an elementary school, on a test-retest basis, in a normal auditory environment. A Pearson product-moment correlation coefficient of .52 was obtained from the raw scores achieved on trial 2 of each testing session. A correlation coefficient of .69 was obtained from the raw scores achieved on trial 3 of each testing session. A similar test had been used previously (Meyer and Simmel, 1947; Rey, 1941). In addition, this task has been described more recently by Taylor (1961, p. 428).

Digit span test. The digit span test was administered and scored on both testing sessions according to the instructions given in the Wechsler Intelligence Scale for Children (Wechsler, 1949). Maximum score for digits forward was 9 points. Maximum score for digits backward was 8 points.

Recall of missing picture. Simple vocabulary picture cards selected from the Stanford-Binet Intelligence Scale, Form L-M (Terman and Merrill, 1960), were used for this item. Three picture cards were selected. They were placed in a horizontal row, one at a time, from left to right, facing the child. Each picture was identified as it was placed on the table. The child was asked to examine the entire row. Ten seconds were allowed, after placing the last object on the table, for this examination. Then all of the picutres were screened from view, one picture was removed, and the gap closed. The child was asked to look once again and guess which picture had been taken away. If the response was correct, the procedure was repeated with a series of four, five and six pictures up to a total number of twelve pictures. The final score was the total number of correct guesses. Testing for this item was stopped after the first trial in which the child did not recall the missing picture.

In order to obtain reliability data for this task, the test was administered to 30 fifth-graders in an elementary school setting on a test-retest basis in a normal auditory environment. A Pearson product-moment correlation coefficient of .69 was obtained. A similar test item had been used some time ago (Kuhlman, 1922; Terman and Merrill, 1937). A recent description of a similar task has been presented by Edith Taylor (1961, pp. 310-312).

Attention test. Test 10 of the Hunt Minnesota Test for Organic Brain Damage (Hunt, 1943) was used for this item. In this test the examiner reads a list of numbers at the rate of about two per second. The subject is asked to tap whenever he hears the number "3." The test was scored as "pass" or "fail" according to the suggestion in the test manual. Four or more correct taps out of a possible number of six correct taps received a grade of "pass." Zero, one, two or three correct taps out of a possible number of six correct taps received a grade of "fail."

Designs. For this item, tasks were selected from the Stanford-Binet Intelligence Scale, Form L-M (Terman and Merrill, 1960). The tasks selected included: Copying a Circle, Copying a Square, Copying a Diamond, and Memory for Designs. Each item was administered and scored according to the procedure described in the test manual. The maximum score possible for these tasks was 6 points.

Syracuse visual figure-background test. This test consists of a series of pictures which are briefly flashed on a screen by means of a tachistoscope, the exposure time being carefully controlled. The pictures consist of common everyday objects which are imbedded in a structured background. The subject is requested, after each exposure, to indicate what he has perceived. The procedure used in administering this test was the same procedure as that described in some detail in a monograph concerned with perception and cerebral palsy (Cruickshank, Bice, Wallen, and Lynch, 1965). Pictures of the slides, as well as reliability and validity data and detailed scoring instructions are also included in this monograph. For this item, performance was scored according to the two major categories suggested by the test authors, i.e., "number of correct responses" and "number of background responses."

The cerebral palsied group received all of the tests described above. The non-handicapped group, however, received only the first four tests, i.e., learning test, digit span test, recall of missing pictures, and attention test.

Analysis of Data

The data were analyzed by an examination of the difference scores[4] resulting from each child's performance under normal auditory conditions and his performance under conditions of reduced auditory input. The effects of order were investigated and found to be negligible. Therefore, in the analysis, simple *t* tests were done.

The statistic used to test hypothesis 1a and hypothesis 1b was the *t* test for paired comparisons (two-tailed). The statistic used to test hypothesis

2 was the *t* test for independent samples (two-tailed).

RESULTS

Hypothesized Results

As Table 2 indicates, the cerebral palsied group showed a positive change in performance, under conditions of reduced auditory input, on certain tasks, i.e., learning test (trial 3), digit span test (backward and total) and recall of missing picture test. Hypothesis la, therefore, was partially supported by the results of this investigation.

In regard to the attention test, it can be observed from Table 3 that six subjects changed from a grade of "failure" on this test under normal auditory conditions to a grade of "passing" under reduced auditory conditions. There were, however, no subjects who changed from a grade of "failure" under reduced auditory conditions to a grade of "passing" under normal auditory conditions. The probability of obtaining a zero to six split is 1/64 or .015. This can be judged as a significant change in performance on the attention test and, therefore, offers additional support for hypothesis la.

It is interesting to note that the performance of the cerebral palsied children improved, under conditions of reduced auditory input, only on those items which involve intellectual and cognitive skills and which depend most heavily on concentration and memory abilities, i.e., learning test, digit span test, recall of missing picture and attention test. There was, however, no statistical evidence of improvement on tasks that depend largely on visual-perceptual skills or visual-motor skills, i.e., tasks involving figure-background discrimination and tasks involving designs.

As can be observed from Table 4, the non-handicapped group showed no significant change in task performance under conditions of reduced auditory input on the learning test, digit span test and recall of missing picture test. Accordingly, hypothesis 1b was not supported by the results of this study. In addition, the shift in performance on the attention test described in Table 5 indicates that there was actually no significant change in the performance of the non-handicapped children on this item under the two auditory conditions.

Hypothesis 2 states that cerebral palsied children will show a greater amount of improvement under conditions of reduced auditory input than will be exhibited by non-handicapped children. A comparison of the performance of the cerebral palsied group and the non-handicapped group on the attention test (Tables 3 and 5) indicated that the cerebral palsied group showed a greater positive change in performance, under conditions of reduced auditory input, on this test, than the non-handicapped group. This finding offered some support for hypothesis 2. However, a comparison of the difference scores of the two groups on the learning test, digit span test and recall of missing picture test showed no significant difference in the amount of positive change shown by the two groups and, therefore, offered no additional statistical support for the second hypothesis. Table 6 shows this information.

Supplementary Analyses

A correlation matrix consisting of Pearson product-moment correlations among sex, IQ and difference scores for tests administered to the cerebral palsied group under normal auditory conditions and tests administered to the same group under conditions of reduced auditory input was prepared. A similar correlation matrix for the non-handicapped was also prepared. Of particular interest in these tables was the indication of a possible negative relationship between IQ and learning test mean difference scores in the non-handicapped group; i.e., the lower IQ children in this group appeared to show greater improvement on trial 2 of the learning test and on the total learning test score, under conditions of reduced auditory input, than the higher IQ children. This suggested the possibility that the low IQ children in the non-handicapped group might show some evidence of positive change in performance, under conditions of reduced auditory input, even though the non-handicapped group, as a whole, showed no significant change in performance on any of the tasks. Accordingly, sub-groups were established consisting of subjects whose IQ is 87 or below and subjects whose IQ is 88 or above. Table 7 shows mean difference scores for the two sub-groups within the non-handicapped group. This table shows some evidence of improvement on trial 2 of the learning test and on the total learning test score in the low IQ non-handicapped sub-group. The high IQ non-handicapped sub-group showed no improvement under conditions of reduced auditory input.

Analogous to the information reported in Table 7, Table 8 reports similar information for the cerebral palsied children. In the cerebral palsied group some evidence of improvement in performance was shown in both the low IQ and high IQ sub-groups.

DISCUSSION

The results of the present investigation have shown that cerebral palsied children improve in their performance on certain tasks, under conditions of reduced auditory input, and show no significant improvement, under such conditions, in their performance on other tasks. In regard to previous research and theory, these findings appear to highlight the fact that, in studies of sensory psychology, any evidence of change in performance is likely to be highly dependent upon the exact nature of the tasks involved. In addition, the fact that the non-handicapped group showed no significant change in performance under conditions of reduced auditory input, while the cerebral palsied group did show some change in performance under such conditions, indicates that, in studies of sensory psychology, changes in performance resulting from changes in sensory input are likely to be somewhat dependent upon the type of sample group being studied.

Analogously, in regard to the findings of the present investigation, it should be noted that any evidence of a positive change in performance observed in this study should be considered specific to the tasks involved. In addition, the findings reported herein should only be considered applicable to children represented by the present sample groups. Accordingly, the reader is cautioned not to generalize the findings of the present study to other tasks or other groups without further investigation.

In addition, another limitation of the findings of the present investigation should be noted, i.e., it is not clear from this study whether improvement in performance was due to the decrease in auditory stimuli experienced by _Ss_ for one hour prior to the test situation, or whether such improvement was due to the fact that _Ss_ actually wore the ear protectors during the test situation itself. Additional investigation would be necessary in order to determine exactly which part of the auditory reduction had the greatest effect on task performance.

In addition to the theoretical implications and limitations noted above, the results of this study suggest several areas toward which future research might be directed. Investigation of the effects of a period of reduced auditory input on the performance or behavior of other groups might include studies involving retarded or low IQ children, brain-injured children who are not classified as cerebral palsied, schizophrenics and other emotionally disturbed children, slow learning children, and, possibly, children who have been identified by their teachers as being highly distractible. Cerebral palsied children who are blind, emotionally disturbed, or affected by severe motor impairment might be studied in a similar manner. It might also be interesting to study a group of children who have been identified by suitable audiometric techniques as being hyperacusic[5] in order to explore the possibility that a reduction in auditory input might have a particularly interesting effect on the behavior or task performance of such children. Different means of auditory reduction might also be investigated, such as the use of a soundproof room or the introduction of white noise as a masking device.

In addition, it might also be worthwhile to explore the possibility that a reduction in auditory input may also reduce anxiety levels. In the present study, a positive change in performance in the cerebral palsied group occurred on at least one task in which performance is known to be adversely affected by a high degree of anxiety, i.e., the digit span task (Siegman, 1956; Glasser and Zimmerman, 1967, pp. 96-97). This suggests the possibility that a period of reduced auditory input might reduce the level of anxiety experienced by an individual and might make disturbed or highly anxious individuals more amenable to a therapy or learning situation.

Certain practical implications have also been suggested by the results of this study. For example, it might be worthwhile to arrange to have a few sets of ear protectors available for the use of cerebral palsied children in schools or hospitals. Ear protectors could be worn at the discretion of the individual child himself. Thus, if the clatter of the dining room felt particularly annoying to a child on a certain day, he might reach for a set of ear protectors to temporarily allay the disturbance. Studies could be conducted to see whether or not cerebral palsied children would, in fact, choose to wear the ear protectors, how often, in what settings, and which particular children would reach for the ear protectors most often. Studies might also be conducted to see if the availability of the ear protectors would, in fact, produce a favorable effect on the actual behavior or performance of cerebral palsied children in school or hospital settings.

Finally, the results of this study seem to suggest some implications that can be applied to IQ testing. Present findings emphasize the importance of establishing an optimum setting in order to evaluate intellectual potential, particularly when the subject is a child who is easily distracted by auditory as well as visual stimuli. Therefore, for some children, such as cerebral palsied and brain-injured children, it may be important to arrange a test setting that excludes, as much as possible, distracting auditory stimuli. It should be noted, however, that concern with this attribute of a test setting is somewhat contradictory to suggestions presently being offered in current testing manuals (Terman and Merrill, 1960, p. 56).

Concerning hypothesis 2, it seems appropriate to consider some possible explanations for the lack of significant difference in a comparison of the difference scores of the two groups. Part of this explanation may be found in the fact that the difference scores for the non-handicapped group, although showing no significant change under conditions of reduced auditory input, did move slightly in a positive direction. In addition, it may be noted that a test comparing two sets of difference scores always loses a certain amount of reliability and this reduction in reliability may have contributed to the lack of statistical significance noted above. Finally, the possibility should also be considered that the use of more rigorous techniques in the matching of the cerebral palsied subjects and the non-handicapped subjects than those used in the present investigation might have resulted in some additional statistical support for the second hypothesis. Such matching techniques might include selecting two groups within a narrow IQ and chronological age range, careful matching of the range of auditory abilities and possible sensitivity reactions within each group, pretest matching on task performance, and complete neurological examinations.

Concerning the supplementary analyses of this investigation, it has already been suggested that the possible beneficial effects of a period of reduced auditory input on the task performance of low IQ children should be carefully investigated.

In addition, it can be observed in Tables 7 and 8 that the only sub-group showing no change in performance under conditions of reduced auditory input, and no indication of movement in a positive direction in task difference scores, is the group composed of high IQ non-handicapped children. One could interpret these findings as suggesting that a reduction in auditory input might improve the task performance of children who exhibit some special difficulty or problem in their behavior and/or functioning (i.e., in this study cerebral palsied children and, possibly, low IQ non-handicapped children), and will be unlikely to improve the task performance of children who do not exhibit a special difficulty in behavior and/or functioning (i.e., non-handicapped children of normal or high IQ).

The implication that normal IQ non-handicapped children are unlikely to benefit in regard to task performance from a period of reduced auditory input is, in fact, consistent with previous findings in this area (Slater, 1966). Accordingly, it is suggested by the present investigator that further investigations concerning the task performance of school-age children, under conditions of reduced auditory input, might produce most beneficial results if they are concentrated on the "exceptional" child.

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Footnotes

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[4]Throughout this study, "difference score" refers to the score obtained under conditions of reduced auditory input minus the score obtained under normal auditory conditions.

[5]Hyperacusis is defined as an abnormal acuteness of hearing and/or a reaction of extreme sensitivity and irritability to auditory stimuli. (Stedman's Medical Dictionary, Baltimore: Williams and Wilkins, 1961.)

Table 1

Means and Standard Deviations of Chronological Age, Mental Age[a] and IQ Score[a] for Cerebral Palsied and Non-handicapped Groups

	Cerebral Palsied (N=30)		Non-handicapped (N=35)	
	Mean	SD	Mean	SD
Chronological Age	114.7[b]	24.3	113.0	21.4
Mental Age[a]	103.9	31.4	106.3	28.4
IQ[a]	92.1	17.7	95.2	15.0

[a]Peabody Picture Vocabulary Test

[b]In months

Table 2

Means, Standard Deviations and Tests of Significance for the Difference Scores for Tests Administered to the Cerebral Palsied Group Under Normal Auditory Conditions and Under Conditions of Reduced Auditory Input

(N = 30)

	Mean	SD	t	p
Learning Test				
Trial 1	.27	2.45	.60	
Trial 2	.23	1.81	.70	
Trial 3	1.00	1.60	3.43	.01
Total Correct Responses	1.50	4.25	1.93	
Trial 3 minus Trial 1	.73	2.56	1.57	
Digit Span Test				
Forward	.30	.84	1.96	
Backward	.30	.75	2.19	.05
Total	.60	1.25	2.63	.05
Recall of Missing Picture	.70	1.42	2.70	.05
Designs				
Copying Designs	-.10	.40	-1.36	
Memory for Designs	.03	.41	.44	
Total Designs Score	-.07	.45	-.81	
Figure Background Test				
No. of Correct Responses	-.13	1.14	-.64	
No. of Background Responses	.00	2.21	.00	

Table 3

Performance of Cerebral Palsied Children on Attention Test Under Two Different Auditory Conditions

	Normal Auditory Conditions	
	Fail	Pass
Reduced Auditory Input		
Pass	6	15
Fail	9	0

Table 4

Means, Standard Deviations and Tests of Significance for the Difference Scores for Tests Administered to the Non-handicapped Group Under Normal Auditory Conditions and Under Conditions of Reduced Auditory Input

(N = 35)

	Mean	SD	t
Learning Test			
Triat 1	.20	2.29	.52
Trial 2	.83	2.53	1.90
Trial 3	.43	2.25	1.13
Total Correct Responses	1.46	5.43	1.59
Trial 3 minus Trial 1	.23	2.71	.50
Digit Span Test			
Forward	.11	.72	.94
Backward	-.06	.84	-.40
Total	.06	1.00	.34
Recall of Missing Picture	.26	1.69	.90

Table 5

Performance of Non-handicapped Children on Attention Test
Under Two Different Auditory Conditions

	Normal Auditory Conditions	
	Fail	Pass
Reduced Auditory Input		
Pass	2	25
Fail	6	2

Table 6

Comparison of Difference Scores of Cerebral Palsied and Non-handicapped Groups for Learning Test, Digit Span Test and Recall of Missing Picture Test

	Cerebral Palsied (N = 30)		Non-handicapped (N = 35)		
	Mean	SD	Mean	SD	*t*
Learning Test					
Trial 1	.27	2.45	.20	2.28	.11
Trial 2	.23	1.81	.83	2.53	-1.07
Trial 3	1.00	1.60	.43	2.25	1.16
Total	1.50	4.25	1.46	5.43	.03
Trial 3 minus Trial 1	.73	2.56	.23	2.71	.77
Digit Span Test					
Forward	.30	.84	.11	.72	.96
Backward	.30	.75	-.06	.84	1.80
Total	.60	1.25	.06	1.00	1.95
Recall of Missing Picture	.70	1.42	.26	1.69	1.13

Table 7

Means, Standard Deviations and Tests of Significance for Difference Scores of the Low IQ[1] and High IQ[2] Subjects in the Non-handicapped Group

	Low IQ Subjects (N = 16)			High IQ Subjects (N = 19)		
	Mean	SD	*t*	Mean	SD	*t*
Learning Test						
Trial 1	0.44	2.31	0.76	0.00	2.31	0.00
Trial 2	2.00	2.03	3.94**	-0.16	2.52	-0.27
Trial 3	1.06	2.35	1.81	-0.11	2.08	-0.22
Total	3.50	5.16	2.71*	-0.26	5.16	-0.22
Trial 3 minus 1	0.62	3.07	0.81	-0.11	2.40	-0.19
Digit Span Test						
Forward	0.19	0.54	1.38	0.05	0.85	0.27
Backward	0.00	0.82	0.00	-0.11	0.88	-0.52
Total	0.19	0.83	0.90	-0.05	1.13	-0.20
Recall of Missing Picture	0.81	1.33	2.45*	-0.21	1.84	-0.50

[1]Peabody Picture Vocabulary Test IQ score of 87 or below

[2]Peabody Picture Vocabulary Test IQ score of 88 or above

*Significant at the .05 level

**Significant at the .01 level

Table 8

Means, Standard Deviations and Tests of Significance for Difference Scores of the Low IQ[1] and High IQ[2] Subjects in the Cerebral Palsied Group

	Low IQ Subjects (N = 16)			High IQ Subjects (N = 14)		
	Mean	SD	*t*	Mean	SD	*t*
Learning Test						
Trial 1	0.19	3.04	0.25	0.36	1.65	0.81
Trial 2	0.12	2.00	0.25	0.36	1.65	0.81
Trial 3	0.81	1.72	1.89	1.21	1.48	3.08**
Total	1.12	4.91	0.92	1.93	3.47	2.08
Trial 3 minus 1	0.62	3.01	0.83	0.86	2.03	1.58
Digit Span Test						
Forward	0.25	1.06	0.94	0.36	0.50	2.69*
Backward	0.12	0.50	1.00	0.50	0.94	1.99
Total	0.38	1.31	1.15	0.86	1.17	2.75*
Recall of Missing Picture	0.81	1.42	2.28*	0.57	1.45	1.47

[1]Peabody Picture Vocabulary Test IQ score of 87 or below

[2]Peabody Picture Vocabulary Test IQ score of 88 or above

*Significant at the .05 level

**Significant at the .01 level

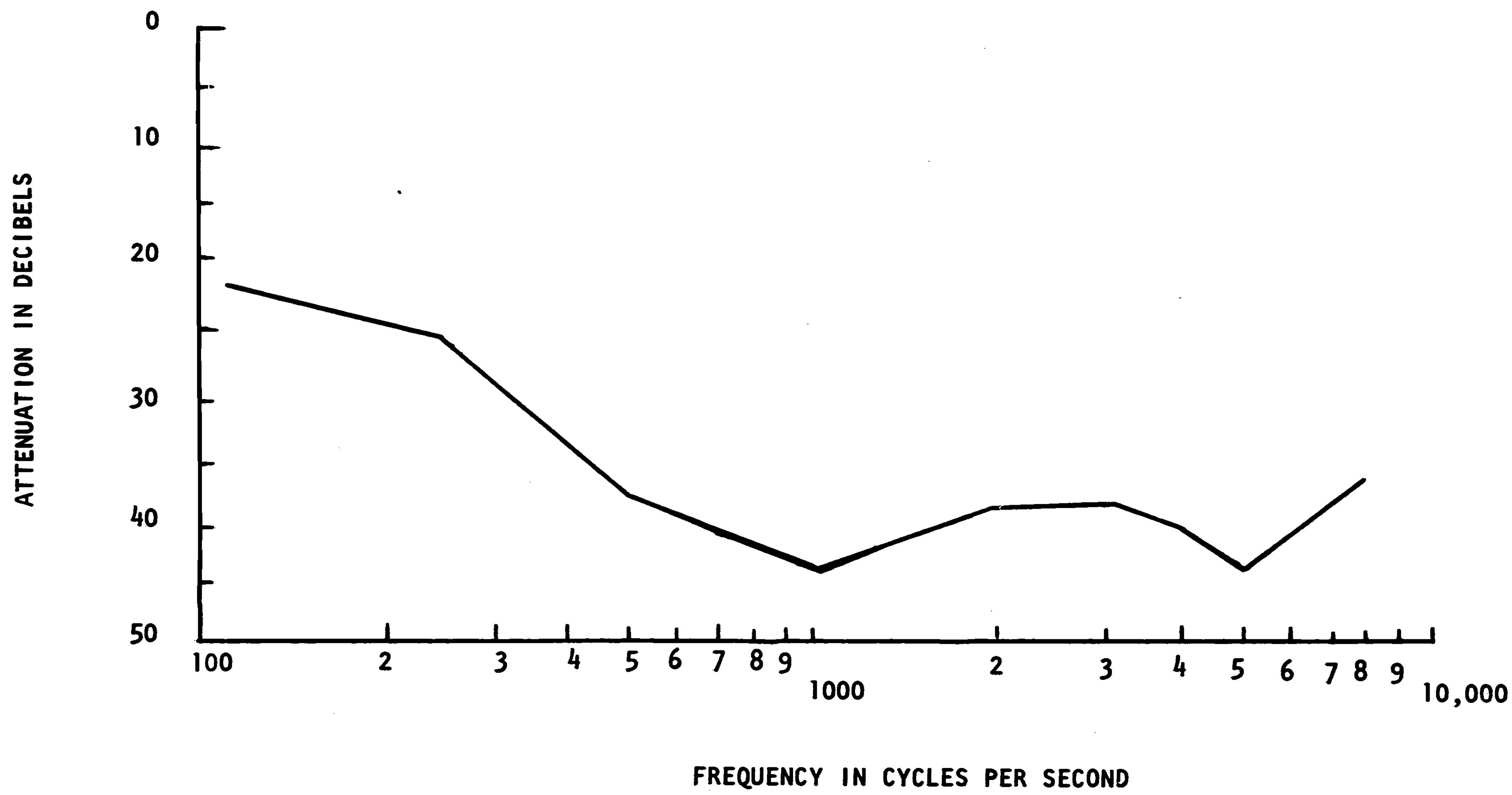

Figure 1. Attenuation data for M-S-A- Noisefoe Mark II ear protectors furnished by Mine Safety Appliances Company, Pittsburgh, Pa., Bulletin No. 0903-11