DOCUMENT RESUME

ED 213 185 EC 141 136

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TITLE Visual and Auditory Attention in Hyperactive and Normal Boys.
PUB DATE Aug 81
NOTE 24p.; Paper presented at the Annual Convention of the American Psychological Association (Los Angeles, CA, August, 1981).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Age Differences; *Attention Span; *Auditory Stimuli; *Conceptual Tempo; Elementary Secondary Education; *Hyperactivity; Males; *Visual Stimuli

ABSTRACT

Sustained attention to visual and auditory stimuli and reflection-impulsivity were examined in 48 hyperactive and 48 normal 9 and 14 year old boys. Multivariate analyses, followed by univariate tests, indicated that the nonhyperactive Ss increased sustained attention efficiency with age to both visual and auditory Stimuli. Hyperactive Ss increased in sustained attention efficiency with age to auditory, but not visual stimuli. Both groups increased with age in reflection-impulsivity as measured by the Matching Familiar Figures (MFF) test. Correlations between the sustained attention scores and the MFF error and latency scores were not significant for hyperactive Ss. (Author)

Visual and Auditory Attention in Hyperactive and Normal Boys

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Paper presented at the Annual Meeting of the
American Psychological Association
Los Angeles, CA,
August 1981

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During the past several years, the acceptance of the central importance of attentional deficits in hyperactive children has emerged in much of the research literature (Anderson, Halcomb, & Doyle, 1973; Douglas, 1972, 1974, 1976; Douglas & Peters, 1980; Dykman, Ackerman, & Clements, 1971; Margolis, 1972). Douglas and her colleagues (Douglas, 1972, 1974, 1976; Douglas & Peters, 1980) have argued that the major disability of hyperactive children involves a deficit in sustained attention and an inability to inhibit impulsive responding on tasks or in social situations that require focused, reflective, organized, and self-directed effort. It has been further suggested that problems with sustained attention and impulse control permeate and impair the functioning of hyperactive children and that these deficits often are directly responsible for their academic failures (Luria, 1961; Douglas, 1972, 1974, 1976; Douglas & Peters, 1980; Sykes, Douglas, Weiss, & Minde, 1971). In fact, the ability to sustain attention has been found to be as important a factor in school success as intelligence (Margolis, 1972).

For normal children, it has been demonstrated that the ability to sustain attention develops with age (Gale & Lynn, 1972). Consequently, it has been suggested that children who have been identified as handicapped in learning may well develop the ability to sustain attention at a slower developmental rate than their normal peers (Ross, 1976). That hyperactive children do not function as efficiently or as accurately on tasks of sustained attention as do normal controls has been demonstrated in a prodigious amount of empirical research (Cohen & Douglas, 1972; Douglas, 1972; Dykman,

Ackerman, Clements, & Peters, 1971; Firestone & Douglas, 1975; Parry, 1973; Sykes, et al., 1971; Sykes, Douglas, & Morgenstern, 1973; Zahn, Abate, Little, & Wender, 1975). Empirical data on the relationship between sustained attention and age for hyperactive children, however, have not been found. Since there is a developmental trend toward sustained attention in normal children, the same developmental trend would be expected in hyperactive children, but that hyperactive children would lag behind their normal peers in this development.

Another line of recent research has suggested that attention to visually presented and auditorially presented stimuli develops differentially in normal children (Hartman, 1961; Perelle, 1972; Quay & Weld, 1980). Several studies of learning and retention have shown that the auditory stimulus presentation mode is superior to the visual stimulus presentation mode for children below 11 years of age (Hartman, 1961; Perelle, 1972). Perelle (1975), in presenting conflicting auditory and visual information simultaneously, found that children above 12 years of age paid more attention to visual information. Whether hyperactive children lag behind their normal peers on tasks of sustained attention to either visual or auditory stimuli remains unknown. Quay and Weld (1980), in examining selective attention to visual and auditory stimuli in normal and learning disabled children, found significant age differences for both auditory and visual stimuli presentation conditions. However, the learning disabled children, in contrast to the normal children in their sample, did not become more attentive with age to visual stimuli. Developmental trends in sustained attention efficiency with age to auditory or visual stimuli in children

diagnosed as hyperactive have not yet been investigated.

According to Douglas (1974, 1976), problems with attention and impulse control occur together and impede learning. Douglas and her colleagues (Douglas, 1972; Campbell & Douglas, 1972) have found consistently significant moderate correlations between measures of various aspects of attention and impulsivity. She noted:

> We have been struck by the degree to which our measures that tap attention, impulse control, and the ability to take an analytic approach to problems seem to go together in these children (Douglas, 1972, p.275).

However, the research findings are conflicting and inconclusive. The results of two investigations of the relationship between impulsivity and visual and auditory selective attention did not supportthe notion that attentional deficits and impulsivity occur together in learning disabled children (Hallahan, Kauffman, & Ball, 1973; Quay & Weld, 1980).

If Douglas' (1972, 1974) statement is correct that impulsivity is a characteristic of hyperactivity, hyperactive children would be expected to be designated as impulsive by Kagan's (1965) Matching Familiar Figures (MFF) Test, the primary index of impulsivity. Although Campbell, Douglas, and Morgenstern (1971) found hyperactive learning disabled children to be more impulsive on both latency and error scores of the MFF, the results of other studies have shown learning disabled children to be designated as more impulsive only by the MFF error score, not by the MFF latency score nor Kagan's double median split (Brown & Quay, 1977, 1978; Quay & Brown, 1980; Quay, Popkin, Weld, & Mc Lesky, 1978; Quay & Weld, 1980). This latter finding

could be a function of the relative validity of the MFF latency and error measures, since the construct validity of the MFF latency measure has been questioned (Block, Block, & Harrington, 1974).

Kagan and his colleagues (Mussen, Conger, & Kagan, 1974) stated but did not demonstrate that children become more reflective with age. Brown and Quay (Brown, 1980; Brown & Quay, 1977; Quay & Brown, 1980) found that both normal and institutionalized behavior disordered 8-year-olds obtained higher MFF error scores than their adolescent counterparts and that the younger, but not the adolescent, behavior disordered group obtained higher MFF error scores than the normals. No differences occurred between any of the groups on the MFF latency measure or the double median split.

One purpose of the present study was to compare the sustained attention performance of 9-year-old and 14-year-old normal and hyperactive children to visual and auditory stimuli. Because the same developmental trend was expected in hyperactive and normal children, it was hypothesized that sustained attention performance would increase with age in both groups but that hyperactive children would lag behind the normal children in sustained attention to both visual and auditory stimuli. On the basis of previous research findings concerning children's preference for visual and auditory stimuli (Perelle, 1975), the younger children were expected to be superior in sustained attention to auditory as compared to visual stimuli, and the older children were expected to be superior in sustained attention to visual stimuli.

Another purpose of this research was to compare 9-year-old and 14-year-old hyperactive children on reflection-impulsivity and to investigate the

efficacy of the MFF latency and MFF error measures in differentiating between hyperactive and normal children.

The relationship between reflection-impulsivity and both visual and auditory sustained attention was examined for both age groups of normal and hyperactive children.

Method

Subjects. Forty-eight hyperactive and 48 normal boys, 24 from each of two age groups, were randomly selected and assigned to either a visual or an auditory sustained attention condition. The mean age of the younger group was 9 years, 4 months. The mean age of the older group was 14 years, 2 months. The hyperactive boys were selected from special education classes in a large metropolitan school system. They were placed into the classes after a rigorous diagnostic examination by qualified psychologists and a history of difficulty in coping with the regular school program. Interviews with the parents, detailed information from the schools, and classroom observations by trained observers pointed to the presence of the hyperactive child syndrome. Their teachers characterized them as being highly inattentive, distractible, and active. Each child's pediatric examination must have been negative for other major diseases and obvious physical defects. A score of 15 on the Conners' Abbreviated Rating Scale (Conners, 1969) had been established as a minimum cutoff score to be considered as a potential subject in this study (Sprague & Werry, 1974). The normal sample was selected from a representative school in the same county school system. All schools served a predominately middle-class population. No child with an IQ below 80 was considered as a potential subject for the study. IQs for the normal children ranged from 85

to 124 with a mean of 95.46. IQs for the hyperactive children ranged from 80 to 102 with a mean of 92.33. The mean IQ scores, derived from the Peabody Picture Vocabulary Test (Dunn, 1965) did not differ significantly for the four groups when analyzed by a one-way analysis of variance. All schools served a predominately middle-class population.

One-half of each age group was randomly assigned to a condition in which the attentional stimuli were presented visually and the other one-half were assigned to a condition in which the stimuli were presented auditorially. The hyperactive children in the visual and auditory conditions did not differ on the Visual Sequential Memory or the Auditory Sequential Memory Test of the Illinois Test of Psycholinguistic Abilities indicating that the groups were comparable in visual and auditory memory.

Procedures. Each child was individually presented with a sustained attention task and was administered the MFF.

Sustained attention to auditory stimuli was measured with a modified version of the Children's Checking Task (CCT) (Margolis, 1972). The test has been shown to be appropriate for use with children in grades 1 through 8. The CCT includes a five page booklet with rows of printed numbers and a tape recording of a series of numbers recorded in random order at the rate of one number per second. The recordings were professionally made with decibel levels controlled. The numbers in the booklet were arranged in 16 rows per page with 14 digits per row. Rows were identified by letters in alphabetical order. The child was required to listen to the numbers on the tape recorder while checking them against an almost identical series in the booklet. The tape and booklet were prepared so that there were fourteen audio-discrepancies for

each page where the digit presented auditorially did not match the corresponding digit in the booklet. The test was scored on two types of errors, omissions (missed discrepancies) and commissions (correct numbers marked as incorrect). Total administration time for the CCT was 30 minutes.

Sustained attention to visual stimuli was also measured with a modified version of the Children's Checking Task (CCT). To evaluate sustained attention to visual stimuli, however, one important change was incorporated. Rather than having presented the numbers auditorially to the subjects via a tape recorder, subjects were presented with the numbers visually on an over-head projector. As in the auditory condition, numbers in the booklet were arranged in 16 rows per page with 14 digits per row. However, the child was required to view the numbers projected from a series of transparencies on a wall while simultaneously checking them against an almost identical series in the booklet. As in the auditory condition, there were fourteen visual discrepancies for each page where the digit presented visually did not match the corresponding digit in the booklet. The test was scored in the same manner as in the auditory condition. The administration time for the CCT in the visual condition was equal to that of the auditory condition. As in the auditory condition, the test was scored on errors of omissions and commissions.

It is recognized that the visual and the auditory procedures may not be precisely comparable. The nature of the differences between the modalities does not permit the evaluation of comparability. However, the two tasks were typical of the way in which auditory and visual attention would present themselves in a classroom setting.

Immediately following the sustained attention task, each child was ad-

ministered Kagan's MFF test. Latency scores (the time required to make the first response to each of the 12 tasks) and error scores (the total number of errors made on the 12 tasks) were obtained for each child.

Results

Table 1 presents the means and standard deviations for the CCT errors of omissions and commissions for the hyperactive and normal children at both age levels in each of the stimulus conditions.

Insert Table 1 about here

The means and standard deviations for the hyperactive and normal children on the MFF error and MFF latency scores are presented in Table 2.

Insert Table 2 about here

A 2(type of child) x 2(age) x 2(stimulus condition) multivariate analysis of variance was carried out, with the dependent measures being CCT omission, CCT commission error scores, MFF error, and MFF latency scores. This analysis indicated that significant differences occurred between age groups $F(4, 85) = 7.61$, $p < .0001$, and between hyperactive and normal children, $F(4, 85) = 14.62$, $p < .0001$. A significant interaction occurred between the stimulus presentation condition and the type of child condition $F(4, 85) = 2.76$, $p < .03$. The difference between stimulus presentation condition approached significance $F(4, 85) = 2.26$, $p < .06$.

Separate univariate analyses of variance were carried out to examine the differences between age groups. These analyses indicated that significant differences occurred for the CCT omissions error measure ($F=11.44$, $p < .001$), the CCT commissions error measure ($F=7.53$, $p < .007$), the MFF error measure ($F=17.77$, $p < .0001$), and the MFF latency measure ($F=3.70$, $p < .05$). An inspection of these data revealed that performance on each of the measures improved with age for both hyperactive and normal children.

Separate univariate analyses of variance to examine the differences between normal and hyperactive children indicated that significant differences occurred for the CCT omissions error measure ($F=38.83$, $p < .0001$), the CCT commissions error measure ($F=29.45$, $p < .0001$), the MFF error measure ($F=9.63$, $p < .003$), and the MFF latency measure ($F=11.06$, $p < .001$). An inspection of the data revealed that hyperactive children at both age levels performed more poorly than the normal children on each of the dependent measures.

Separate univariate analyses further indicated that the interaction between stimulus presentation and type of child conditions occurred for the CCT commissions error measure ($F=9.49$, $p < .003$). Separate T tests (two-tailed) indicated significantly more errors for the hyperactive children in the visually presented stimuli condition ($p < .0001$).

To ascertain whether impulsivity was related to sustained attention, correlations were calculated between both MFF error scores and MFF latency scores and total sustained attention scores both for normal and hyperactive children at both age levels. It can be seen from Table 3 that for the hyperactive children, none of the correlation coefficients were significant. For the normal children, only two of the eight correlation coefficients were significant

and they are not in the predictable direction. The most reasonable explanation is that they occurred by chance.

Insert Table 3 about here

Discussion

The findings support the results of other studies in demonstrating that there is a difference between younger and older children in their ability to sustain attention. Furthermore, for normal children, the age difference occurred for both visual and auditory stimuli. However, the hyperactive children, in contrast to the normal children, did not become more attentive to visual stimuli. This failure of hyperactive children to develop increased attentional efficiency to visual stimuli may be related to their school failure, since the school makes stringent demands for attention to visual stimuli in its requirements for silent reading, visually presented mathematics problems, library work, and "seat work" (Quay & Weld, 1980). These findings suggest that hyperactive children might benefit from special tutorial assistance in developing sustained attentional efficiency to visual information. Currently, we are engaged in such training programs with hyperactive children, and our results appear to be extremely promising (Brown, 1978, 1980; Brown & Kroll, in press; Brown & Alford, Note 1).

Contrary to the expectations based on Perelle's (1975) findings, differences between auditory and visual attentional efficiency only approached significance. However, the procedures utilized by Perelle (1975) differed from the procedures of this study in that Perelle's procedure required the children to make a choice between competing auditory and visual stimuli. Whether hyperactive

and normal children are able to attend equally well to both types of stimuli awaits further investigation.

On Kagan's MFF Test 9-year-old hyperactive children were shown to be more impulsive than their normal peers on both MFF error and latency measures. Also, the finding that significant differences occurred as a function of age for both normal and hyperactive children may be interpreted to suggest that hyperactive children become less impulsive with age. In fact, in follow-up studies of hyperactive children Weiss and her colleagues (Minde, Lewin, Weiss, Laviqueur, Douglas, Sykes, & Minde, 1971; Weiss, Minde, Werry, Douglas, & Nemeth, 1971; Weiss, Hectman, & Perlman, 1978; Hechman, Weiss, Finklestein, Weiner, & Benn, 1976) found that their subjects became less hyperactive when they reached adolescence. The present finding that the normal children in this sample became more reflective with age appears to be further consistent with Kagan et al.'s (1974) speculation that MFF scores are a function of age.

The finding that hyperactive children differed from their normal counterparts on both MFF latency and MFF error scores is consonant with the findings presented by Douglas and her associates (Douglas, 1972, 1974; Campbell, Douglas, & Morgenstern, 1971; Campbell & Douglas, 1972). However, the present findings of no clear relationship between attention and reflection-impulsivity as measured by the MFF does not support Douglas' notion that problems with attention and impulse control occur together in hyperactive children. None of the correlations between MFF scores and measures of sustained attention were significant for the hyperactive children in this sample. This finding indicates either that reflection-impulsivity and sustained attention do not necessarily occur together in hyperactive children or that the most widely used methods for assessing each characteristic are inadequate.

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Footnotes

[1] The author is indebted to Delores Allen for her assistance in collecting and analyzing data. Address all correspondence to Ronald T. Brown, Ph.D., Department of Special Education, University of Illinois-Chicago, P.O. Box 4348, Chicago, Illinois, 60680.

Table 1

Means and Standard Deviations For Visual and Auditory Sustained Attention Scores of Hyperactive and Normal Children at Two Age Levels

	CCT Omissions		CCT Commissions		Total CCT Errors	
	Mean	SD	Mean	SD	Mean	SD
Hyperactive						
Visual						
9-year-olds	46.00	18.44	54.58	23.20	101.00	29.83
14-year-olds	18.50	23.41	28.00	43.45	46.42	59.95
Auditory						
9-year-olds	30.58	23.48	21.50	31.99	52.00	49.89
14-year-olds	21.00	26.59	9.08	9.92	30.08	36.29
Normal						
Visual						
9-year-olds	5.83	6.69	5.83	5.97	11.66	8.07
14-year-olds	5.42	8.65	2.75	4.94	8.17	9.36
Auditory						
9-year-olds	13.92	5.95	7.92	4.32	22.00	7.78
14-year-olds	4.50	2.65	2.25	2.26	6.75	3.98

Table 2

Means and Standard Deviations for MFF Error and MFF Latency Scores of Hyperactive and Normal Children at Two Age Level

	Error		Latency	
	Mean	SD	Mean	SD
Hyperactive				
9-year-olds	14.88	7.38	97.38	36.03
14-year-olds	8.67	5.36	117.67	42.75
Normal				
9-year-olds	9.96	5.52	133.71	76.39
14-year-olds	6.37	3.72	157.46	55.58

Table 3

Correlation Coefficients Between Total Sustained Attention Scores and MFF Error and MFF Latency Scores of Hyperactive and Normal Children at Two Age Levels

Group	MFF Error		MFF Latency	
	Auditory	Visual	Auditory	Visual
9-year-olds				
Hyperactive	-.08	-.12	.14	-.04
Normal	.37	.68[a]	-.07	-.48
Combined	.30[b]		-.29[c]	
14-year-olds				
Hyperactive	.07	.13	-.40[d]	-.01
Normal	.12	.10	-.73[d]	-.08
Combined	.30[b]		-.29[c]	

a. $p < .02$.
b. $p < .003$.
c. $p < .005$.
d. $p < .007$.