VISUAL IMAGERY IN BRAIN-INJURED CHILDREN

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Summary.—The incidence of eidetic imagery and prolonged after-imagery was investigated in a population of young retardates. Incidence of eidetic imagery was 19%, significantly higher than normal samples, and all children with eidetic imagery were classified as "brain-injured" by common neurological diagnostic criteria. Children with long, stable afterimages had a significantly higher mean IQ than those with short afterimages, capacity for fixation and task learning being controlled. A possible explanation of the IQ discrepancy in terms of how a longer time to process visual input into short-term memory may be functional for children of low intelligence is presented.

The original impetus for this study came from two sources: first, the diagnostic testing of several retarded children who displayed unusual ability to retain and use visual images; second, recent work on the incidence of eidetic imagery in normal, retarded and partially non-literate populations (Haber & Haber, 1964; Siipola & Hayden, 1965; Doob, 1964, 1965, 1966). Siipola and Hayden found 9 of the 34 older retardates tested to have eidetic imagery, a significantly higher incidence than in Haber's sample of normal school children. Eight of the 9 were classified as "brain-injured" in school records. Initial questions in this study, therefore, were (1) whether the incidence of eidetic imagery in young retardates would differ significantly from that in normal children and (2) whether eidetic imagery would be as highly correlated with the diagnosis of "brain-injured" in our group as it was in the Siipola and Hayden sample.

In the course of testing the children, it became apparent that there was within the population a discontinuous subgroup with prolonged, pronounced and easily obtained afterimages. The relationship of "long" vs "short" afterimages to eidetic imagery, and some of the distinguishing characteristics of these subgroups of the sample, were also investigated.

Early work on eidetic imagery showed great variability in procedures and terminology; in some studies "eidetic image" describes positive or negative afterimages, in others a memory phenomenon for which there was no essential image concomitant at all (Kluever, 1928; Meenes & Morton, 1936). However, the recent work of Haber and his associates has established eidetic imagery as a verifiable characteristic of about 8% of school children, who score discontinuously on all measures used to define it, and it is their method of testing that is followed here (Haber & Haber, 1964). Some expansions and alterations were necessary in working with these young retardates, but it is not felt that any variations from the Haber procedure that were introduced biassed the observed incidence. The procedure is thoroughly described, however, that the reader may judge.

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Method

Subjects

Children studied were enrolled in two private schools for brain-injured and retarded children. Age range in School A was 5½ to 10 yr., mean 8 yr. 7 mo.; in School B the age range was 8 to 14 yr., mean 10 yr. 9 mo. All children had at least one diagnostic neurological report and one psychological test report available in the school files. Classification of a child as "brain-injured" was based on the neurological diagnosis as such or as "chronic brain syndrome," or a history including epilepsy, encephalitis, hydrocephalus or accidental brain injury. "Non-brain-injured" includes children diagnosed as having Down's syndrome, "learning disability," "slow learners," or "moderately retarded of unknown origin," and may therefore include children with subtler levels of brain insult in addition to retardates of genetic or other origins. WISC and WPPSI intelligence test scores were available for all but 7 of the children, for whom Stanford-Binet scores were used. These 7 children are not clustered in any way that might influence comparison between groups. Mean IQ in School A was 81, range 69 to 106; mean IQ in School B was 75, range 49 to 97.

Testing Situation

The children were seen in a small windowless room furnished with a table and two chairs, with constant ambient light, one of a number of rooms used for individual tutoring and designed to be quiet and free of distraction. A small Playschool triangular easel, painted neutral gray, tilted away from S, having a narrrow ledge along the bottom, was used for display of material. A tape recorder that could be unobtrusively manipulated without distracting the children was used to record verbal content, and a silent wrist stopwatch was used to obtain duration of hand-raising and eye fixation. E sat at right angles to the child, in such a position as to be able to move materials quickly and observe the reflection of the test materials in the child's pupils, the child being positioned approximately 20 in. from the easel.

Procedure

A major problem in testing these children that was not reported by Siipola and Hayden was the frequent failure to establish stable fixation on the stimulus. The standard Haber procedure requires fixation on the colored squares for 10 sec.; many of these children were unable to do this, sometimes as a result of too much general body movement, sometimes too much eye movement. Four of the 14 children seen in School A and 17 of the 46 children in School B did not meet the fixation criterion. Setting what may be called a physiological baseline for Ss seemed necessary, since not doing so would have included many children as Ss who did not attend to the stimulus. Thus the "physiologically stable eye response" criterion left a total of 39 children in the study sample.

Several alterations in the Haber testing procedure were made with the in-

tention of maximizing unambiguous and non-verbal indicators of the children's responses. Since the Haber pictures involve such sophisticated literary content as Alice in Wonderland and Hiawatha, relatively simple pictures from various preschool books were used. These were a picture from "The Sword in the Stone," a farm and barnyard scene, a playyard scene, and a collage of animal pictures, all of which could be easily described by the children in a trial population in the same schools. The color range included all primary colors and was similar to that of the Haber pictures. On several of the pictures the internal arrangement of the parts was made such as to make it clear whether or not the child was scanning the picture, although there seemed to be no problem in observing this, as it turned out, in any of the eidetickers. If anything, their responses involved more pointing and concrete indicators of response than is characteristic of normal children as described by Haber.

The second change was the preliminary training of the children to give a stable non-verbal response to a flashing light on a white background. These children included many who used language quite idiosyncratically and some who were not very verbal; the change in tense in moving from an eidetic image to a report from memory that Haber found so consistently in normal children is not characteristic of the children reported on here. The children were trained to report by hand-raising, time being recorded by the examiner with a silent stopwatch. This turned out to be an easy and stable response to establish; only two children were eliminated for failure to reach criterion of 10 out of 10 trials reported without delay at onset or offset. One of the children eliminated was hyperactive, the other seemed particularly agitated by the flashing light. Once children reached criterion on reporting the flashing light accurately, the sequence of events was the same for all children. A 4-in. red square, centered on a 10- by 12-in. white poster board, was placed on the easel for 10 sec. and then removed, exposing a blank white poster board underneath. Each child raised his hand to report the presence of an afterimage and held the hand elevated until the afterimage disappeared. Some verbal report of color seen was usually given spontaneously; if not, it was elicited. Three other colored squares, similarly mounted and always in the same order, were presented (blue, black, yellow). After the 4 squares, 4 pictures were presented for 30 sec. each, then taken away, again exposing a plain white surface. Similar instructions to those given by Haber to the normal children were given at all stages, with some further explanation if it seemed necessary. The children had no trouble understanding the difference between fixating and scanning and responding appropriately.

Scoring

Many problems were anticipated in planning this research. The children might not comprehend the task or might not be able to learn the response. The correspondence between response and underlying phenomena might be questionable if the children were distracted or poorly motivated. What was not anticipated was that the occurrence of eidetic imagery would be so qualitatively different as to be almost startling. The eidetickers all gave surprised or pleasurable response to the removal of the first picture and exposure of the underlying white card; all seven scanned the white card, pointing at what was "up there," "over here." Initial surprise and pleasure was followed in two cases by consternation and denial; one child continued scanning, saying intermittently that he didn't see anything, the other looked away and said, "it's not there." The same worried wondering appeared in some children when they reported seeing afterimages to the colored squares, but it was fairly easy to reassure them. It seemed characteristic of this population, as of many retarded children, to be both dependent upon and accepting of the examiner's authority. They are generally uncomfortable and obvious in any attempt at deception.

Haber's criteria for distinguishing report of eidetic imagery from afterimagery may be summarized as follows:

duration color	Afterimage usually short usually negative, more easily evoked by high contrast	Eidetic Image relatively persistent positive, appears even with low contrast stimuli			
location visual conditions	"out there" fixation of stimulus essential, moves or disappears if eyes move	"out there" scanning of stimulus essential, image always scanned			

Additional criteria used by Haber were (1) a scaled judgment of accuracy of memory and amount of detail and (2) consistent use of the present tense in reporting eidetic or afterimages (as opposed to past tense for report from memory). Accuracy of memory alone was not discriminating in the Siipola and Hayden sample. In our population, tense could be reliably judged for most but not all Ss and for only 4 of the 7 eidetickers. Therefore, the criteria of "present tense" and accuracy of verbal report were considered too problematical to use here. All children knew colors and reported them accurately.

All children gave at least some report of negative afterimages to the colored squares; the "long afterimage" subgroup consists of those children who gave 4 out of 4 reports of negative color of at least 10 sec. duration, average mean duration being 35 sec. Table 1 summarizes the derivation of the population subgroups and gives mean age and intelligence scores for each subgroup.

RESULTS AND DISCUSSION

Data concerning long afterimage and eidetic image production is summarized in Table 2. Color report was appropriate in all cases, i.e., negative for afterimages and positive for eidetic images, and is not included in the table.

Incidence

As can be seen from Table 1, 7 children within the qualifying population of 37, or 19%, reported eidetic images according to the criteria discussed in the

	N	M _{Age} (mo.)	% Injured	Mig	SD19
School A	14	103	100	81.6	12.8
School B	46	133	72	74.3	12.4
Combined population	60	124	78	76.4	13.1
Unstable fixation	21	123	86	72.7	16.3
Task non-learners	2	135	50	75.0	
Qualifying population	37	122	76	78.0	10.0
Short afterimage	19	125	62	73.9	10.0
Long afterimage	18	121	89	82.7	9.8
Eidetickers (subclass of long afterimage group)	7	125	86	80.0	10.0

 TABLE 1

 Derivation of Experimental Population: Age, Intelligence and Per Cent

 Brain-injured for Each Subgroup

scoring section. This proportion is significantly different from that in Haber's normal sample (p < .05, $\chi^2 = 4.05$), although not as high as that found in Si-ipola and Hayden's sample of older mental retardates.

Relation to "Brain-injured" Diagnosis

Siipola and Hayden found 50% of those classified as brain-injured to be eidetickers; only 1 of their 18 familial retardates was eidetic. Since all children seen in School A were classified as brain-injured, and 72% of the population of School B were, this is not a particularly good population to look to for a discriminative index between these two classes of retardates. However, all 5 eidetickers in School B were diagnosed as brain-injured, which lends some support (p = .14) to their hypothesis that eidetic imagery is an indication of brain injury in those retardates in whom it occurs.

Intelligence Levels

Of great interest, and consistent in both schools, is the significant discrepancy between mean IQ of groups with long afterimages and short afterimages (p = .01 for the combined populations; see Table 1). The lower mean IQ of children who could not fixate or attend to the task is understandable; such children are probably poor in many behaviors that require more than momentary attention, such as an intelligence test samples. Why children within the qualifying population who have afterimages of long duration should have a higher mean IQ than those who do not seems to require an explanation on a more fundamental neurophysiological level, however.

Current views suggest that eidetic imagery may be a possible index of inefficient, defective, or delayed development in perceptual and memory functions (Friedes & Hayden, 1966; Siipola & Hayden, 1965). When eidetic imagery occurs in normal children, by their own report, they do not find it particularly useful as an aid to memory, and find it easily disturbed by superimposing verbal

Child Age		IQ	Afterimages	Eidetic Images Report Duration (sec.) Tense, Location					
(mo.)		M Duration	Report			tration (sec.)		Location, "out there"	
		(sec.)		M	Range	Scanning	present	"out there"	
				Sci	hool A				
4	72	95	38	+	short (2 only)		?	?	for 2
					did not repeat				
5	121	80	63	+	1 did not		+	?	?
					repeat				
9	104	91	37						-
10	110	63	28	+	75	40-130	+	+	++
12	109	88	17	+	82	60-225	+	+	+
13	107	106	13						
14	97	75	32						
				Sc	hool B				
1	123	80	17						
3	115	80	70	+	68	45-98	+	+ ?	+
12	135	91	33	+	58	38-112	+	?	+
16	130	71	23	•					
20	106	80	33						
30	126	88	36	+	39	25-80	+	?	+
37	141	83	14	,			·		
38	140	77	82	+	128	60-240	+	?	+
42	170	80	22	•			•		
45	142	73	45	+	73	35-120	+	+	
47	140	88	35				•	,	

TABLE 2						
SUMMARY OF	RESPONSES OF LONG-AFTERIMAGERY GROUP					

thought (Leask, Haber, & Haber, 1969). For most children, the role of concrete visual processing may be dominated in the course of normal development by linguistic coding, but this may not be so for many retarded or borderline children. Factor analysis of intelligence test subtests indicate that what such children do best within the WISC, for example, are tasks such as Object Assembly and Picture Completion, which involve memory and manipulation of concrete visual material. Vocabulary, Information and Picture Arrangement, dominated by verbal and visual sequential skills, are what retarded children do most poorly (Thompson & Margaret, 1947; Johnson, 1958; Gallagher & Lucito, 1961). Visual imagery is apparently more efficient for the storage of item information in memory, whereas verbal symbolic systems are particularly efficient for storing sequential information (Paivio & Csapo, 1969).

It is Hebb's view that imagery, particularly eidetic imagery, results when first-order visual assemblies are either more excitable or less subject to neuronal inhibitory action than is usual. This may be a reasonable explanation for the higher incidence of eidetickers in brain-injured populations. It may be, however, that children who have not evolved securely to a stage of development dominated by language categories and abstraction (which would describe most retarded and borderline children) may find a prolonged visual iterative process in the sensory register an advantage in processing concrete visual input into memory. While pronounced visual imagery may be a good index to brain-injury, having a slightly longer time to process visual input may still be an advantage to children of low intelligence, whose primary intellectual strengths continue to be concrete and visual.

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