Imaging And Aphasia

Joyce A. West

Veterans Administration Hospital
New York, New York

If you've ever seen me do a jig saw puzzle or administer a Raven's Progressive Matrices Test with my crib sheet in hand, you may well wonder how I have the nerve to be discussing any topic related to right hemisphere functioning. Just remember the old adage: "Those who can't, teach". It seems these days that all the evils of the world are being attributed to the right hemisphere, and it is with some relief that I report that mine functions in a more or less idiosavant manner. It is quite remarkable at map-reading, for example, fails completely in any of those paper-folding tasks, never sees pictorial ambiguities, but never forgets a face.

The concept that cerebral specialization has resulted in two distinct types of thinking is consistent with present understanding of brain function. The left brain is associated with verbal symbolic thinking, the right brain with thinking associated with visual spatial concepts. Thus, "a verbal processing system which is specialized for speech and abstract information, may be primarily a left hemisphere function, while a visual processing system, which is more adept with spatial and concrete information, is more predominately associated with the right hemisphere" (Seamon and Gazzaniga, 1973).

The present paper will review the research leading to the conclusion that visual imagery and verbal processes represent alternate coding systems in cognition and consider the role of nonverbal visual images and verbal symbolic processes in learning and memory. Allen Paivio, a major theorist and researcher in visual imagery, views images and verbal processes as alternative coding systems, or modes of symbolic representation.

Paivio (1971) argues that:

> Imagery develops as a symbolic capacity or mode of thought through the individual's perceptual-motor experiences with concrete objects and events, and remains particularly functional in dealing symbolically with the more concrete aspects of situations. Verbal processes develop through language experience...Verbal thought remains functional in coping with concrete situations but surpasses imagery in its capacity to deal with abstract tasks requiring the integration and manipulation of spatially and temporally remote objects or events, or tasks involving abstract reasoning (p.18).

Paivio (1975) sees the two processing systems as being functionally independent but partly interconnected cognitive systems for encoding, storing, organizing, transforming, and retrieving stimulus information. Only when imagery is compared to other constructs, however, particularly verbal thought, can it be understood, for it does not stand in isolation. "Imagery is specialized for the symbolic representation of concrete situations and events, whereas the verbal system is characterized by its capacity to deal with more abstract stimulus information (Paivio, 1971)". Paivio (1969) regards images as symbolic processes which are linked developmentally to associative experiences involving concrete objects and events. Abstract words and events do not

readily evoke images, whereas concrete words or phrases readily evoke images of the objects or events to which they refer.

Now, what has all this to do with aphasia? Let me state my reasons for my interest in visual imagery and the research relating to this topic as baldly as possible. Imagery involves the right hemisphere (I think). Aphasic individuals have an intact right hemisphere (usually). Ergo, tap the right hemisphere by using visual imagery. Of course, there is nothing in the "real" world or the "real" brain that is quite so simple, but given that language is dually coded as it is learned, it may stand to reason that an image of the word, event, object, etc., may remain even though the verbal processes associated with the word or event do not remain or are unavailable. I believe, then, that visual imagery can function as a mode of symbolic representation and as a strategy for storing and retrieving memories. Varying coding strategies may result in hemisphere differences.

Retrieval processes and cerebral laterality effects seem functionally related to coding strategies. There is a growing body of research on this particular topic which will not be reviewed here, but the reader should refer to Seamon's (1974) chapter for a complete review. He concludes his discussion by stating, "rehabilitative progress may be possible if the visual processing system is utilized to maximum advantage (p.200)".

A negative position would hold that since visual and verbal coding processes are so "intertwined" in their developmental acquisition, both will be lost at onset of aphasia. A more intermediate position would be that even though they are intertwined in development, one representation may serve to "revive" the other. For example, recalling the visual symbol may revive the verbal symbol, and vice versa. While it seems clear that both hemispheres are involved to some degree in the acquisition of these two symbolic systems, normally they do not function independently of each other, nor in one capacity only (Paivio, 1971). Situations may be represented imaginally, but their elements organized verbally, for example. Even though our aphasic patients may be unable to retrieve the verbal code, the visual symbolic code may remain. Tapping the visual symbolic code may trigger retrieval of the verbal code. Hence, visual imagery in this case would serve as a facilitator. On the other hand, it may not, in which case my argument would be that the visual symbolic system may serve as an alternative means of symbolically representing events in the world.

More importantly, I am interested in how we as speech pathologists can tap the right hemisphere, making it either function verbally or exploiting more fully its visual imagery capabilities so that it might become an alternative communication device, if you will. I feel that we have been too long locked into the view that as aphasia therapists we had to restore verbal symbolic functioning and that somehow the right hemisphere was none of our business.

The Differential Availability Of Concrete Images And Verbal Processes As A Function Of Stimulus Dimension

Frequency of occurrence, meaningfulness, abstractness, and picturability are all obvious variables that have strong effects on how effectively words or sentences are learned or remembered. But what is the functional significance of nonverbal imagery and verbal processes in associative meaning, mediation and memory? Extensive research conducted in the decades since 1960 provide many of the answers.

Paivio and his associates conducted a series of experiments (see Paivio, Yuille and Madigan, 1968) in which they had subjects rate 925 nouns of varying Thorndike-Lorge frequencies for concreteness, imagery and meaningfulness. A subject was asked to rate each of the words presented to him for its capacity to evoke images of the event referred to by the word. Each word was rated on a 7-point abstract-concrete scale, on a 7-point low imagery-high imagery scale and on a similar scale for meaningfulness.

One of our MA candidates, Linda Cannizzo Berger, has been conducting a study to determine the effect of imagery on a word-matching task. Aphasic subjects are shown a word for study. Following this exposure, a second word is shown. The patient's task is to decide whether the second word is the same or different from the first. Now, this is a very easy task for aphasic subjects, one which is virtually error free. Linda is looking at reaction time and that is why we felt we wanted an error-free task. Her hypothesis is that words of high imagibility will be more quickly matched than those of low. My only point in bringing up her thesis here is to show you how she has used the lists of Paivio and his associates.

Linda holds meaningfulness and word length relatively constant across her lists, varying imagability and frequency. Imagability, as you can see, is associated with concreteness. The arousal of imagery is "coordinated to an abstract-concrete dimension of stimulus meaning (Paivio, 1969). The higher the concreteness of a stimulus item, the more likely it is to evoke sensory images that can function as mediators of associative learning and memory. The conclusion that Paivio and his associates draw from many, many experiments, a conclusion verified independently in several different laboratories (e.g., Atwood, 1971; Bower, 1970; Jorgensen and Kintsch, 1973; Rohwer, 1970) is that imagery is one of the most influential of all the variables studied. Concreteness-imagery is viewed as a major dimension of word meaning and one of the most potent yet identified among familiar words.

To pause for a moment and relate what I've been saying directly to treatment, I do think it behooves us to consider the imagability of the stimulus items we use in treatment. Obviously, pictures of concrete nouns are by definition going to be of high imagability. But pictures do vary as to their image-provoking ability, and it is one argument why color, for example, would be important in therapy. Not so much color for color's sake, but color for its ability to heighten images. Somewhere along the way we seem to have been diverted by our feeling that the abstract-concrete dimension was a "messy" one and we've been ignoring it because of that. I hope that I can convince you of the importance of the imagability dimension in terms of the items you select for use in treatment as we go on. Why? Well, the following quote by Paivio (1969) is extremely relevant to the issue of treatment:

> The hypothesis is that concrete terms such as "house" derive their meaning through association with concrete objects and events as well as through association with other words, and thereby acquire the capacity to evoke both nonverbal images and verbal processes as associative (meaning) reactions, which could function as alternative coding systems affecting mediation and memory.
>
> Abstract terms such as "truth" on the other hand, derive their meaning largely through intraverbal experiences and more effectively arouse verbal associative than imaginal processes (p. 248).

What this means in terms of our aphasic patient is this: depending upon how you as a therapist choose your stimulus material, you can assure that you have two coding systems going for your patient, or at least one. If the verbal coding system is absolutely not going to "work" then at least you should assure that the nonverbal coding system is allowed to function by selecting materials for their image arousing potential. This implication runs throughout all of today's discussion. What we must do is choose material that effectively arouses nonverbal images. Hence, the more concrete the material the better. I think, by the way, that this meaning of the word "concreteness" is different from the term as used by Goldstein (1948). Surely no one denies that brain-damaged patients tend to be terribly concrete, reductionistic, if you will. But here I'm talking about concreteness in a different sense: the ability of concrete words and phrases to more effectively arouse images.

The bulk of the work on imagery has been done with paired associate learning tasks (PAL). This is not meant to imply that imagery has no role in other forms of learning such as serial or free recall tasks, but rather, I suppose, that many of the interesting questions raised about imagery could be readily approached through PAL. Basically, the experimental situation is the following: You as a subject are shown two items. Let's say, two pictures. Your task is to remember that the two go together so that when I show you the stimulus, you'll remember the response. You'll do this most effectively, say the people working in imagery, if you form images linking the two together. In other words you should use an image as the mediating form between the two items. Its the "one is a bun, two is a shoe" technique expounded by Miller, Galanter and Pribram in Plans and Structure of Behavior (1960). They teach the following rhyme:

> one is bun...two is shoe...three is a tree...four is a door...
> five is a hive...six are sticks...seven is heaven...eight is
> gate...nine is a line...and ten is hen (p.135)

After you've learned the rhyme you have part of Miller, Galanter and Pribram's Plan. The second part works like this: when given a list of 10 words to remember in sequence you set about learning them by forming a ludicrous or bizzare association between each of those words and each of the images evoked by the rhyme above. Thus, if the first word of the to-be-remembered list is "ashtray" you would form a bizzare image that includes an ashtray and a bun. For the second work on your list, "firewood", you form a ludicrous image linking it to "shoe" and so forth. Mnemonic techniques such as these have been used since antiquity. The Greeks (see Yates, 1966) advocated using locations (loci) within a building carefully chosen for its distinctive structural landmarks. You were to imagine yourself walking systematically through the building; at the designated loci you placed the items you wished to remember. You had then only to recall your imaginary walk through the building to remember each item in the order that you came to it. The formation of the loci was of greatest importance for the same set of loci could be used again and again for remembering different material. What I am describing is the use of perceptual imagery to mediate response retrieval. This has been called the "conceptual peg" hypothesis. The argument is that that the stimulus member of a pair serves as a "conceptual peg" to which its associate is hooked during learning and from which the response member can be retrieved on recall trials when the stimulus member is presented alone. Imagery aids PAL by linking the stimulus and response member of a pair together during the study trial. Given the stimulus during the recall trial, the

image is recalled and with it the response member of the pair.

On the assumption that imagery can serve as a mediating function it follows that:

> ...ease of learning the stimulus-response association will depend partly on the image-arousing capacity of the individual nouns and of the stimulus member in particular. ...the image-arousing value (of the stimulus) would be particularly important, for the stimulus member must serve as the cue that reinstitutes the compound image from which the response component can be retrieved and recoded as a word (Paivio, 1969, p.243).

I'd like then, to summarize briefly the research on PAL as it relates to imagery. Much of the research has been carried out by Allen Paivio and his associates and much of it is applicable to other forms of learning as well (see Paivio, 1969, Rohwer, 1970, or Levin, 1976 for reviews of the imagery research).

1. Nouns rated high in their capacity for arousing imagery (high imagery nouns) are easier to learn as paired associates than those rated low in their capacity for arousing imagery.
2. Concrete noun pairs are easier to learn than abstract noun pairs.
3. Concrete nouns are higher in imagery value than abstract nouns.
4. The image evoking value of nouns correlates more highly with PAL than any other known attribute.
5. Even when a subject is given explicit instructions to use verbal mediation, there is a high correlation between PAL and the imagery value of the stimuli.
6. Imaginal mediators predominate when both members of a pair are concrete.
7. Verbal mediators predominate when both members are abstract.
8. Pairs reported by subjects to be linked by imagery are more frequently recalled than pairs associated by verbal mediation.
9. The rated subjective vividness of an image-mediated association correlates directly with the probablility of recall.
10. Subjects recall associations better when instructed to imagine scenes in which the parts are linked by actions and spatial relations into easily visualized wholes than when instructed to imagine the parts as separated in space and non-interacting.
11. A positive effect of noun imagery is greater on the stimulus side than on the response side of pairs.
12. Action imagery is more memorable than static imagery.
13. Locational static imagery is more memorable than coincidental imagery.
14. The ability to profit from the stored images is contingent upon the subject's ability to store an appropriate verbal representation of the object along with its image.
15. Imagery instructions produce more facilitation than sentence instructions.
16. The capacity for deriving profit from imagery representations develops later than the capacity for deriving profit from verbal representations.

Pictures

We are much more likely to be using pictures in our treatment with aphasic patients than we are words. What about the differential availability of coding for pictures versus words? Again, a Paivio (1970) quote:

> Pictures, if familiar and unambiguously labeled, readily evoke both concrete imagery and verbal coding, but the availability of the latter (verbal coding) is relatively lower because an extra transformation is involved and would be lower still if the pictures were unfamiliar or ambiguous. The verbal code is directly and equally available in the case of concrete and abstract words, but the former (concrete words) are more likely to evoke images (p. 257).

With normal subjects, words can be read faster than objects can be named (cf. Fraisse, 1964) indicating the higher availability of the verbal code in the former case. I suspect the same is true for aphasic individuals, seeing no reason why this shouldn't be generally true except in the case of specific dyslexia. Image arousal to words is slower than verbal coding of words or familiar pictures.

Just as concrete nouns evoke imagery more readily than abstract nouns, so pictures evoke imagery more readily than concrete nouns. Accordingly, the prediction would be that picture items, especially in the stimulus position, should be easier to learn than word items (Rohwer, 1970).

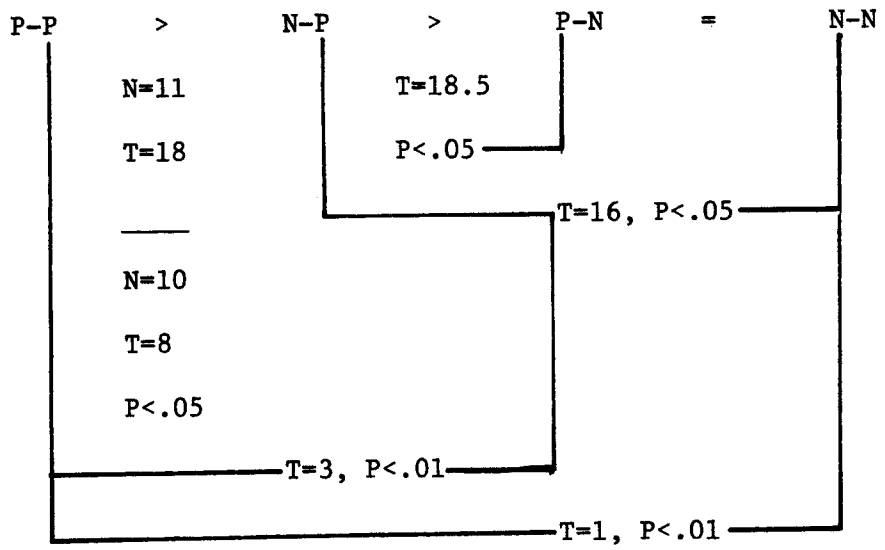
Dilley and Paivio (1968) presented concrete nouns or line drawings of objects to nursery school, kindergarten and first-grade children. The picture-word contrast was manipulated independently for stimulus and response positions so that four different lists were used: picture-picture (P-P) pairs, picture-noun (P-N) pairs, noun-picture (N-P) pairs and noun-noun (N-N) pairs. One of our MA theses, completed by Michele Altman at Hunter College, CUNY, presented lists organized in similar manner to aphasic subjects in a PAL task. Her nouns were rated as high in imagery, concreteness and meaningfulness. All in all her experiment was very similar to Dilley and Paivio's except that their subjects could talk and they gave their responses verbally. We made the practical assumption that aphasic subjects might well remember as association but be unable to verbally give the response when shown the stimulus, so the experiment provided response alternatives. For example, if the study pair were the word-word combination, table-queen, the patient during the recall trial would see the word table followed immediately by the response alternative slide for that pair: flower - queen - candy - snake.

Thus, the patient had only to point to the item which correctly completed the pair; no oral response was required. Now, this raises an important point, because Paivio and Dilley found that the preferred mode of storage for children is imagery: pictures are more likely to evoke imagery than words. But the requirement that a response be given verbally entails a transformation of information if it is stored visually. Therefore, the picture-word pairs are superior to all other in children because the word is provided. Rohwer and his associates (cf. Rohwer, 1970), however, suggest that the capacity for deriving benefit from pictorial modes of representation develops later than the capacity for deriving benefit from verbal modes.

Michele found that learning under the picture-picture condition was

better than learning under the other conditions, although there was no statistical significance between the picture-picture and the noun-picture conditions unless we threw out the one subject in 16 whose scores went in the reverse direction: discarding him, a fluent, very impaired patient, resulted in the picture-picture condition always being superior (see Table 1).[1]

Table 1. Performance Of 20 Aphasic Subjects Under Four Conditions of Paired-Associate Learning.



P-P = picture-picture
N-P = noun-picture
P-N = picture-noun
N-N = noun-noun

We see here an extremely strong effect of pictures as stimuli. Whenever the patients made the direct match between picture and picture, performance was better. When the study trial involved pictures in the response position and the patient had to choose his response from picture choices, he always did better.

Michele also looked at the correlation between her subjects' performance on the PAL task and performance on Parts A and B of the Minnesota Test for Differential Diagnosis of Aphasia (MTDDA) (Schuell, 1965). That is, she asked what the correlation was between the number of errors made on the MTDDA and the number correct under PAL, and found a correlation significant at the .01 level. The better the subject did on the MTDDA, the better he did on PAL. Now, these 20 patients are "real" aphasic patients, moderate to severe in the degree of aphasic impairment as rated by thetherapists on our staff (mean age

[1] Our thanks to Louis Gerstman, City University, for his invaluable advice on the design and data analysis.

about 57 years in all experiments; mean number of months post onset approximately 3.5 years). We feel that these results provide some substantiation of Paivio's dual-coding hypothesis: when the verbal code was more available, as it presumably is in the case of the less severely impaired patients, PAL was better. The patients with the less severe aphasia had two codes available. Additionally, when she looked at response times, her results held: PP<NP<PN<NN.

Michele's experiment really involves recognition memory and the results from studies with normals are similar to hers: recognition scores are higher for concrete than for abstract nouns (Gorman, 1961) and pictures in turn are easier to recognize than are their names or words generally (Jenkins, Neale and Deno, 1967; Shepard, 1967). Taken together, these findings indicate that recognition memory increases from abstract to concrete words to pictures and lead to the conclusion that such a hierarchy of difficulty has application to treatment and diagnosis of aphasia.

Paivio (1970) argues that image arousal to words is slower than verbal coding of words or familiar pictures. A ranking of the availability or arousal probability of each code for the different stimuli is the following: image arousal, in the case of pictures, and verbal coding, in the case of words, have the highest availability, the verbal code to pictures second, imagery to concrete words third, and images to abstract words fourth. Thus, he says, the summative availability to <u>both</u> codes is highest in the case of pictures, intermediate for concrete nouns, and lowest for abstract nouns. "The effect of concreteness on memory is hypothesized to be a direct function of the availability of each code in that the appropriate verbal response can be retrieved from either (p.257)".

Thus, Paivio articulates what he has called the "dual coding" hypothesis. What this means in practical terms is that with pictures both codes, the verbal and the visual imagery code, are more readily available.

In terms of treatment we might consider the issue this way. If I use concrete pictures as my treatment stimuli, then I am going to arouse both the verbal and the imagery code. Now, in aphasic patients, because of their linguistic deficit, arousal of the verbal code is at least depressed. So I instead arouse the visual code--at <u>least</u> I arouse the visual code. But if one code is able to assist in retrieving the other, then arousal of the visual code will facilitate arousal of the verbal code. In other words, I increase my chances of arousing the verbal code by using pictures. On the other hand, if the naming impairment, for example, or aphasia in general is so dense that no verbal code is aroused, I've at least aroused the visual imagery code. Something presumably has happened to affect coding. My plea today is that using visual imagery to its fullest can serve as an effective mediator to chain what is visualized to the verbal code. It was basic to Aristotle's theory of memory (see Yates, 1966) that imagination be viewed as the intermediary between perception and thought. I suggest that we consider this as a strategy for the aphasic individual.

The conclusions we have reached, then, are these. Aphasic patients do seem able to image. Both by manipulating the stimuli, using items of high imagability, and by giving the patient appropriate instructions, one can create imaging conditions. There is evidence to suggest that the right brain is involved in coding strategies such as the ones we've been using--- I've not really had a change to review that literature here, but I think therein lies exciting potential. There are numerous experimental treatment programs that undoubtedly bring the right brain into more predominate play: VIC, MIT and gesture therapies all owe part of their success at least to right

brain take-over. The idea of the right brain participating is not new. Jackson in 1874 said that "words revive meaning by recalling the image of the objects they symbolize". I suggest that in 1977 we should also allow the same to occur.

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