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ABSTRACT

Contemporary research findings in the fields of perceptual psychology and neurology of the human brain that are directly related to the study of visual communication are reviewed and briefly discussed in this paper. Specifically, the paper identifies those major research findings in visual perception that are relevant to the study of visual communication in regard to the key variables in picture perception, examines those key neurological and neurophysiological findings that relate to the study of images insofar as the hemisphere specializations of the brain are concerned, and provides some examples and suggestions for empirical research in visual communication drawn from the review of the few key studies that now exist in the field. (Author)

# BIOMETRIC RESEARCH IN PERCEPTION AND NEUROLOGY RELATED TO THE STUDY OF VISUAL COMMUNICATION

by

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## ABSTRACT

Contemporary research findings in the fields of perceptual psychology and neurology of the human brain which are directly related to the study of visual communication are reviewed and briefly discussed. The acknowledgement of the existence of such relationships was found to be of great importance to the conscientious visual communication researcher who recognizes the need to bridge the gap between scientific evidences and subjective interpretation.

Specifically, this study (1) identifies those major research findings in visual perception which are relevant to the study of visual communication in regard to the key variables in picture perception, (2) examines those key neurological and neurophysiological findings which relate to the study of images insofar as the hemisphere specializations of the brain are concerned, and (3) provides some examples and suggestions for empirical research in visual communication drawn from the review of the few key studies which now exist in the field.

The research and publication of empirical studies in visual perception and the neurology of the human brain has consistently and systematically increased during the last ten years. However, studies on visual communication that acknowledge, let alone utilize, these findings are practically non-existent. The need to bridge scientific evidence with subjective interpretations is paramount. Studies on visual communication, for the most part, have relied on and employed research methods and techniques which are obsolete. Considering the technological advances in research instruments and the sophisticated scholastic and scientific research methodologies employed by perceptual psychologists and neurologists, for example, it is understandable why visual communication has not as yet been developed as a legitimate and separate academic discipline.

There are many commonalities governing both the study of visual communication and the study of visual perception and neurology of the human brain. The biometric findings of the process of visual perception and the neurology of the brain are both directly related to the study of images and their construction, perception, interpretation, and response.

The purpose of this study is to acknowledge empirical research on the processes of visual images. Specifically, this study: (1) identifies the major research findings in visual perception which are relevant to the study of visual communications insofar as the key variables of picture perception are concerned, (2) examines those key neurological research studies that relate to the study of images insofar as the hemispheric specializations of the brain are concerned, and (3) provides some examples and suggestions for empirical research in visual communication drawn from the review of the few such studies which now exist in this field.

## From Perception to Cognition

How are visual stimuli (exposed in the visual world) perceived and processed? How are they recognized?

Obviously, film and television directors who structure pictures for communicative purposes are directly concerned with answers to the above questions, both of which cover the study and the discipline of visual perception, the process by which the potential stimuli, randomly exposed in the visual world, become effective stimuli—are picked up by the eyes and processed by the brain into cognitive structures.[1] The distinct mechanical steps followed by the eyes in perceiving a stimulus and the chemical and mental process by which the optical system processes the stimulus in the brain are pre-eminent to constructors of visual images via the media of film and television. Among the numerous studies that deal with the path of visual perception, the most recent and important ones (in terms of their relationship to the process of visual communication) will be reviewed here.

The first area of study is the psychophysics of vision which explores the methods used to measure, control, and study how potential stimuli are turned into effective or registered stimuli. In order to understand the visual communication process and, consequently, measure its effects, researchers must consider the effects of such critical vision variables which Boynton[2] describes as (1) intensive, (2) spectral, (3) geometrical, and (4) temporal. Their relation may be shown by the formula:

$$\varepsilon = hc/\lambda$$

This means that the wavelength ( $\varepsilon$ ) is directly related to the energy ( $\lambda$ ), with the velocity of light ($c$) and ($h$) Planck's constant.[3] In simple terms, this formula provides the means by which TV and film directors can measure and correlate the intensive and accessive lighting of an action on the set, for example, in relation to the visual energy exerted by the set itself and the rest of the visual elements. Such psychophysical methods of studying the effects of various stimuli are related to the study of images where emphasis is placed on objects and subjects for more direct communicative effect. For example, the predominance of colors, the preference for certain shapes, the retention of visual images based on their motion, etc., are all taken into consideration (precisely and accurately) by Boynton's psychophysical equation above.[4] Directors and researchers in the visual communication media who stage for maximum visual effects and measure the impact of such effects will find Boynton's equation useful.

Another area of study may be borrowed from the numerous psychological studies on human perception and reaction, all of which deal with the relationships between information given and reaction performed.[5] Broadbent states that:

It [information theory] deals with a set or ensemble of possible messages which are to be transmitted through a given channel, and the ways in which the signals in that channel may be encoded so as to convey the messages as fast as possible with a given amount of noise (unwanted disturbance) in the channel, and a specified degree of error. It can be shown, for example, that the average time taken per message in such a situation is proportional to

$$\sum_{i=1}^{i=n} -- p_i \log p_i$$

where $p_i$ is the probability of the $i$th message in an ensemble of size $n$. This expression is known as the average amount of information per message.[6]

This means that intelligibility (understanding the text) is related to the probability of understanding the individual words. In simpler terms, it provides the means by which TV and film directors can control, measure, and correlate the possibility of accurately perceiving the key words of a scene, considering the degree of distortion (signal-noise ratio) caused by the channel of communication above.

For film and television researchers who are concerned with the impact visual images have on viewers, the precise knowledge of the intensity of the message, the time it takes for the message to be perceived, and the amount of disturbance, error, or noise it contains are all of prime importance. These variables can be isolated and controlled. They can be measured and, consequently, correlated for maximum communicative effect.

Additional areas of study provided by recent findings in perceptual psychology related to the study of visual communication are based on (1) the perception of motion (e.g. Spigel,[7] Kolers,[8] Matin and MacKinnon,[9] and McFarland[10] dealing with analytical discussions and control of the variables involved in moving images), (2) the processing of visual stimulation (e.g. Boynton,[11] Fraisse,[12] Averbach and Sperling,[13] Crovitz and Daves[14] examining the ways by which the eyes scan the visual field), (3) the perception of form and pattern (e.g. Hochberg,[15] Haber and Haber,[16] Ganz,[17] Beck[18] discussing the means by which we recognize geometrical figures and other visuals), and (4) the perception of objects in space (e.g. Epstein,[19] Kaiser,[20] Natsoulas,[21] Julesz,[22] Rock and Victor[23] which analyze the variables involved in object size, size constancy, and depth). Studies such as these provide valuable clarification on the ways the eyes select and process visual stimuli. The precise measure of the effects images have on viewers depends greatly on knowledge of the above findings.

Another major area of research provided by perceptual psychologists and directly related to research on visual communication is found in studies examining the manner in

which the eyes move to perceive surfaces and contours of objects. The nature of vision ,along with its process, has produced classic research findings by Gregory,[24] Luria and Strauss,[25] Noton and Stark,[26] Pettigrew,[27] Ratliff,[28] Thomas,[29] and James, Pierce, Warren, and Macchello.[30] Careful consideration of the findings of the above studies will aid visual communication researchers enormously in their own field. For example, the variables involved in the process of scanning the visual field and the experimental conditions necessary for this process are thoroughly examined and isolated by these studies. In addition, these studies provide precise and accurate measuring devices, instruments, and testing techniques which range from the old trapezoidal window, one, two, or three field tachistoscopes, eye-maker camera, apparatus for studying perceived depth, apparatus for studying eye-brain correlations, and monocular and binocular pupilometers to the newest reciprocal-innervation model used to stimulate various eye movements. All of these apparatuses follow, control, and are able to test with great accuracy the saccadic movement of the eyes.

Studies provided by perceptual psychologists which refer to the differences and/or similarities between real objects (exposed in the visual world) and their images (reproduced in the visual field) is another major area of consideration. Gibson[31] was the first scholar to study systematically and distinguish between "objective seeing" (observing phenomena in the visual world) and "subjective seeing" (observing phenomena reproduced in the visual field). In turn, studies on these differences stimulated research exploring the nature, the characteristics, and the perception of pictures. Representative studies in this area are (1) "The Psychophysics of Pictorial Perception" by Hochberg[32] which considers the interaction between systematic psychology and the study of pictorial communication, (2) "A Factor Analytic Study of Children's Picture Interpretation Behavior" by Higgins[33] which uses a model of picture interpretation consisting of two interdependent forms of behavior (objective and inference drawing) to attempt to answer the question of what psychological processes are involved in drawing inferences from pictures, (3) "The Pictures In Your Mind" by Fleming where the characteristics of pictures and the meaning assigned to them are discussed,[34] (4) "Cultural Conventions of Pictorial Representation: Iconic Literacy and Education" by Mangan which concludes that interpretation of visual images is learned,[35] and (5) "Pictorial Support and Specific Instruction on Design Variables for Children's Concepts and Rule Learning" by

Tennyson,[36] etc. The usefulness of the above studies is found in (1) the construction of visual images (where artists/constructors manipulate the medium to present faithful images) and (2) the measuring of the impact of these images on viewers (whether or not the intended scope was achieved).

Studies on monocular and binocular vision are equally important because of the compositional and aesthetic implications derived from them. A major characteristic of the visual field, which is horizontally oriented, is its dimensions which seem to be restricted in order to coincide with our binocular vision. According to Stone and Collins[37] our binocular visual field roughly extends to form a rectangle of 180° in length (horizontally) and only 150° in height (vertically).

This scientific finding prompted the structure of conventional TV and film screens and inspired the slogan that film and television pictures are a window on the world[38] allowing only a portion of the world to be seen.

Depending upon the particular amount of energy expelled by the various stimuli, the eyes (1) perceive them, (2) transfer them to the optic system as effective stimuli, and (3) process them to the brain as perceived stimuli where they are turned into cognitive structures or known patterns and forms with an assigned meaning.
This is the cycle of visual perception from seen to recognition or from perception to cognition. The identification of all the variables involved in this delicate and complex process as well as their relationships and interactions with other factors in the process are important to the researcher of visual communication. They provide answers to such questions as: What makes a stimulus an effective one? How are "sensory register" and "control processes" interrelated? What elements contribute to better recall of stimuli in "long term storage"? etc.

In summary, recent studies and scientific findings on (1) psychophysics of vision, (2) eidetic perception (eye movements and processing of visual information) and (3) pictorial presentation are directly related to the study of visual communication. The basic variables involved are common to both fields and consequently should be considered by communication researchers. In addition, the restrictions imposed by the necessary experimental conditions and the measuring apparatuses themselves must be considered.

## How Does the Brain Process Visual Information and What Functions Are Performed By Each of the Two Hemispheres? Does the Brain See the World Asymmetrically?

A discussion on the way the human brain processes visual information must, inevitably, include the subject of biological duality and man's two modes of consciousness. The human brain is such a complex machine that its functions and their implications extend to cover such areas as neurology, psychology, psychiatry, anthropology, sociology, and even philosophy, religion, and mysticism. The literature on right and left symbolism alone is quite extensive.[39] The visual communication researcher should familiarize him/herself with the empirical findings (the hard facts) in all these areas, but this is not always possible. Today, it seems that everyone in every academic discipline uses the bipolar dichotomy of the human brain to explain every phenomenon.[40] Even worse, perhaps, is the fashion which leads researchers to interpret various findings on the distinct functions of the right and left hemispheres of the brain to his/her own likes, dislikes, and biases, often giving meaning to things, objects, and circumstances that are meaningless or placing value on elements and situations which are valueless. It is in this area that the critical eye of the visual communication researcher needs to be even sharper to be able to disregard the unnecessary and underline the important clues of these neurological findings.

This section will concentrate primarily on those neurological studies most closely connected with the structure of visual images for an effective communicative and aesthetic impact.

Neurologists have long known "that the brain's control of the body is reversed—the left side of the cortex connects with the right side of the body, the right half of the cortex with the left of the body."[41] The nature of such control and the unique tasks performed by each of the two hemispheres of the brain were systematically studied first by Sperry of the California Institute of Technology,[42] Gazzaniga,[43] Bogen,[44] Domhoff,[45] Luria,[46] Kimura,[47] Ornstein,[48] etc. Experimenting with animals first, and later on with brain-damaged patients, they managed surgically to separate the two halves of the brain connected by the corpus callosum and to study the various tasks performed by each hemisphere. Pursuing further experiments, these neurologists and their associates found that such distinct functions of the brain occur equally in normal people and that the

various specializations of the left and right hemispheres are always present. Taking the results of these studies even a step further, contemporary neurologists offer a series of clues, scientific findings, to visual communication researchers for their investigation.

Summarizing the most recent results on this subject, Ornstein[49] provides a series of clues and empirically tested suggestions. Trotter[50] also discusses the distinct functions of the human brain, providing an illustration to this effect. This biological duality or asymmetry of the brain is extended to the asymmetrical way in which we observe phenomena in the world. And if we can demonstrate that this asymmetry also occurs in the visual field (TV & film screens, for example), we will be able to bridge scientific evidence with existing plain speculation.

In the field of visual communication, research studies accounting for such neurological and neurophysiological findings are almost non-existent. Worse yet is the fact that we, in the field of visual communication, are still using paper and pencil data-gathering methods and measuring techniques in our studies. This process, however, is a function of the left hemisphere of the brain (logic, mathematics, inferential thinking, etc.) whereas the elements we are trying to measure (images, perception of abstractions, patterns, recognition of figures, etc.) are functions of the right hemisphere of the brain. As McLuhan says in his rather recent article on the subject:

> Nowhere is this more evident than in the Western approach to the study of media and its effects. The left hemispheric Westerner approaches the study of media in terms of linear motion or sequential transportation of images as detached figures (content), while the right hemisphere approach examines the ground of media effects instead.[51]

Approaching the subject from a slightly different perspective, Fletcher, in his recent paper on "Empirical Studies of Visual Communication," has also warned that we are using the wrong tools for our research on the effects of visual images.[52] I, myself, am guilty of committing a series of errors in approach, method, and technique of data gathering in my dissertation study.[53]

First, although I correctly assumed that the theories of asymmetry of the brain and asymmetry of the screen interrelate and that one complements the other, I was wrong in assuming that my conclusions regarding the placement of visual elements on the left and right sides of the TV screen resulted from procedures similar to the ones employed by neurologists in their studies of asymmetry of the brain. While they used modern, scientific apparatuses, I used the old paper and pencil procedure.

Second, my subjects were asked to look at visuals placed on the right and left side of the screen and then to write down and describe their preferences and reactions. This is a contradiction in itself since perceiving the visuals is a right hemisphere function and writing down their preferences is a left hemisphere function. Although the brain is, generally, flexible enough to account for these adjustments, the results cannot be completely without bias.

While I was spending valuable time with primative methods, neurologists were getting more reliable results by implanting very thin, low-voltage electrodes into the right and left hemispheres of the brain (Electroencephalogram or EEG) to measure changes in the blood flow of the brain as the intensity of visual stimulation increases or decreases.[54] Great strides have also been made in studying eye movement to determine cognitive mode. Studies indicate that when a subject is asked a question of a verbal, analytical, or mathematical nature, his/her gaze will shift to the right. If the question involves spatial or holistic mentation, his gaze will shift to the left while thinking.[55] These findings were not taken into account in my study of asymmetry of the screen.[56]

The communication researcher interested in the impact of neurophysiological findings on the construction and measurement of pictures should draw basic information from the recently published findings which follow. The studies reviewed here clarify and

discuss numerous visual communication variables which were unknown or previously overlooked by communication researchers.

An answer to the problem regarding the specific qualities of the right hemisphere of the human brain which, compared to the ones on the left, have been neglected by researchers is being provided by the combined efforts and research of anthropologists, psychologists, psychiatrists, sociologists, and neurologists.[57] They studied the behavior, characteristics, habits, etc., of the Inuit Eskimos in Canada from all points of view utilizing modern techniques for gathering data. According to Trotter, the results of these scientific efforts are as follows:

> In general he [Katz] found the left hand side of the body (right hemisphere) to be associated with the symbolic, ritualistic, mystical, mythical, omnipotent, transcendental, supernatural, evil, profane, foreign and alien. The right hand is typically associated with social order, politics, organization, social system, morality, goodness, sacred, explicitly verbal, mathematical and ordered.[58]

New insight regarding the organization of the brain which clarifies and isolates key variables in the process by which the brain interprets visual information is provided by Luria's recent study.[59] The important conclusions of this study are that (1) the exact place within the brain where the centers for speech and writing are located has been identified and (2) it is now possible to manipulate and change the unilateral functions of the brain. In the words of Luria:

> Finally, the neuropsychological approach gives us a new insight into the effects of learning on the brains processes . . . Patients who cannot write from dictation are often able to sign their names readily. It appears, therefore, that training or habituation changes the organization of the brain's activity, so that the brain comes to perform accustomed tasks without recourse to the processes of analysis.[60]

The implication that the predominance of the left hemisphere of the brain in its various functions over the right (such as writing and right-handedness) might be due to some particular structural difference between the two hemispheres has been supported by Galaburda, LeMay, Kemper and Geschwind in their study "Right-Left Asymmetries in the Brain."[61] The striking importance of this study which makes it relevant to the study of visual images is, first, the conclusion reached that language and right-handedness (both of which are functions of the left hemisphere) are interrelated, second, that the exact locations of these left and right asymmetries of the brain have now been identified, and third, that language and auditory functions are also found to be correlated. This points out the need to correlate images and sounds for an effective communication result.[62]

A number of new studies pertinent to the subject of reading habits and directional scanning (left to right, right to left) have been reported in the Journal of Cross-Cultural Psychology, Neurologia, etc.[63] The importance of these studies to the researcher of visual communication is twofold. First, the study of reading and writing habits is directly related to the perception (the saccadic movements) of the visual images within the field, and second, such variables as visual weight, importance, predominance, attractiveness, interest value, direction, etc., are all discussed, controlled and measured providing a clear understanding as to how viewers read pictures. Explaining the findings of their study, Nachshon, Shefler and Samocha state:

> The results showed that, while directional stimulus characteristics affected the direction of scanning of letter stimuli, reading habits affected the strength of these directional scanning tendencies. Nonletter stimuli were found to be differentially affected by reading habits. Experimentally manipulated conditions affected performance, but specific set effect was found for Hebrew readers only. Finally, Takala's finding of subjects' tendency to attend to stimuli in the left visual field was reconfirmed and extended in the present study.[64]

Similar to this study were the results found in a pilot study by Fayad Kazan, a doctoral candidate in Communications at Temple University, on "The Effects of Culture [writing and reading conditions from right to left and left to right] on Pictorial Perception: Asymmetry of The Screen Revisited."[65] Not only do people from some Eastern cultures perceive pictures differently, but the starting point of their fixation depends on the subjects' reading and writing conditioning. Such findings and their derivatives are of prime importance to the researcher of the visual communication media, of film and television.

Undoubtedly, the bipolar dichotomy of the brain with its two modes of consciousness and the distinct ways by which each hemisphere "sees," processes, and interprets the phenomena in the world is a new area of consciousness, a new field of study not only for

the student of neurophysiology but equally for the student of behavioral science, anthropology, art, religion, mysticism, symbolism, communication, etc. In the words of Wilbur Schramm:

> For a number of centuries we have devoted most of our instruction to print and writing that are highly abstracted from life, and very little instruction to the iconic code that is selective but not abstracted. Therefore, we have subordinated a large area of human experience, and neglected the development of one hemisphere of the brain while working very hard to develop the other hemisphere.[66]

## Some Suggestions For Research in Visual Communication

Empirical research in visual communication which acknowledges and accounts for the findings in psychology and neurology is scarce, practically non-existent. Some occasional efforts have been made by researchers in advertising, TV programming, and by video artists which attempt to apply these findings to current visual communication research. This indicates that there is concern for this issue.

Advertisers are pioneers in these attempts. Krugman's[67] recent experiments were based on the asymmetrical (dual) functions of the brain. An important point made by Krugman is that the "recall" and "retention" of images is weak and minimum whereas the "recognition" of images is strong and maximum.[68] This finding stems from the fact that the processes of "recall" and "retention" are functions of the left hemisphere of the brain while "recognition" of images is a function of the right. In order to determine (measure) the viewers' recall, recognition, and reaction to certain ads, tiny electrodes were placed on key locations of the brain.[69] Krugman's procedure confirms the conclusion reached earlier in this paper that the paper and pencil method of data gathering in cases like these is crude. It is suggested that either EEG (when possible), pupilometers, skin measurements or on-the-spot, spontaneous recall techniques will provide more accurate and unbiased responses than written ones.

Another important observation made by Krugman is that "what we call 'print' or print advertising is probably not really a left brain phenomenon . . ., it is primarily a picture, or a right brain medium, too."[70] It is suggested that when we construct visual stimuli, the choice of the placement of such stimuli within the concentrated field, the TV or film screen, for example, is as important as their actual nature. Krugman's observations, all of which derive from his experimental studies in advertising,

provide some suggestions that are of great value to the visual communication researcher. He states:

> Those who wish to do research on comparison of qualitative differences among media might be reminded that within TV itself one can compare response to still and moving pictures, print and print-over, and voice and voice-over . . . Now something new has been added. Students of media behavior may yet confront the embarassing fact that television audiences give close attention for long periods of time to stimuli that create no thought or little recall. Why do they do it? What's happening? Perhaps a way has been opened to find out.[71]

Research on the effects of such TV programs as "debates," "newscasts," "sports reports," "children's programs," etc., conducted recently by scholars in visual communication underline the need for further systematic research which takes into account neurological functions and also provide suggestions for further studies as emphasized in this paper.

Tiemens' study on the presidential debates of 1976, for example, concluded that a number of differences in how the candidates (Carter and Ford) were visually portrayed could be measured and documented.[72] Such variables were differences in production techniques, image size, compositional balance, vertical screen placement and height, asymmetry and horizontal screen placement, reaction shots, and eye contact with the cameras. All these variables identified and controlled by Tiemens have also been identified and studied by perceptual psychologists and neurophysiologists. Tiemens' study suggests that a visual analysis of the elements of the screen is possible to determine their effects and impact on viewers. The precise research instruments and techniques by which we can measure such variables as the ones mentioned by Tiemens above are equally important. Such modern and accurate instruments and techniques are provided by visual psychologists and neurophysiologists.

Baggaley and Duck's[73] study on the influence of background visuals on newscasters' credibility and Coldevin's[74] studies on the effects of variable background visuals on newscasters' believability are headed in the right direction. The variables they attempted to manipulate and measure, such as (1) static location establishment visuals, (2) symbolically established visuals, (3) placement and location of visuals within the field, (4) influence of visuals on newscasters' credibility, etc., are all important for the systematic study of TV production. As Coldevin puts it: "An "intuitive" selection of presentation strategies may have been accepted practice in an earlier period of television, but is decreasingly justifiable today given the sophistication of readily adaptable research techniques and quickly verifiable results."[75]

Studies in video art, conducted mostly with portable or small format TV equipment, are purely experimental and have not reached the state of empirical research as yet.[76] The artistic methods, the theoretical concepts, and the predictable goals of these experimental studies have not been clearly developed, studied, and measured. There is a pressing need for empirical research fin this area, particularly since psychologists and neurologists have already begun experimenting and researching with such variables as shadows and light, colors, figure-ground relationships, psychological closure, the perception of patterns and forms, etc.[77]

In conclusion, the suggestions for research in visual communication provided above should not be overlooked. The task of visual communication researchers (depending on their particular interests) is to interrelate their methodological approaches, their methods of research, and techniques of data gathering with those discussed here so that a fruitful integration of science and intuition (subjective speculation and scientific evidence) will dictate and underline future research in the field of visual communication.

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