The Role of Pupil Size in Communication

Changes in attitude can be detected by measuring changes in pupil size. It now appears that enlarged or constricted pupils can also affect the attitude and responses of the person who observes them.

by Eckhard H. Hess

When we say that someone's eyes are soft, hard, beady, cold or warm, we are in most instances referring only to a certain aspect of that person's eyes: the size of the pupils. The commonplace idea that the eyes can express emotion has been confirmed by experiment. Ten years ago I described in these pages how the viewing of a pleasing image is accompanied by a measurable dilation of the viewer's pupils, and how in general changes in pupil size are objectively correlated with emotions and mental activity (see "Attitude and Pupil Size," by Eckhard H. Hess, SCIENTIFIC AMERICAN, April, 1965). More recently I have been interested in another aspect of changes in pupil size: the role of such changes in nonverbal communication. I have found that pupil size serves as a signal between individuals, usually at an unconscious level. It is obvious that the eyes play many roles in nonverbal communication, as when someone averts his eyes in talking to someone else. Here, however, I am referring only to the role of the pupil.

The changes in emotions and mental activity revealed by changes in pupil size are clearly associated with changes in attitude. Accordingly the measurement of changes in pupil size, which I have named pupillometrics, has become a useful tool in the study of attitudinal change. In my laboratory at the University of Chicago changes in pupil size are measured while the subject views slides projected on a screen. In order to adapt the subject's eyes to the brightness of the stimulus slide, he is first shown a control slide that has the same average brightness as the stimulus slide that is to follow. The subject views the control slide for 10 seconds and then the stimulus slide for 10 seconds. The difference between the average size of the pupil when the subject is viewing the control slide and its average size when he is viewing the stimulus slide is recorded as the pupil response. One of our methods for measuring pupil size is to photograph the subject's eye during the experiment with a motion-picture camera. Later the film is projected on a screen and the pupil size is measured with a millimeter scale.

We have also been using an electronic pupillometer that scans the eye and automatically measures the diameter of the pupil while the experiment is in progress.

The usefulness of pupillometrics in the study of attitudinal change has recently been further validated by the results of a study in my laboratory by Paul W. Beaver. He presented color slides of several kinds of food to 20 people who had missed their previous lunch or dinner and who had not eaten at all for the past five to eight hours. Another group of 20 subjects who had eaten lunch or dinner two hours before were also shown the slides. When the pupil responses of the viewers were measured, it was found that the increase in pupil diameter among the hungry subjects was greater than that among the satiated subjects. In fact, in some instances the satiated subjects showed a constriction of the pupil. The results demonstrate that even a temporary change in attitude can be detected by measuring pupil response.

Our studies of the pupil as an indicator of attitude led us to consider the possibility that one person uses another person's pupil size as a source of information about that person's feelings or attitudes. In one experiment I showed two photographs of an attractive young woman to a group of men. The photographs were identical except that in one the woman's pupils had been retouched to make them larger and in the other they had been retouched to make them smaller. None of the men reported noticing the difference in pupil size, but when they were asked to describe the woman, they said that the woman in the picture with the large pupils was "soft," "more feminine" or "pretty." The same woman in the picture with the small pupils was described as being "hard," "selfish" or "cold." There could be little doubt that the large pupils made the woman more attractive to the men.

Women used to put the drug belladonna, meaning "beautiful lady," into their eyes because they thought it made them more beautiful. The active principle of belladonna is atropine, which causes the pupils to dilate. Indeed, an eyewash preparation containing atropine was popular among women not many years ago, until the U.S. Food and Drug Administration put a stop to its sale.

Where did the notion that larger pupils make a woman look more attractive come from? It would be easy to dismiss it as mere folklore, but it clearly has a basis in reality. For one thing, younger people have larger pupils than older people, so that large pupils are associated with an obvious constituent of physical attractiveness. What is really appealing about large pupils in a woman, however, is that they are an indicator of interest, which can be interpreted as sexual interest. Moreover, when men view a picture of a woman with large pupils, their own pupils dilate. In other words, seeing large pupils gives rise to larger pupils.

The pupil responses of men and women, all stably married and presumably heterosexual, were investigated by Thomas M. Simms, who was then working at the University of Toronto. The subjects were shown two pictures of a man, one with large pupils and the other...
PHOTOGRAPHS OF TWO WOMEN were retouched so that each woman had large pupils in one photograph and small pupils in the other. Male subjects were shown eight different pairs of the photographs: all the possible combinations of the two women. As subjects viewed each pair they were asked in which of the two pictures did the woman appear to be more sympathetic, more selfish, happier, angrier, warmer, sadder, more attractive, more unfriendly and so on. When the question concerned a positive attribute, male subjects tended to choose the photograph of the woman with the large pupils. When the question concerned a negative attribute, they tended to choose the photograph of the woman with the small pupils. Neither woman, however, was consistently chosen as being the more attractive or the more unfriendly. The selection in most instances appeared to be made unconsciously on basis of pupil size.
with small pupils. They were also shown two pictures of a woman, one with large pupils and the other with small pupils. The pupils of the male subjects dilated the most when they viewed the picture of the woman with the large pupils. Similarly, the pupils of the women dilated the most when they viewed the picture of the man with large pupils. With both men and women the dilation in response to the picture of a person of the opposite sex with small pupils was much less.

Even more interesting were the pupil responses of the men and women to the pictures of the person of their own sex. The men showed almost no increase in pupil size as they viewed either picture of the man. The women, on the other hand, showed a smaller pupil response to the picture of the woman with the large pupils than they did to the picture of the woman with the small pupils. This finding is supported by the results of another study carried out by Robert A. Hicks, Tom Beaney and Lyon Hill of California State University at San Jose. In interviews with a group of women they found that the women preferred a picture of a woman who had small pupils to a picture of the same woman with large pupils. These findings suggest that women's magazines will not increase their newsstand sales by printing pictures of women with large pupils on the cover.

Additional evidence comes from a study conducted by John W. Stass and Frank N. Willis, Jr., of the University of Missouri at Kansas City. They introduced a subject to two individuals of the opposite sex and asked the subject to select one of them as a partner for an experiment. One of the proposed partners had been given eye drops to dilate his pupils; the other had not. Both men and women tended to choose the person with the large pupils. Stass and Willis also observed that eye contact—a direct exchange of gazes—during the introduction was a factor that increased the likelihood that the individual with the large pupils would be chosen. Most of the subjects were not able, however, to say whether they had used the large pupils or the eye contact as the basis for choosing their partner.

A study of men who identified themselves as homosexuals, conducted by Simms at the University of Toronto, further confirms the effect of pupil size in sexual communication. Simms found that male homosexuals distinctly prefer a picture of a woman with constricted pupils to a picture of the same woman with dilated pupils. Apparently the signal of sexual interest that is transmitted by the dilated pupils of a woman does not appeal to male homosexuals.

Another interesting finding by Simms is that heterosexual "Don Juan," men who identified themselves as being more interested in having sexual relations with many women than in forming a lasting relationship with one woman, have the same pupil response to pictures of women with large and small pupils that male homosexuals do. This finding suggests that such men also have an aversion to women whose pupils indicate sexual interest.

In the experiments I have been describing the test pictures were retouched photographs of a complete face. I set out to examine whether or not similar responses might be elicited by a purely schematic pair of eyes. Because of my interest in ethology, the study of the biological basis of behavior, I wondered if large pupils might not act as a "releaser." Ethologists have shown that a small portion of an animal may in itself be sufficient to release a specific pattern of behavior in another animal. For example, a robin will usually attack another robin that intrudes on its territory. David Lack of the University of Oxford found that a robin will also attack a single red feather that is put in an upright position in some strategic place such as a tree limb. The feather, which apparently symbolizes the red breast of a robin, releases the attack behavior of another robin. Could the size of the pupils release a pattern of behavior that is innate or perhaps learned very early in life?

I drew three kinds of schematic eyes that consisted simply of a circle with a
A pair of eyes the two circles were slightly separated so that they would resemble a pair of eyes in a face. In the slide showing three eyes the spacing of the circles was the same as that of the two eyes of the pair. I showed the schematic eyes to a group of subjects and observed how they responded in terms of their own pupil size. The responses to the single eye and the triple eye did not vary systematically in relation to the size of the schematic pupils. When I displayed the paired eyes, however, there was a significant change in pupil size. In the large pupil tests, the schematic eyes were clearly visible. Simil

In children, the size of the adult's eye is approximately the same as the infant's eye. Below t

While an adult's eye is approximately the same as the infant's eye, in their twen

The Asherm

Although...
change in the dilation of the subjects' pupils. The paired schematic eyes that had the largest pupils caused the viewers' pupils to dilate much more than paired schematic eyes with smaller pupils did. In female subjects the dilation of the pupils was greater than that in male subjects. The fact that even a pair of schematic eyes will give rise to a dilation of the pupils strongly suggests that the dilation response is innate and not learned.

Similar results were obtained in an experiment with schematic eyes by Richard G. Coss of the University of California at Los Angeles. He, however, got a smaller pupil-dilation response to the paired schematic eyes than I did, possibly because he had placed the schematic eyes so close together that they did not resemble a pair of eyes in a face.

In children the absolute—not relative—size of the pupils is larger than it is in adults. Whatever other reasons there are for this difference, having large pupils is probably advantageous to a child in that it makes him more appealing to the adults who take care of him. Very young children have other features that may release the caring response in adults. An infant's head is large in proportion to his body. His eyes are large and are located below the middle of his face. His limbs are short and fat. The "lovable" cartoon characters created by Walt Disney and other artists tend strongly to have these babyish features and large pupils.

While studying the behavior of infants Janet Eare Asheur of the University of Chicago noticed that she seemed to elicit more smiles from infants than some of her fellow workers did. It turned out that in average room lighting her pupils were larger than those of most other people. To find out if large pupils in an adult do affect the smiling behavior of infants, she arranged to visit 16 infants in their homes. The infants were between three months and three and a half months old, an age when they smile at adults and have not yet developed a fear of strangers. Asheur made two visits to each home, and on each visit she interacted with the infant, talking and smiling, and recorded the number of times the infant smiled. On one of her visits she had her pupils artificially dilated with the drug phenylephrine hydrochloride. On the other visit her pupils had been artificially constricted with another drug, pilocarpine hydrochloride.

The infants smiled more often when Asheur's pupils were dilated than they did when her pupils were constricted. Although the experiment was only a pi-

DRAWINGS OF TWO FACES WITHOUT PUPILS were given to subjects who were asked to draw in the size of pupil that best fits the face. One face was smiling and the other was scowling. Men and women drew larger pupils on the happy face than on the scowling face, and so did a group of college students ranging in age from 18 to 25 years. Younger people between the ages of nine and 15 tended to draw pupils of about the same size on both faces, which indicates that they do not attribute different meanings to pupils of different sizes.
AGE DIFFERENCES in perceiving a face with large pupils as being happier than a face with small pupils were found in study of individuals ranging in age from six to 22. The subjects were shown drawings of two faces and were asked to choose the happier one. Subjects up to the age of 14 were just as likely to choose the face with the small pupils (gray bars) as the one with the large pupils (black bars). Subjects who were 16 years of age or older, however, strongly tended to choose the face with the larger pupils as being the happier one.

lot study and was obviously open to experimenter bias, the results nonetheless suggest that in infants the positive response to large pupils may not be learned but is part of the infants' perceptual development. Perhaps large pupils act as a releaser in infants as well as in adults.

An unexpected result of Asher's pilot study was the reactions of the mothers. When the experimenter's pupils were constricted, the mothers said that she appeared to be "harsh," "hard," "brassy," "cold," "evasive" and "sneaky." One of the mothers said that Asher appeared to be trying to hide something from her. When Asher came with dilated pupils, she was described as being "naive," "young," "open," "soft" and "gentle."

Children's books sometimes have illustrations that make use of different pupil sizes to depict good and bad characters. One finds that the "wicked witch" has tiny pupils and the "beautiful princess" very large pupils. There is an interesting difference between older books for children and more recent ones. Many of the older books have illustrations in which the pupils of the characters are rendered in various sizes; many of the newer books have illustrations in which the pupils of the characters are the same size.

I have conducted an experiment with drawings of faces that have no pupils. The faces were drawn about three-fourths the size of an average adult face. One face was smiling and the other was scowling. When I gave these faces to 10 men and 10 women and asked them to "draw in the size of pupils that you think best fits the face," I found that 15 of 20 subjects drew larger pupils on the happy face than on the scowling face (see illustration on preceding page).

I also had students in several of my classes draw pupils on the same two faces. The results were unequivocal: 47 of 50 students drew larger pupils on the happy face than they did on the scowling one. When I tested a group of younger people, between the ages of nine and 15, I found that they tended to draw the pupils on both faces the same size; in fact, the pupils on the scowling face were on the average slightly larger.

One of my students, James Dickson McLean, investigated the response of individuals ranging in age from six to 22 to drawings of faces that had pupils of different sizes. In one experiment the subjects were asked to choose the "happier" of two female faces. One face had large pupils and the other had small ones. McLean found that up to the age of 14 a person does not necessarily perceive larger pupils as being happier than smaller pupils. His finding agrees with the results I obtained in my study of the youngesters between the ages of nine and 15. McLean concluded that the turning point for attributing different meanings to pupils of different sizes comes at about the age of 14. It may be, however, that the answers given by children reflect not their actual perception but their understanding of the question (or lack of understanding). By testing the pupil responses of children to pictures of faces with large pupils and small pupils, we might find that they are more influenced by the size of the pupils than by the size of the faces.

BLUE-EYED SUBJECTS drew larger pupils on a sketch of a happy face and smaller pupils on a scowling face than brown-eyed subjects. In addition, when viewing a picture that normally causes dilation or constriction, blue-eyed people show a greater change in pupil size.

PUPIL SIZE (MILLIMETERS)

BLUE-EYED SUBJECTS BROWN-EYED SUBJECTS BLUE-EYED SUBJECTS BROWN-EYED SUBJECTS

0 1 2 3 4 5

We have brown picture stricts spect the su range and the et same photon shows group viewers of the more and is all two etc.

Neisen as more however photon the qt butt negati to pupils. tive at strong browb. Why more brown to see than is brown to ass favore in blue people.
ron her, d pupils, "naive," bite, " have il- erent pu- 1 charac- d witch" iful prin- is an in- fer books es. Many ations in utes are y of the in which the same vent with 0 pupils, at three- hul face. or other wa ces to 10 them to ou think 15 of 20 se happy ne ills. al of my ame two vocal: 47 ils on the se scowl of young- nine and draw the size; in ling face gor. Dickson use of in- six to 22 pupils of ment the he "hap- face had ad small r the age arily pere- pie than sees with study of nine and turn meanings at about war, that eft not in under- of un- pupil re of faces aps, we may find they have the same dilation re- sponses that adults do.

Of particular interest was another find- ing by McLean: blue-eyed subjects were more likely to judge large pupils as being happier than brown-eyed subjects. When we asked another group of sub- jects to fill in the pupils on drawings of happy faces and angry ones, we found that the blue-eyed subjects drew larger "happy" pupils and smaller "angry" pu- pils than the brown-eyed subjects (see bottom illustration on opposite page). We also found that blue-eyed people have a stronger pupil response than brown-eyed people when they view a picture that causes pupil dilation or con- striction. To be more precise, with re- spect to the total range of response from the smallest pupil size to the largest the range is greater for blue-eyed people than it is for brown-eyed people. (This statement applies, of course, only to changes in pupil size resulting from emo- tions or attitudes.)

I shall conclude with the results of a study we have just completed. We took two identical photographs of a woman and in one made the pupils large and in the other made the pupils small. The same was done with a second pair of photographs of another woman. We showed these photographs in pairs to a group of male subjects. As the subjects viewed each pair they were asked which of the two women was more attractive, more selfish, happier, more unfriendly and so on. The subjects were shown eight different pairs of photographs, that is, all the possible combinations of the two women.

Neither woman was consistently cho- sen as being the more attractive or the more selfish or whatever. The subjects, however, strongly tended to choose the photograph with the large pupils when the question concerned a positive attrib- ute. When the question concerned a negative attribute, the subjects tended to choose the photograph with the small pupils. The tendency to associate posi- tive attributes with large pupils and nega- tive attributes with small pupils was stronger in blue-eyed subjects than in brown-eyed subjects.

Why do blue-eyed people respond more to large and small pupils than brown-eyed people? It is of course easier to see a pupil surrounded by a blue iris than it is to see one surrounded by a brown iris. Perhaps it is not unwarrant- ed to assume that the response has been favored by evolutionary selection more in blue-eyed people than in brown-eyed people.