*Perceptual and Motor Skills*, 1994, 78, 299-303. 

# GAZE ORIENTATION IN PERCEPTION OF REVERSIBLE FIGURES [1]

VEZIO RUGGIERI AND MILA FERREIRA FERNANDEZ

*University of Rome "La Sapienza"*

*Summary.*—We hypothesized that during perception of reversible figures the direction of gaze toward a specific *perceptual focal point* plays a determining role in the identification of the images, i.e., when subjects are asked by the experimenter to perceive one of the two images, a displacement of the eyes toward a specific spatial area of the figure occurs. For each image we think there is a particular point of the figure which acts as perceptual organizer. The stimuli were the Hill and Boring, Ehrenstein, Rubin, and Schroeder reversible figures. Subjects were 47 undergraduate psychology students (32 women and 15 men). The number of ocular movements toward a different spatial direction were calculated for each suggested image of the reversing figure. Analysis showed that, in perceiving reversing figures, specific ocular displacements were present for each suggested image.

In the present research we examined the role of ocular movements in perceiving different images of a reversible figure. In particular we observed what happens when a suggestion is given to see one of the two images of the reversing figure. With this instruction we eliminated the problem of the perceptual "choice" of the subject and of the spontaneous shift of images that, we think, represent important components of the perceptual processes. Previous researchers (Gregory, 1974; Flamm & Bergum, 1977) did not observe a relationship between ocular movements and reversing perspective figures, we believe, because they considered only the total number of reversals and of ocular movements without examining the relationship between *specific* ocular movements and *specific* images. With our instructions we wanted to examine only a fragment of a more complex perceptual process in which different functional levels (encephalic and peripheral, mental, and physiological) interact.

We think also that previous researchers showed contradictory results for ocular movements because the role of the eyes was not clear in the different models of explication of the reversing figures. For some models eye movements were considered as the basis for the reversal process; for others they were only correlates of central events, while other authors thought that for the reversal process movement of the eyes is not necessary. Our hypothesis was that each mental visual representation (real, perceptual, or imaginative) is related to the activity of the eyes (Ruggieri, 1991; Ruggieri & Alfieri, 1992). The eye movements are involved in the first phase of the perceptual sequence; they determine the direction of the visual apparatus (the eyes) toward the object that must be focalized and cortically perceived. But the

[1]Requests for reprints should be sent to Vezio Ruggieri, Via dei Marsi 78, 00185 Rome, Italy.

same ocular movements are modulated by the central nervous system where mental cognitive and motivational activities occur. So it is possible to hypothesize that mental activity influences the ocular movements. Then, the movements of the eyes are regulated by the nervous system through reflex pathways or through the activity of multistable internal systems that, following the literature (Attneave, 1971; Petersik, 1979), are hypothetically involved in perception of reversing figures.

The "satiation theory" (Bonaiuto, 1969; Ellis, Wong, & Stark, 1979) and the "decision-making" theory are both compatible with our model because, we think, internal events (physiological and psychological) act always to modulate the ocular movements. The central point of our hypothesis is that ocular movements can be considered simultaneously as effectors of the central nervous system and starting points of the perceptual sequence. To understand this concept it is necessary to say that, for us, an important role for the organization of the perceptual input is played by the so-called "focal perceptual point." In fact, we hypothesized that the perceptual image is constructed by the nervous system using the perceptual stimuli (fragments of a total image) that are placed in correspondence with a particular focused point of the figure. This idea is grounded on the assumption that in perception the eyes focus not on a wide surface, i.e., planes, but on specific focal points.

In conclusion we hypothesized that, in perception of a reversible figure, the displacement of the eye toward different focal points of the figure involves different perceptual fragments that can represent the basis for the construction of two different cortical images. In other words, independently of the encephalic causal mechanisms (related to decision-making processes or to multistable systems), the perception of one of the two images of a reversible figure depends on ocular displacements that, in orienting the eyes toward one part of the figure, are determining the selection of the focal perceptual point. In this experiment we examined if this hypothesized process occurs when perceiving reversible figures in a particular condition: when the experimenter says to observe one specific image of the figure. The hypothesis was that there is a strong relation between movements of the eyes toward a specific area of the figure and the perception of a specific image. For example, if the eyes are oriented to the right part of the Ehrenstein figure, perception of a duck is present, while subjects perceive a hare when the eyes are oriented to the left part of the figure. *The displacements of the eyes toward a specific area of the figure are, we hypothesize, necessary for the perception of each image of all the reversible figures.*

## METHOD

### *Subjects*

The research participants were 32 women and 15 men, undergraduate students in psychology of ages 20 to 30 years. All subjects had normal vision (20/20).

*Apparatus and Procedure*

The stimuli presented were the Hill and Boring figure representing the images of a young girl and an old lady (Boring, 1960), the Ehrenstein figure representing the images of a duck and a hare (Ehrenstein, 1934), the Rubin figure representing the images of a profile and a cup (Rubin, 1915/1958), and the Schroeder figure representing the images of right and reverse stairs (Schroeder, 1858).

Ocular movements were observed using a videotape recorder (Philips vkr 6847). The stimuli (of dimensions $21 \times 30$ cm) randomly presented were placed at a distance of 164 cm from a subject who observed the figure while sitting on a chair with the head in a headrest.

The experimenter said to the subject, "Normally, people observing this figure see two different images. Are you able to observe the two images?" When the subject had responded positively, the following instructions were given: "Attend please to this figure. I will tell you to perceive specifically the images represented in this figure and you try to see that suggested image."

The videocamera was placed in front of the subject at a distance of 1 m to register ocular movements while the subject was observing the images of the figure designated by the experimenter. The experimenter gave the command to perceive each image of the figure fourfold, alternating randomly the command to perceive each one of the two images of the figure. For each subject we calculated the number of ocular displacements toward the four spatial directions after four suggestions to perceive each image present in the reversible figure.

In conclusion, for each suggested image, four possible directions of ocular movements might be present. On this basis we have constructed four ocular directional movement scores, toward right, left, up, and down. For example, for the reversible figure "old woman-young lady," for which subjects received in random order suggestions to see the young or the old woman, the score was constructed by calculating the number of ocular displacements toward each of the four spatial directions after each suggestion of an image.

## Results

In Table 1 are indicated the mean number (and the standard deviation) of ocular displacements scored for each spatial direction after each suggestion to perceive an image of the four reversible figures presented. In the same table the results of a one-way analysis of variance for repeated measures are indicated. The differences were statistically significant ($p < .01$) for all specified images. The ocular displacement toward one of the four spatial direc-

TABLE 1

MEANS AND STANDARD DEVIATIONS OF FREQUENCIES OF OCULAR MOVEMENT TOWARD DIFFERENT SPATIAL DIRECTIONS FOLLOWING SUGGESTIONS TO PERCEIVE SPECIFIC IMAGES OF REVERSIBLE FIGURES

| Figure/Image | Movement | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Right | | Left | | Up | | Down | |
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Hill and Boring | | | | | | | | |
| Old | 3.96 | 1.88 | 0.23 | 1.03 | | | | |
| Young | 0.04 | 0.29 | 3.89 | 1.97 | | | | |
| $F_{3,46}$* | 114.21 | | | | | | | |
| Schroeder | | | | | | | | |
| Right Stair | 1.51 | 2.17 | 2.04 | 2.32 | | | | |
| Reversed Stair | 1.96 | 2.20 | 0.72 | 1.72 | | | | |
| $F_{3,46}$† | 3.56 | | | | | | | |
| Ehrenstein | 0.15 | 0.55 | 3.72 | 1.98 | | | | |
| Duck | 3.66 | 1.95 | 0.21 | 0.81 | | | | |
| Hare | | | | | | | | |
| $F_{3,46}$* | 96.03 | | | | | | | |
| Rubin | | | | | | | | |
| Profile | 0.47 | 1.43 | 0.17 | 0.84 | 0.11 | 0.52 | 2.66 | 2.43 |
| Cup | 0.23 | 0.91 | 0.11 | 0.73 | 3.47 | 2.25 | 0.11 | 0.60 |
| $F_{3,46}$* | 41.45 | | | | | | | |

*Note.*—Analysis of variance for repeated measures: $*p < .0001$, $\dagger p < .01$.

tions was different for each suggested image. For the Ehrenstein figure the suggestion to perceive the duck was followed by ocular movements toward the left, while the suggestion to perceive the hare was followed by movements toward the right. For the Schroeder figure the perception of the right stair was related to movements toward the left and the reversed stair to movements toward the right. For the Rubin figure the suggestion to perceive the profile was followed by movements prevalently downward while the perception of the cup was related prevalently to movements upward. For the Hill and Boring figure the direction of the ocular displacement was toward the left for the young lady and toward the right for the old woman.

## DISCUSSION

Our results contradict many previous researches (Gregory, 1974; Flamm & Bergum, 1977) which have indicated no role for ocular movements in perception of reversible perspective figures. The data indicate that the induced perception of single images of each of the reversible figures was related to ocular movements toward the specific areas of the stimulus-figure. *We think that ocular movements are important in the selection of stimuli. Around these the subject organizes the perception of the whole figure (focal perceptual points)*. For example, the data indicate that to perceive the young lady focussing on the left upper area occured while in the perception of the old woman focus was on the right inferior area of the same figure. In our experiment the perception was induced by the experimenter, but we think that the phenomenon of the selection of specific focal perceptual points is present also in spontaneous reversing of these images related to supposed internal mechanisms of saturation or to so-called psychological unconscious motivations. All the internal mechanisms act, we hypothesize, in a conscious or unconscious way, moving the eyes toward specific focal points. This hypothesis is coherent with our concept of a circular relationship between the activity of the central nervous system and that of the sensory receptors at the periphery. In further research we will examine the role of ocular movements in spontaneous reversing.

## REFERENCES

ATTNEAVE, F. Multistability in perception. *Scientific American*, 1971, 225, 62-71.

BONAIUTO, P. Sulle ricerche psicologiche europee in tema di monotonia percettiva e motoria ("Sensory deprivation" e simili), Il processo della saturazione di qualità fenomeniche. *Kappa Roma*, 1969, 70-82.

BORING, E. G. A new ambiguous figure. *American Journal of Psychology*, 1930, 42, 80-88.

EHRENSTEIN, W. *Einfuehrung in die Ganzheit-psychologie*. Leipzig: Barth, 1934. Pp. 30-35.

ELLIS, N. R., WONG, J. H., & STARK, L. Absence of accommodation during perceptual reversal of Necker cubes. *Vision Research*, 1979, 19, 953-955.

FLAMM, L. E., & BERGUM, B. O. Reversible perspective figures and eye movements. *Perceptual and Motor Skills*, 1977, 44, 1015-1019.

GREGORY, R. L. Choosing a paradigm for perception. In E. C. Carterette & M. P. Friedman (Eds.), *Handbook of perception*: Vol. 1. *Historical and philosophical roots of perception*. New York: Academic Press, 1974. Pp. 263-266.

PETERSIK, T. Optical defocusing reverses perceptual organization. *Perception*, 1979, 8, 225-228.

RUBIN, E. Figure and ground. In D. C. Beardslee & M. Wertheimer (Eds.), *Readings in perception*. Princeton, NJ: Van Nostrand, 1958. Pp. 194-203. (Reprint)

RUGGIERI, V. On the hypothesized physiological correspondence between perceptual and imagery processes. *Perceptual and Motor Skills*, 1991, 73, 827-830.

RUGGIERI, V., & ALFIERI, G. The eyes in imagery and perceptual processes: first remarks. *Perceptual and Motor Skills*, 1992, 75, 287-290.

SCHROEDER, H. Ueber eine optische Inversion bei Betrachtung verkehrter, durch optische Vorrichtung entworfener, physischer Bilder. *Annales fuer Psychophysiologie und Chemie*, 1858, 181, 40-45.

*Accepted November 29, 1993.*