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THE RUNNING HORSE STOPS: THE HYPOTHETICAL ROLE OF THE EYES IN IMAGERY OF MOVEMENT[1]

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Summary.—To examine the hypothetical role of the eyes in visual mental imagery of movement 72 undergraduate women students in psychology were asked to imagine a running horse and then to produce the same mental image without moving the eyes and the head. In 59% of the subjects interesting modifications of the imagined movement appeared: 37% observed an inhibition of the movement and 19% an evident slowing up of the moving figure. The interpretation of this result was made by hypothesizing that the eyes are concretely involved in visual imagery processes.

The present research examined the role of the eyes in visual imagery exploring in particular the possible role of ocular movements in imagery of movement. The theoretical psychophysiological framework of this investigation considers that in perceptual and imaginative processes is present, independent of the intermediate physiological mechanisms, the same final event, i.e., the mental "representation." For example, I can perceive a visual stimulus placed in front of me or, closing my eyes, I can imaginatively recall, even if with some formal differences, substantially the same visual stimulus. In both cases I produce a mental representation. For a deeper analysis of the imagery processes, see Kosslyn (1994) who made some most interesting investigations in this field and also presented the critical questions and hypothesis. At first the author "will focus on the nature of the internal events that underlie with the mind's eye; the experience of imagery is a sign that the underlying brain events are taking place" (p. 3). About this last topic there is a wide literature (Farah, 1989b; Kosslyn, 1994) demonstrating that the brain activity of visual imagery is localized in the same areas as decodification of visual stimuli (posterior areas of the cerebral cortex). So the literature suggested a correspondence between visual perceptual events and visual imagery. My suggestion is that the correspondence between the two phenomena involves not only the cerebral cortex but also the eyes. About relationships of imagery and perception and their similarities there are interesting researches. For similarities between perception and visual imagery there is a wide psychological literature. Similarities refer to interactions between the two processes (Finke, 1980; Farah, 1989a; Ishai & Sagi, 1997) or to the encephalic structures producing perception and imagery, in particular the cortical Area 17 of visual perception decodification (Farah, 1989b; Kosslyn,

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1994) or to some formal aspects of the phenomenology of two events. Kosslyn observed that the inspection of a mental image is similar to the visual exploration of a scene. During imagery the "attention" focalizes different points of a mental represented scene as in "real" perception.

Kosslyn, Ball, and Reiser (1978) asked subjects to cover mentally the imagined map of an island; the linear function linking response times and distances would indicate the presence of analogies between real perception and imagery.

Our hypothesis suggests that imagery and perception are involved in not only the same encephalic but also in the same peripheral physiological structures, i.e., in visual imagery the eyes, of the perceptual processes. In other words, following this hypothesis, the only difference between perception and imagery would be in the initiation of the processes by the external environment in perception, self-evoked in imagery. Confirming this hypothesis, Ruggieri and Alfieri (1991) observed the same functional modifications of the crystalline lens in imagery and perception.

In particular, they observed that, through ecographic measurements, in imagining a "near stimulus" (subject imagined with closed eyes reading a word of a page of a book) the bending of the crystalline lens increases and reduces when the subject imagines a "far stimulus" (the subject imagined seeing a ship on the horizon). Why during imagery is present an accommodation of the crystalline lens present as in "actual perception"? Is it a biological behavior without any concrete functional role? What is the physiological meaning of the peripheral activity of the eyes during imagery? Only a functional redundancy? One of the possible interpretations of this phenomenon is that, during visual imagery, subjects are really seeing what they are imaging.

Other data go in the same direction. Previous researches showed interesting modifications of the "mental" imaginative activity by covering the eyes while subjects are imaging with open eyes (Ruggieri, 1991). For the majority of the subjects the mental image disappeared when only one of the two eyes was covered (35% for the right and 5% for the left).

In these subjects the mental image did not show any modifications when the contralateral eye was covered. Then, in 7% of the examined subjects a curious phenomenon was observed: by covering one eye subjects observed "half" of the mental image disappeared, i.e., a subject of this group, imaging a tree, observed by covering the right or the left eye, the disappearance, respectively, of the right or the left part of the tree.

Another aspect of the relationship between eyes and imagery was investigated (Ruggieri, 1994) by asking subjects to image with open eyes and, looking through a zoom lens, to project the mental image onto a white screen. While the subject was imaging, the experimenter moved the lever of

the zoom in the direction of an hypothetical enlargement. This movement evoked in a large number of subjects (35%) an unexpected enlargement of the mental image.

All the cited researches indicated that the eyes could play an important role in mental imagery. On the basis of those results it was hypothesized that during imagery, independently of the motivational mechanisms of starting (which we do not consider now) to produce a mental image, encephalic centers stimulate the retinal activity of the eyes. This activity, as in real perception, represents the basis of neural afferences that reach the cerebral cortex. In the cerebral cortex the process ends, producing a mental representation.

The present research explored the hypothetical involvement of ocular movements in mental images representing moving figures. Possible interactions between ocular movements and imaginative processes are suggested by Brandt and Stark (1997). During clinical experience with imagery manipulations in a "day dream" we observed occasionally an interesting phenomenon: asking a subject to image a running horse, the horse stopped when the subject blocked movements of the eye and head.

Naturally the ocular and head movements are employed in "perception" to "follow" perceptually a moving stimulus. So it was hypothesized that the inhibition of the movement of the stimulus during imagery could indicate that, as in real perception, ocular and head movements are involved also in mental representation of movement.

To confirm this hypothesis, it is necessary to examine the consistency of the phenomenon clinically observed. So the present investigation must be considered as a first report of a preliminary research which needs further work with a direct control of ocular and head movements.

The suggested set of the present investigation is very simple: subjects are asked to imagine a running horse under two conditions, the first sitting on chair while free moving without any postural restriction and the second without moving eyes and neck. In this first investigation we explored the phenomenon without any restraint, in the most natural fashion. Subjects had no headrest to help them to not move the head and neck. Only verbal control was given.

It is possible that the inhibition of the ocular movement is not completely present, but this fact could only reduce the consistency and the extension of the phenomenon.

About the movements of horse, it would be necessary say that these are always present only in the imaginative subjective introspection by subjects, but this is basic to their existence! Other so-called objective measurements could be considered to be correlated (with many possible contextual meanings), with a phenomenon whose presence is only subjective.

Method

Participants were 72 undergraduate women, students in psychology and between 20 and 30 years of age. Each subject sat in an armchair. To explore the phenomenon in the most natural fashion, in this first investigation a subject had no headrest to help her not to move the head and neck. Only verbal control was given. The instructions were "close your eyes; try to imagine a running horse which moves in your visual field from right to left or from left to right. As soon as you imagine the running horse say yes." After this first step, the experimenter asked subjects to image "the same running horse without moving the eyes, head, or neck and to report any change in mental image present with respect to the previous imaginative experience."

Results and Discussion

The classification of the very simple verbal responses did not require particular criteria for classification because they were easily placed into four categories: disappearing of the mental image, modifications of the movement of the figure, no modifications, and difficulties in visual imagery.

Four subjects (5.55%) had difficulty with the visual imagery. Forty-one subjects (59% ca) observed during the second experimental phase modifications of the movements of the imagined figure; for 27 subjects (37.5%) the horse stopped and for 14 subjects (19.44%) the horse moved more slowly. There were 20 subjects (27.77%) who observed a disappearing of the mental image, and seven subjects (9.72%) who observed no change in mental image between the two phases.

The present investigation must be considered as a preliminary report of a phenomenon observed in the clinical domain that requires further study using direct control of ocular movements. The suggested sets of the present investigation are very simple; subjects are asked to imagine a running horse in two conditions, the first without any postural restriction while sitting unrestricted in a chair and second without moving eyes and neck.

Asking subjects to imagine moving figures such as a running horse and then to inhibit the movements of the eyes and head, interesting modifications of imagery appeared. Present results confirmed the clinical observations; for a wide group of subjects (59%) interesting modification of the movement of the figure was present; for 37.4% the horse stopped, and for 19.4% moved more slowly. Also, 27% of the subjects observed a disappearing of the mental image.

The disappearing of the mental image could be interpreted considering a strong inhibitory effect of nonmoving eyes but could also be related to a relative weakness of the visual imagery process of this group of students.

Before we suggest interpretation of the results it is necessary to note that in the present investigation the inhibition of the movement of the eyes

and of the head was not objectively controlled so that it is possible that not all subjects produced the requested immobilization or produced it only partially. This possibility must be considered here and controlled in a further research. But the data are congruent with our hypothesis about the active role of the eyes in imagery and of the apparent structural physiological similarity between visual perception and visual imagery.

In the introduction to this paper we presented the experiments supporting the hypothesis that mental visual imagery is produced by a physiological mechanism linking the area of the cerebral cortex underlying decodification of visual perception stimuli to the activity of the eyes. The hypothesis suggested that the encephalon stimulates the eyes to produce retinal activity which, through neural afference reaches the cerebral cortex where the mental representation develops. The present results indicate that the eye movements may act, during imagery, in a way similar to that in the perception of so-called actual stimuli (Ruggieri, 1993). Eye-movements are important during perceptual processes to follow the spatial displacements of the stimulus. So it is possible to hypothesize that the same mechanism of eye movements could be utilized during imagery of a moving stimulus.

Another important aspect that must be considered in further research is the possibility that the immobilization of the imagined moving figure is strictly related to the inhibition of the movements of the eyes and the head or to the inhibition of movements of other body parts.

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