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Psycho-Physiological Hypothesis about Visual Mental Images Projection

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ABSTRACT

The investigation aims at analyzing some psychophysiological aspects concerning the visual projection phenomenon. We effectively define these aspects as the perception-like of a depictive mental image sent outside and localized in the external environment. This phenomenon has been studying in the literature on perception-imagery similarity and interaction. The similarity between these two processes poses some physiological questions that the current research aims at focusing on. We hypothesize that in the visual projection a physical component is present, probably consisting of weak electromagnetic waves (according to Bòkkon). The investigation consists of two studies; the first one, in which 31 participants (undergraduates students of Psychology, both male and female) were asked to imagine a lit candle and to send this image, with open and closed eyes, towards two white not reflecting panels placed at 90° to each other. Then, the participants were asked to send, initially with closed eyes, the same mental image towards two mutually reflecting mirrors, whose presence they were not aware of, placed in the same position of the panels. A second study repeats the same experiment but in the dark. The participants were 67, both males and females, undergraduates students of Theatre and Literature. As the results of both the experiments have showed, when the mental image was projected on the mutually reflective mirrors, a duplication or a multiplication of the subjective perception-like mental image appeared. This phenomenon did not appear sending the image toward the two not reflecting panels. The mental image projected on the mirrors would act in a similar way to a light beam generating an optical reflection phenomenon.

Introduction

The present research aims at examining the visual projection's phenomenon, which we effectively define as the perception-like experience of a depictive mental image sent outside and localized on some structures of the environment (eg. screens, objects, cards etc.) or in the free space. It is easy to observe, in pre-experimental experience, that the majority of subjects asked to send to the external space an imagined object, are able to do this. The mental image projected appears to the subject as an external object located in a wider context. The subject has a new perceptual-like experience of the mental image, which apparently would act as an "external visible event". Which are the physiological mechanisms of this type of experience?

In particular we will be investigating whether sending a mental image toward external objects with different physical structures, eg. paper, panels or reflective mirrors placed at 90° to each other, will cause specific changes in the image's form as it is subjectively perceived by the participants. The outside projection of a mental image could be considered similar to the projection of a film on a screen: the brain is the generator of the images sent to the outside world. However, the hypothetic similarity of the two processes (the physical-optic of the movie and the psycho-physiological projection of the brain) is difficult to uphold: while the images of the film are composed of electromagnetic waves, the mental images are considered abstract psychological events without physical substance.

We wonder what is the physiological mechanism, that allow a subject to perceive the projected image as localized in the external world. Does the "mental representation", which unifies in a unique context the perception of the external world and the outward projected mental image, take place only in the Brain? Or does the outward projected image produce electromagnetic waves like the other visual objects of the external world?

Only the person who produces the outward projected image can displayed it and this image is not visible by another person. We rather think that a phenomenon, which commonly exist in the subjective experience of persons must have a physiological ground. Moreover, we notice that many authors (see below), in examining some aspects of imagery, usually ask to the participants of their investigations to send visual mental images on external screens. However they do not consider the projection itself as a worth-studying phenomenon.

At first we try to analyze some physiological components of this complex phenomenon.

Sending a mental image towards a screen we have to direct our view towards it. In the case where the projection is oriented toward the shapeless stains of a card, as it happens in the Rorschach test (Bohm, 1969, italian translation), we can identify a sequence of physiological events. This sequence describes some complex interactions between the visual-perceptual system and the imagery. The specific psycho-physiological sequence is: 1) perception of a shapeless stain on a cardboard sheet, 2) cerebral representation of the stain, 3) its transformation into an image with a shape, and 4) projection of the image on the same card. At first the participant is asked to observe the shapeless stains of a cardboard sheet answering to the question: “what could be this?” (Bohm,1969, Italian translation, p. 37).

The shapeless stains stimulate the production of internal depictive images that the participant then projects on the same stains of the cardboard sheet. These stains thus assume a new well-defined form reproducing in some way the mental image. In fact the participant is asked to locate and to indicate on the cardboard sheet where the single elements of the new projected image are located. The subject punctually describes over the stain the projected imagine, as he/she perceive it. Does the new figure stand as an actual and real external stimulus, or does its representation take place only in the brain? In the light of current knowledge it is more likely that this is a purely cerebral process. But in our view the perceptual assumptions require a thorough experimental investigation.

The projection employed in researches dealing with imagery

We highlight that, though there is a lack of specific investigations about the physiology of projection, the phenomenon of projection has been used in order to analyse some aspects of the imagery, in particular some of its spatial characteristics (Thompson Hsiao and Kosslyn, 2011; Borst and Kosslyn ,2010; Slotnick and Kosslyn, 2005, Ling et al. (2013) Spivey and Geng (2001), Brandt and Starks (1997). However, the aforementioned authors have not payed any specific attention to the analysis of the projection per se! In these studies the subjects were usually asked to send their mental image toward distinct areas of external displays, underlining the presence of the substantial localization, in both a spatial and an external dimension, of the mental image. This assumption leads us to hypothesize that the projection structurally requires an active and specific physiological interaction with the external world. For example Thompson, Hsiao and Kosslyn (2011), in order to demonstrate that imagery and attention represent two distinct processes, asked participants to “visualize in an empty square on the computer screen mental images evoked by words representing objects” (p. 256). Moreover Borst and Kosslyn (2010), studying the individual differences in spatial imagery, asked participants, to memorize a configuration of four black dots (which act as a mental imaginative basis for the following comparison); then, they were asked to indicate if some arrows, which were actually external presented (according to the current perception), were oriented to point at one of the mentally memorized dots. The authors write in the procedure of the experiment: ” First we asked participants to study a pattern of dots (...) and then to draw to location of the dots from memory on a blank sheet of paper (p. 2034)”. It is evident that they are interested in the “new image scanning paradigm” (abstract’s citation p. 2031) in order to make a comparison between mental dimensions and real-concrete ones. Thus, the projection’s mechanism was implicit but it was not the real goal of the work, which was rather oriented to the analysis of the mental internal space. Furthermore, Slotnick, Thompson and Kosslyn (2005), in examining through magnetic resonance the correspondence between the early cerebral areas of visual perception and visual imagery, used in some way the mechanism of projection “asking participants to indicate if some of the targets (i.e. the red squared as perceived) were inside or outside the imagined stimulus”. Ling et al. (2013) in a paper with the title “the effect of perspective on perception of space and presence” investigated “how the sense of presence (defined as “the sense of being in one place or environment, when one is physically situated in another”) is affected by various aspects of the perspective when a subject is looking into a virtual world “through a screen” (p. 1)”. Here the subjects experience the sending of the mental construct of the “perspective” which they have internally elaborated (i.e. an imaginative construct) toward an external screen.

Visual projection as a special form of imagery

As the outward projection of visual mental image is a special form of the process of imagery, the analysis of this phenomenon is linked to the framework of neural functional similarity between imagery and perception (Kosslyn,1978; Farah,1989, Farah,1988; Farah et al. 1988; Finke and Kosslyn 1980; Finke,1980; Finke,1989; Finke,1985; Ganis,Thompson and Kosslyn, 2004 ; Ishay, A., and Sagi, D., 1995; Kosslyn, 1994; Kosslyn, Ganis and Thompson, 2001 ; Kossslyn and Thompson 2003 ; Kosslyn Ganis and Thompson,2003; Kosslyn, 1999; Kosslyn et al. 1996; Levine Warach Fahrah

1985 ; Li, Piech and Gilbert,2004; Mazard et al., 2004; Mechelli et al. 2004; Mellet et al. 1996; Nanai 2010; Paivio,1986; Slotnick Thompson and Kosslyn 2005, 2012 Segal and Fusella, 1970). The shared thought is that imagery and perception have a similar neural activity in the areas V1 and V2 of the cerebral cortex though with different commitment of some specific circuits (Mechelli et al. 2004).

The problem of the perceptual like imagery

The definition of imagery has two fundamental components: the similarity with perception and the absence of retinal input. Finke (1985) remarks: (p. 236) "what is most striking about mental imagery is how closely it seems to resemble to actual perception". The same author puts a fundamental question: "How can these apparent resemblances between imagery and perception be explained?".

Finke (1980) also argued: "the relationships between imagery and perception which have been clarified by experiments have shown that mental image of objects or events often have behavioral effects similar to those that occur when objects or events are actually observed" (p. 113).

Finke and Kosslyn (1980) demonstrated the similarity between perceptual and imagery processes also pointing out that during the imagery, as well as the perception, the visual acuity of the represented objects reduces when participants observed "the peripheral region of the visual field" (p.138). Thomas (1999, p. 207) speaks about "quasi perceptual experience

As for the absence of the retinal input, Ishai and Sagi, (1995, p. 1772) argued: “Visual imagery is the invention or the recreation of a perceptual experience in the absence of retinal input”; Broggin et al. (2012) referred to “(…) an internally conscious created visual experience in the absence of retinal input”.

Laeng and Suluvedt (2013), citing Edelman (2004) and Moulton and Kosslyn (2009), argue that “a mental image is a willed simulation of perception” and ask the following question: “ (....) is the brightness of mental image comparable to that of the actual scene?” (p. 1).

A more dynamic definition of imagery is given by Thompson, Hsiao and Kosslyn (2011): “Visual mental imagery involves creating, interpreting, and transforming visual internal representations seeing with the mind’s eye”... (p. 256)”. The issue above mentioned by Finke since 1985 has not received unequivocal and clear answers yet. Thus we wonder if the perceptual-like characteristic of imagery could involve not only the cerebral cortex but also the entire visual system, including the eyes. The dominant hypothesis is instead that the mind’s eyes can see the mental images (Kosslyn, Ganis and Thompson, 2001, p. 641; Slotnick, Thompson and Kosslyn,2012, p. 14; Pearson, Rademaker and Tong, 2011).

Thompson, Hsiao and Kosslyn (2001) said: ”Imagery in many way “stand in” for re-present a perceptual stimulus or situation (2001, p. 241)”. We agree with this statement, but we also widen it to involve the perception. We actually think that the similarity between perception and imagery is not only linked to the neural basis but especially to the fact that both phenomena have in common the production of the "depictive mental representations". Thus, we notice the ocular activity transforms the electromagnetic energy emitted by the external objects in neuronal bioelectrical activity, which generates at cortical level "depictive mental representation" of the object itself. There is no conscious visual perception without cortical representation. We underline that the external world (through perception) and the internal world (of pure imagery) are brought back to a unique structural code, which is that of the mental representations i.e. the images (Ruggieri, 2001). In both cases the cortical neural activity produces bioelectric activity; but what we are seeing in both cases are the effects of such activities, that are the depictive images. The representation of the perceived external object, which “stands for” the real object, becomes a component of a unique inner world, as it interact with the universe of the images in the Brain.

The mental visual images actually perceived, as well as the recalled images of previous visual perceptions and the new images of pure imagery activity, interact each other and with other modes of perception (trans modal perception). They are the basis of cognitive activities, under the transformative processes of brains (abstraction, etc.) (Ruggieri, 2010; 2011).

Interactions between imagery and perception

In order to give a response to these questions it would be interesting to study the similarities as well as the reciprocal interactions and interferences between imagery and perception. The Perky’s effect (1910) has showed that subjects, who saw dim facsimiles of objects before seeing “actual” objects, described the dim facsimiles (i.e. the previous mental images) rather then the actually perceived objects. Segal and Fusella (1970) observed that imagery reduces sensitivity for perceptual stimuli (visual or auditory). Ishai and Sagi (1995) using a “lateral masking paradigm” proved that “flanking visual mask facilitates detection of a visual task”(p.1). Nanay (2010) sustained the idea that when a subject perceives an object, which is partially hidden, he has a mental representation of the whole object through an interaction between the actual concrete perception and a pure holistic imaginative representation of the same object. Thus, we can wonder how and where, in the complex visual system, the neural interference or interaction takes place. Mechelli et al., 2004, gave a partial answer to this question by identifying the brain circuit that are activated in the perception and imagination of common objects such as faces, houses and chairs. As for the perception, they showed that the cerebral circuits start from the visual areas while for the imagination the circuits originate in the frontal cortex. They also said that “the extent of these patterns of activation is currently unknown” (p. 1256). They moreover spoke of mind’s eye (p. 1256).

Even if we can continue this discussion considering that mental images are seen by mind’s eyes, according to the leading hypothesis (Kosslyn, Ganis and Thompson, 2001, p.

641; Slotnick,Thompson and Kosslyn, 2012, p. 14; Pearson, Rademaker and Tong, 2011), this hypothesis does not exempt us from researching: 1. what are the physiological mechanisms that allow us to see with the mind's eyes and 2. what the mind's eyes " are seeing".

Bòkkon (2009) has made a very important contribution to the study of imagery. He identified the biochemical basis of neural activity of the cerebral areas V1 and V2 that would produce a luminescence phenomenon due to weak electromagnetic waves. These waves could form the physical structure of the depictive images that we are seeing during imagery.

Role of the oculomotor movements in some investigations about projecting imagery

It is evident that the participants, in order to send a mental image toward a defined spatial area thus making it subjectively visible, have to position the oculomotor activity (eye movements) toward the same area of the projecting image. Brandt and Stark observed (1997) that oculomotor movements, which were produced looking at a blank screen and imagining "a previous perceived "grid pattern", were similar to those produced looking at the original perception of the" grid pattern". Thus, even this research implies the use of oculomotor activity in the projection! Spivey and Geng (2001 p. 235) observed that the participants "while imagined or recalled objects that were not present in the visual display, spontaneous looked at particular blank region of space". They also underline that "(...) when people are imagining a complex event, they activate some of the perceptual motor mechanisms used for viewing the complex event" and suggest that "oculomotor" behavior responds to perceptually based spatial mental models that are computed during (...) mental representation" (p. 237).

Johnsson et al. (2012), Johansson, Holsanowa and Holmqvist (2006), shared with those authors the same opinion. They pointed out that the patterns of eye movements were similar in watching a pictures or recalling them imaginatively in light or in darkness. The researches of Laeng and Teodorescu (2002, 2001) led to the same conclusion, underlining that "eye scanpaths during visual imagery reenact those of perception of the same visual scene and that play a functional role "(2001 abstract citation p. 1). Going back to the oculomotor-imagery relationship, we have to face the problem of the lack of the physical components of the image, already mentioned in the title of Spivey and Geng's paper (2001): "Oculomotor mechanisms activated by imagery and memory: Eye movements to absent object". Starting from the idea that there are not "objects" to see, the oculomotor activity could be considered as a useless redundancy, a sort of epiphenomenon. For some authors (Spivey and Geng 2001; Johansson et al., 2012) it could have the role of generating, in a reflex way, some mental images.

In a discussion with Ferreira et al. (2008), Richardson et al. (2009, p.1) underline that "when subjects memorize a specifically located object of a visual scene and then are asked to recall the memorized scene looking at a blank screen (i.e at an empty external space) the gaze of the "subjects would return to the location where the objects had been". The authors interpreted the recalling of spatial localization through the concept of "spatial index" "that would be part of the memory representation" (p. 1).

Other components of the visual system involved in imagery

We want to remind that the similarity between visual imagery and visual perception lays in the subjective perceptual–like experience and in the physiological activation of the same cerebral areas (frontal-parietal and occipito-temporal regions even if involving some different cerebral circuits) (Kosslyn, Thomson and Ganis 2012 p. 20; 2006; Mazard et al. 2004) as well as in other components of the physiological visual system. We notice that the main components of this system are: the eyes' movements, the pupil, the crystalline lens and in some way the retina.

Indeed Laeng and Suluvedt (2013) demonstrated that the subjects dilated or constricted the diameter of the pupil when they were imagining respectively a "dark room" or a "sunny sky" like in real perception. Ruggieri and Alfieri (1994) showed, through an ecographic measurement system, that participants asked to imagine reading a phrases of a book close to them or seeing a ship far on the horizon, have modified the bending radius of the crystalline lens producing a physiological "accommodation" identical to that of visual perception for close and far perceiving objects. These findings are coherent with Kosslyn, Ganis and Thompson (2012) opinion that claims "Imagery not only engages the motor system but also affects the body, much as can actual perceptual experience" (p. 641).

What is the physiological function of so manifold anatomic-physiological and peripheral components of the visual system during imagery? Are the eyes' activities oriented only to see "nothing" (i.e. absence of images)? Or have they just a reflex generating role that link the orientation of eyes toward a well-defined external space with the mental image (Spivey and Geng 2001)? We hypothesize **some jet undiscovered** physiological connections between the neurological perceptual afferent and motor efferent pathways of the visual system that act as a sort of physiological bridge in imagery production. Could the retina have this role of bridge?

Some experimental evidences

Some findings could suggest a positive answer. Ruggieri (1991) observed particular forms of interactions between imagery and perception. Subjects were asked to imagine with open eyes, looking at a white screen through the holes of two cylindrical viewing tubes. As they signaled the presence of a vivid image, the hole of one of the two tubes was occluded (the right or the left) so that the corresponding eye was suddenly in the dark, while the contralateral one continued seeing the illuminated screen.

The experience of imagery was then repeated occluding only the hole of the contralateral eye. The occlusion of one of the tube, generating an abrupt darkness in one of the eye, determines a variation of the retinal input, thus interfering with the vision of the mental image, which disappeared.

Surprisingly the disappearing of the mental image took place in about the 50% of the subjects only by covering the right eye and in the 9% only by covering only the left one; the 17% lost the image when both the right and the left eyes were covered separately. Further unexpected result was a 7% of subjects who experienced, when each eye was covered, “a loss of one part of the image, the right or left part of the image corresponding to the right or left covered eye” (p. 828).

However, these results suggest that there is a functional relationship between the eyes and imagery, and there are interesting individual differences! The most interesting result we have to explain concerns to the reason why the majority of participants observed the loss of the mental image covering only one eye, while obscuring the other eye (the contralateral one) in most cases the mental image does not disappear. Perhaps the eye which was obscured and lost the image was committed to the imagery-visual process; while the other eye, though obscured, does not lose the image because it is not committed to the imaginative vision supported only by the other eye

However, there are individual differences.

Could we assume that, in the relationship between imagery and perception, in a large number of cases, the two eyes carry out different functions?

Pending further and further investigation we can believe that while one eye focuses on the mental image, the other one keeps the visual-perceptual contact with the external environment. In every day life it often happens that while two people are speaking to each other, thus visually perceiving, at the same time they have some mental images referring to imaginative contexts different from the current one. The visual perception and the visual images coexist. While a person perceives the external environment can simultaneously develop visually other images!

Ruggieri (1999) showed that asking participants to imagine a running horse and later, as they continued to imagine, to block any movement of the eyes and the head, the 40% noticed the mental image disappearing and as many as the 59% of the participants observed either the horse immobilization (37%) (as the running horse stopped) or a marked slowdown of the moving figures (as the horse was moving on a treadmill) (19%). Spivey and Geng (2001) cite this research rejecting "the functional role of the eyes in imagery, sustained that eye movements are purely reflexive" (p. 237). We will try to better understand what the authors mean by "pure reflexive" and by the following request: "(...) thus, it that may be the case eye movement reserved respond to imagery but imagery does not respond to eye movements "(p. 237).

We definitely agree with them when they emphasize the following automatism: the eyes follow the movement like the mental image moving in space, like a real object that moves in real space. Perceiving a moving object, the eyes themselves move following the movement of the object. If in everyday perception we stop the eyes and the head’s mobility, it becomes difficult or impossible to allow visually the moving object. The hypothesis of a “spatial index” suggested by Spivey and Geng (2001), which would be useful when a memorized mental image is recalled, is useless in a research considering the eyes that actually follow the mental image of a moving horse. The inhibition of ocular movements slows down or stops the movement (in the 59%): the effect refers only to the movement of the imagined figure and not to the figure itself, that does not disappear. If the subject imagines a moving object with the eyes’ movements, we are led to believe that the subject "sees" through the eyes even the images. But this hypothesis clashes with the shared knowledge about the absence of retinal input during the imagery.

Another experiment (Ruggieri, 1994) drives us to discuss the potential role of the eyes in imagery. The participants were asked, after placing a zoom lens before their eyes, to imagine with open eyes and to project the mental image through the lens onto a white screen. While the participant was imaging, the experimenter moved suddenly and silently the lever of the zoom, thus modifying the focal length of the lens in the direction of an enlargement of an hypothetical visual stimulus. The participants did not know the existence of the lever nor were conscious of the action of the experimenter. After moving the lever, the most surprising result is that as many as 37% of subjects observed a sudden and significant mental image magnification and enlargement as if a zoom lens acted on real perceptual stimuli. Many participants of this group observed “an enlargement of some detail of the imagined figure with disappearance of the other part of the image as it occurs in real perception after the movement of a zoom lens oriented toward a real stimulus” (p. 453).

How can we explain this phenomenon that is present in a high number of subjects? The enlargement of the image was produced by a zoom lens placed before the eyes; the appearing of the greatly enlarged image was sudden, unexpected and surprising. The subjects had not time enough for a cognitive cortical elaboration. We wonder how the zoom lens act here if we assume that the mental image is only a cerebral event and it was not made up by a path of light rays emitted by the subjects.

The present research aims at answering these questions according to a physiological reasoning linked to the results of the Bòkkon investigations (2009). His researches have radically changed some concepts of brain functioning by opening new horizons to the understanding of the visual imagery and perceptual processes. The author says (Bòkkon, 2009 p.1): ”we put forward a redox molecular hypothesis about visual imagery and perception. Namely the retinal converts photon signal from the external visual world into electrical signals that carried to the striate cortex by the optic nerve. This retinotopic electrical information can be converted into regulated biophoton signals by mitocondrial redox processes that made it possible to create intrinsic pictures in retinotopically organized cytochrome oxidase-rich visual areas during visual imagery and visual perception". In other words, what we see in imagery could be the form taken by the biophotons emitted from the bioluminescent process of neurons that produce visible phosphenes".

Wang et al., (2011), also citing Sun et al. (2010), indicate the different definitions of ultraweak biophoton emissions (p. 1): "This ultraweak photon emission biological systems are ultraweak electromagnetic waves in the optical range of the spectrum. The spontaneous photon emissions are known by many names including biophotons, low intensity chemioluminescence, dark luminescence, electromagnetic light, ultraweak autoluminescence and ultra weak photons. (They) cannot be seen by the naked eye but can measured by very sensitive instruments such as photomultiplier tube (PMT) or an electron multiplier CCD (EM-CCD) camera as well by in situ biophoton autography". In other words Bòkkon argues that what we "see" in imagery are the photons emitted by the neurons of the cortical areas V1 and V2. He suggests the existence of an actual physical substrate which indicates the transition from neuronal bioelectrical to building a depictive image" (Dotta, Saroka, Persinger, 2012, p?). Following both these authors and Wang et al. (2011) that observed the bioluminescence phenomenon in the imagery also in the retina, we hypothesize that the eyes emit light rays but not visible by the naked eye and in the dark.

Some General Hypothesis about visual projection

Starting from the assumption that some peripheral parts of the visual system, including the retina, are also involved in projection, we hypothesize that the mental images are processed in the brain in form of weak electromagnetic waves and they are sent through the eyes into the external environment.

In particular we hypothesize two different responses projecting the image towards both screens, made up of two mutually reflecting mirrors that where placed with respect one to another at 90°, and towards two non-reflective white cards placed on the same place of the mirrors. If the projected image is constituted by ultraweak electromagnetic waves, it could be multiplied or doubled by the mirrors rather than by the white cards.

The brain then would act as a film projector and the projected image, not visible by naked eye, would take place in the external world.

Previous control of the presence of the optical reflection effect between the two mirrors effect in a pre-experimental phase

Before starting the experiment, we sent a bright red beam of a torch (Laser Diode) towards both the two panels and the two mirrors, in order to verify if, unlike the white cartons, the two mirrors are, for their position, really reflective The beam sent towards the white panels has produced only a single bright spot of 2mm in diameter placed respectively: between the two panels fixed at 90° to each other; or at one of the two panels. The beam sent towards the mirrors placed in the same positions has determined a duplication or multiplication of the spot (Fig. 1A and1B; Fig.2ABC)..

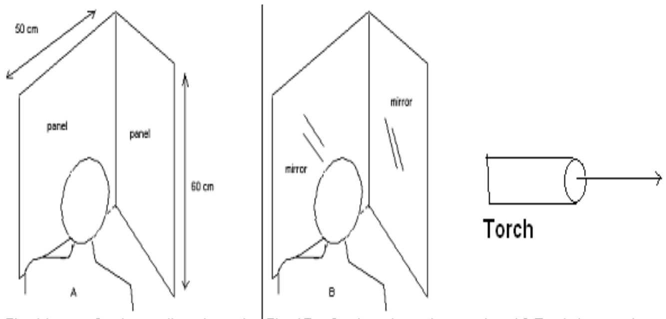

Fig. 1A not reflective cardboard panels | Fig. 1B reflective mirrors (see text) 1C Torch (see text)

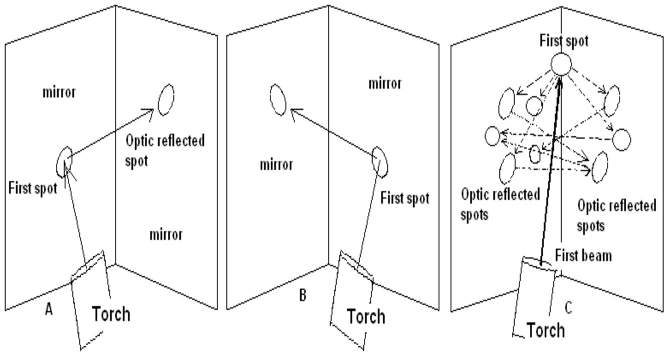

Fig. 2A, B, C: Physical optical reflection phenomenon was observed sending a laser light of a torch towards the area between the mirrors (2C) and toward one of the mirrors (2A and 2B) obtaining, respectively, a multiplication and duplication spots. The beam of light was send by the research before performing the experiments with subjects.

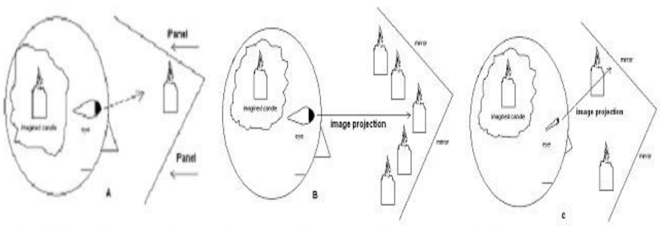

Fig 3 Visual imagery observed after sending mental image toward white no reflecting panels (A) and after sending toward mirrors (B, C). In B and C a physical refleting like phenomenon appeared.

Our research will be performed twice with two different groups of subjects, each of them with different cultural orientations: the first one is composed by students of psychology; the second one by students of literature. In both the experiments we have examined the phenomenon of projection with both eyes open and eyes closed. In the second we have added the condition "in the dark".

Moreover we have to face the problem of the suggestion effect. In order to avoid this inconvenience, we have built the first experiment so that initially the participants are invited to send the mental image with open eyes toward the two white panels placed at 90° to each other. The panels covered the mirrors of the same sizes. Then the subjects are asked to close their eyes and to send the mental image towards the same structure. In the meantime, the experimenter removes the panels in such a way that the subject sends the image toward the mutually reflecting mirrors, with no awareness of their presence.

In the second experiment each participant send the mental image towards the mirrors also in the dark. In this case as well, the participants are not aware of the presence of the mirrors. They consciously have seen the mirrors only in the second step (see procedure).

Moreover, as the mental images are fragile and fleeting and the participants not always focus on them with full awareness, it is necessary to pay attention to specify some alternatives in order to detect the possible presence of the reflecting phenomenon in the context of multiple responses. This kind of procedure is applied in sending the image to the white cards as well as to the mirrors.

Experiment n. 1.

According to discussion we have broadly explained in the introduction, we can make the following hypothesis: if we ask participants to send a mental image towards screens, that are put on the external environment and placed at 90° to each other (see figure 1B), the participant themselves locates the image on the screens. In the case of mutually reflecting mirrors the subject observe the optical effect of duplication or multiplication of the image; this phenomenon does not appear if the image is sent to the white cards. We also argue that the projection phenomenon takes place even if the participant has his eyes closed.

This experiment was composed of four phases. In the first two, the participants were asked to project a mental image (a burning candle) to screens consisting of not reflective cardboard panels in two situations: 1. (a) with eyes open 2.(b) with closed eyes; in the last two phases they were asked to project the mental image on screens consisting of reflecting mirrors in two different situations: 3. (c) with closed eyes and 4.(d) with open eyes. We want to stress that in phase 3, as the participants begin with the eyes closed, they are unaware that the screens to which they are invited to send the mental image are mirrors.

Participants

There were 31 participants, 6 males and 25 females, undergraduate Psychology students aged 25 SD 2.5.

They were generically informed the research dealt with mental image projection and they agree to participate signing a form of informed consent. They were also informed that they could terminate the experiment at any time.

Apparatus

The apparatus is composed of two white not reflective cardboard panels (Fig 1A), size 50x60 cm, placed at 90° to each other, forming a dihedral angle rectum and positioned on a table in front of the subject, at the height of 80 cm from the floor. The white panels cover two mirrors (Fig 1B) of equal size and relative position, which will be discovered only in phase 3, after removing the white panels without the participants being aware of this.

Procedure

All participants had a vision of 10/10 (with or without correction with glasses).

They were seated on a height-adjustable chair in front of the panels with their head resting on height-adjustable head restraints at a distance of 50 cm from the corner formed by the two panels placed on the table

Phase 1. (looking at the panels with open eyes). The participants were asked to imagine, with open eyes, a burning candle. In case they responded positively the investigator added: "If you look at those panels placed on the table in front of you, can you send to them the mental picture and tell us what you are seeing, specifying any changes of the mental image like shape, size, number of images, or color?”. Then the experimenter argues:

“Please, let us know how vivid is the image you are seeing on a scale from zero to then”.

Results of the first experiment

Our results show that by sending a mental image towards two types of screens (the first one composed of two white board cards placed at 90° to each other; and the second one composed of two mirrors placed in the same position of the cards and therefore mutually reflective) the participants had two different response modes. As indicated in tab.1, we notice that after sending the mental image towards the white panels, with both open and closed eyes, all participants had the perception of a single mental image located on the panels. A large number of participants reported to have a perception-like duplication or multiplication of the image projected and located on the mirrors. We call this phenomenon “optical reflection-like phenomenon”. The number of participants to each phase observing this phenomenon is indicated in tab.1.

		Panels (in the light)		Mirror (in the light)		Totals	DF	p-value
		Eyes		Eyes				
First experiment	physical optical imaginative reflection-like	Open	Closed	Closed	Open			
	Yes	0	0	23	18	41		
	No	31	31	8	13	83		
	Totals	**31**	**31**	**31**	**31**	**124**	**3**	**<,0001**

Tab.1 Number of participants who stated a like-perception of duplication or multiplication of the mental image sent towards the panels and mirrors in the four phase of the experiment. Freedman test Chi Square 31.335, DF 3, p<.0001; Chi Square corrected for ties 51.126 p<.0001.

The difference among the four phases is statistically significant: Freedman test Chi Square 31.335, DF 3, p<.0001; Chi square corrected for ties 51.126 p< .0001. In particular:

Phase 1. (toward panels with open eyes): all participants were able to imagine a burning candle and after sending this image toward the panels they saw the image as localized on the panels (in the corner between them, or on one of the two.

No modifications of the projected image appeared. Vividness of the image mean value= 5.7 Sd 1.

Phase 2. (toward Panels with closed eyes): the participants showed the same results as in the previous phase. Vividness of the projected image mean value = 6.2 SD 2.0

Phase 3 (toward mirrors with closed eyes): 23 participants (74.19%) observed a duplication or multiplication of the projected mental image. Vividness of the projected image m= 5.7 Sd 2.1.

Phase 4. (toward mirrors with open eyes): 18 participants (58%) observed a duplication or a multiplication of the projected image..

Vividness of the projected image mean value = 5.3 SD 2.6

The vividness among the four phases did not show statistically significant differences (One way Anova F 1.77 DF3, 30, p<.157).

Also between the two situations "mirrors with closed and open eyes" there are no statistically significant differences.

Comments

Our results, which require further verification, seem to confirm the hypothesis that the sending of a mental image toward mutually reflecting mirrors undergoes changes similar to those that are generated by the same mirrors on an actual and real beam. Though we gave the same instructions for panels and mirrors, it is important to underline that the phenomenon of the optical reflection-like did not appear in any of the participants when the mental image was directed towards the panels.

The mirrors, as they produce a duplication or multiplication of the image, act according to the principles of optical physics reflecting the electromagnetic waves. In case of projected images, could we consider them as weak electromagnetic waves (Bòkkon 2009) and could we interpret this effect in projection by assuming that the mental image acts similarly to the image of a slide sent on a screen by a projector? About the suggestion effect, though always possible, we have pointed out that for the way the experiment was built (i.e. four identical independent phases with identical instructions) the participants, in the phase of the mirrors, initially with closed eyes were unaware of the presence of mirrors thinking of sending the image to the white panels.

It is interesting to underline that the participants often showed signs of surprise at seeing the mirrors in the transition from closed to open eyes, that is, from phase 3 to phase 4. However, a question, not easy to face with, remains to be answered: why is the projected image in both situations (panels or mirrors) viewed only by the participants who produce it and not by other subjects?

Moreover, we consider it necessary to repeat the experiment using a wider sample. In further investigations it will be essential to value objectively whether the orientation of the gaze is directed towards one of the mirrors or in the space between the two mirrors, so as to better define the relationship between the spatial orientation and the effects respectively of duplication and of multiplication of the projected image.

Experiment 2.

This experiment, though based on the same assumptions as the previous one, has two more phases "in the dark with eyes closed and open". Moving from the phase "towards panels with closed eyes" to the phase "towards mirrors in the dark with closed eyes" without ever opening the eyes, the participants, unaware of the presence of mirrors, are sure of sending the mental image towards the panels.

Subjects

The research participants were 67, 14 males and 53 female, of age 25.567, sd 2.824, undergraduates students of Literature and Theatre.

They were generically informed the research dealt with mental image projection and they agree to participate signing a form of informed consent. They were also informed that they could terminate the experiment at any time.

Apparatus and procedure

The "apparatus" and the "procedure" were the same as explained in Experiment 1, except for one important addition, represented by the building around the "subject and panels - mirrors" complex, of a movable black cabinet, sized 180 x170x170 cm, thus creating a condition of total darkness for both "eyes closed" and "open eyes" situations. Therefore, in this new research the situations differ between dark and ambient light. So the phases were: 1. Panels in the light with open eyes, 2. Panels in the light with closed eyes, 3. Panels in the dark with closed eyes, 4. Panels in the dark with open eyes, 5. Mirrors in the dark with closed eyes, 6. Mirrors in the dark open eyes, 7. Mirrors in the light with closed eyes, 8. Mirrors in the light with open eyes. The situations were not randomized because the subject had to maintain their eyes closed in the transition from the ambient light to the darkness of the black box, without being aware of the presence of the mirrors.

RESULTS

The number of participants that observed a duplication or the multiplication of the projected image in each of the 8 phases is indicate in table 2. As we can see, the phenomenon of duplication or multiplication of the projected image in the external environment appears only sending the mental image on the mirrors and not on the white panels.

	Panels (in the light)		Panels (in the dark)		Mirror (in the dark)		Mirror (in the light)				
	eyes		eyes		eye		Eyes			DF	p- value
	Open	Closed	Closed	Open	Closed	Open	Closed	Open	Totals		
Yes	0	0	0	0	33	22	7	29	90		
No	67	67	67	67	34	45	60	38	446		
Totals	67	67	67	67	67	67	67	67	536	7	<,0001

Table 2 Number of participants that for each phase presented the phenomenon of duplication or multiplication of the projected mental image. Freedman Chi Square 55,463, DF 7, p<.0001

Among the 8 phases there is an high statistically significant difference (Freedman Chi Square 55,463, DF 7, p<.0001).

Observing analytically each phase we have founded that the phenomenon appeared: in the phase “mirror with closed eyes in the dark ” in 33 Ss (49.25%); in the phase ”mirror dark with open eyes” in 22 Ss (32.83%). Between the two phases there is not any statistically significant difference (Wilcoxon Test: Z-Value –1.724, p>.084).

In the phase “mirror-light-closed eyes” the optical phenomenon appeared only in 7 Ss (10.44%) and in the phase “mirror-light open eyes” in 29 Ss (41.79%). Between the two situation there is a statistically significant difference (Wilcoxon Test: Z - Value –3.292, p<.001).

Significant difference also appeared between “Mirror-dark closed eyes” and Mirror-light closed eyes” (Wilcoxon Test: Z-Value –4,292, p<.0001). Between “Mirror-dark open eyes and Mirror-light open eyes” the difference is not statistically significant (Wilcoxon Test: Z-Value –1.071, p<.284).

Discussion

The second experiment seems to confirm the results of the first one. In fact, even in participants with different cultural orientation, the sending of a mental image towards the mirrors determines a multiplication-duplication of mental representation (perception-like) of the projected mental image. However, a significant reduction in the number of subjects, which observe a duplication-multiplication of the image in the sending on mirrors with closed eyes in ambient light, emerges in this context. The significant reduction may be probably due to the visual shock caused by the transition from dark to light which takes place also through the closed eyelids. Such a shock may have determined inhibitory mental image interference. However, in opening again the eyes in light situation, the number of subjects that observe the phenomenon of the image duplication- multiplication increase. We consider these as first results that require further investigation.

DISCUSSION AND COMMENT

In these searches we have started from the assumption that the visual projection’s phenomenon, which consists in sending a mental image towards the external environment and to perceive it subjectively as one stimulus-event located outside, should have a well-identifiable physiological basis. Numerous authors, such as Finke (1980, 1985) and Finke and Kosslyn (1985) and others mentioned in the introduction, have stressed the substantial neural perceptual similarity of mental representations (images of external objects) produced in the brain by the perception and those ones produced in the same brain areas from the pure imaginative process. From a physiological point of view, while it is well known that a person transforms into visual depictive images the electromagnetic waves emitted by external objects, in the case of imaging it is not recognized a physiological equivalent of the electromagnetic waves nor any physiological component is supposed to be. The imaging is considered an abstract mental process without physical substance, as “seen only through the eyes of the mind”.

Nevertheless, both our research has shown that in many subjects sending mental images to screens placed in an external space induce a subjective perception of the projected image. This image is modified in relation to the physical layout of the screen, be it reflecting or non-reflecting. In fact, the sending of a mental image on mutually reflecting mirrors produces a duplication or multiplication of the projected mental image subjectively perceived; while sending the same image to the non-reflective screens this phenomenon does not occur. To explain this phenomenon we do use the hypothesis of Bòkkon (2009), according to which both brain neurons and the retina produce the luminescence phenomenon constituted by the formation of weak electromagnetic waves generated by biochemical neural activity. In fact, we link the hypothesis of Bòkkon to numerous investigations (see introduction) that sustained that in imagery are also involved, in addition to the cerebral cortex, other parts of the visual system (oculomotor apparatus, the crystalline lens, the pupil and the retina).

This hypothesis may also explain the physiological mechanism concerning the results of a previous research (Ruggieri, 1994), in which subjects looking through a zoom lens placed before their eyes sent a mental image toward a screen. Then they observed a sudden and surprising enlargement of projected image when the experimenter moved the zoom lever. Could the zoom determining the magnification of the image act on the weak electromagnetic waves, which were not visible to the naked eye coming out from the imaging eyes?

In conclusion, according to the results of our research and to the related psychophysiological argument, it is possible that in the visual projection, eyes emit weak electromagnetic waves in the external environment. These waves underwent some changes similar to those described by optical physics as regard to the electromagnetic waves emitted from external objects. Thus, the visual projection could be considered as similar as that of a film projector that sends images on a screen: the brain would produce the mental images that are sent outside through the retina.

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