TECHNICAL NOTE

Brain Activities in a Skilled versus a Novice Artist: An fMRI Study

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ABSTRACT

Functional Magnetic Resonance Imaging (fMRI) scans of a skilled portrait artist and of a non-artist were made as each drew a series of faces. There was a discernible increase in blood flow in the right-posterior parietal region of the brain for both the artist and non-artist during the task, a site normally associated with facial perception and processing. However, the level of activation appeared lower in the expert than in the novice, suggesting that a skilled artist may process facial information more efficiently. In addition, the skilled artist showed greater activation in the right frontal area of the brain than did the novice, which the author posits indicates that such an artist uses "higher-order" cognitive functions, such as the formation of associations and planning motor movements, when viewing and drawing a face.

This paper and the following paper by Chris Miall and John Tchalenko report on a project that was undertaken to study the physiological and psychological functions of a leading British portrait artist, Humphrey Ocean, as he rendered a drawing. In one study, conducted by myself and my associates then at Stanford University, functional Magnetic Resonance Imaging (fMRI) scans were taken of Ocean's brain as he sketched drawings of faces; in another study, conducted by Miall of the University of Oxford and Tchalenko of Camberwell College of Arts, the same artist's eye and hand movements were monitored as he drew a sketch of a model. In both instances, Ocean's brain and eye/hand movements were contrasted with those of novice artists.

In the brain scan procedure, the artist showed activation of an area of the brain that is implicated in facial processing; somewhat surprisingly, however, his activity level appeared to be less than that of the novice. Also, it appeared that the artist engaged parts of the brain that dealt with "higher order cognition."

In the eye movement procedure, Miall and Tchalenko found that the fixations of the artist while drawing were twice the duration of those when he was not, and that his patterns of cerebral activity (and other patterns) differed from those of novice painters. Other differences were noted between Ocean's hand movements and those of novice artists.

Taken together, these results shed important insights into the cerebral, visual and motor performance of a professional artist. These initial findings suggest that an important methodology in studying artists may include brain scanning technology as well as the measurement of hand-eye movements.

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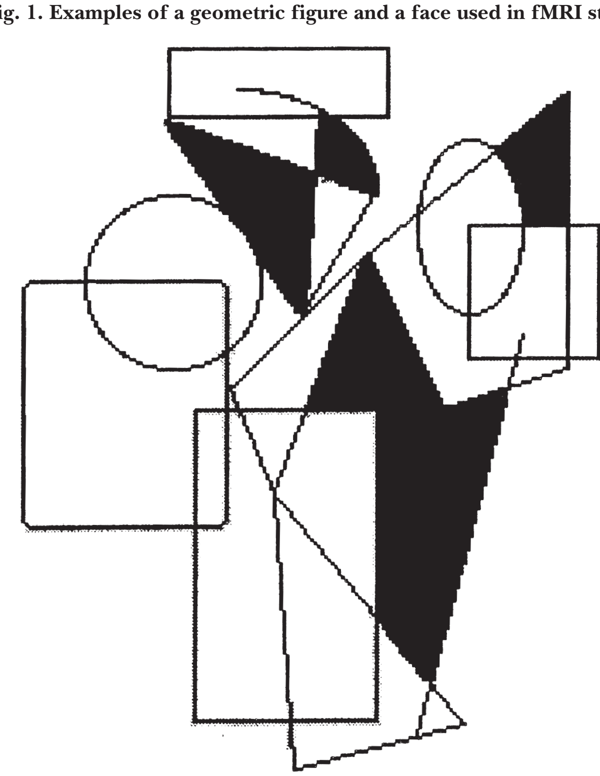
Fig. 1. Examples of a geometric figure and a face used in fMRI study. (© Robert Solso)



(a)

(b)

The Painter's Brain-Eye-Hand

Experts in any field of endeavor, be it mathematics, music, sports or art, demonstrate skills that are markedly different from those of novices [1]. Underlying these performance differences are the neurological structures and processes that contribute to these special talents.

fMRI Technology

Recently, the evaluation of brain functions by means of Positron Emission Topography (PET) and functional Magnetic Resonance Imaging (fMRI), in addition to other methods, has greatly expanded our knowledge of the links between cerebral activities and mental events. Yet, because of the massive instrumentation involved in current imaging devices and the restrictive surroundings required, the range of experimental studies of specialized activities (such as drawing a portrait) has been limited.

Previous imaging research (both fMRI and PET) has shown that specific cortical regions are implicated when a person views an object [2], attends to color stimuli [3], processes words semantically [4], uses working memory [5] or is involved in a number of different cognitive processes. These methods involve measuring changes in blood flow and are appropriate for assessing both the structural sites and the functional processes involved in cognitive tasks.

Brain Imaging and Skilled Performance

We found that it was possible to use an MRI scanner, only slightly modified, to gather information about the brain activity of a skilled artist as he drew several portraits.

In developing a strategy for interfacing fMRI measures of brain activity and an artist performing a specialized act, a single case was considered. Here, a detailed measure of the brain activity of a portrait artist contrasted with the brain activity of a non-artist. While generalizations to all artists or even all portrait artists must be made with caution, it was possible to obtain a cerebral image of a contemporary artist as he attended to and sketched faces. These data could serve as a reference point for longitudinal studies that could give insight into the influence of environmental factors versus genetic influences on expertise [6].

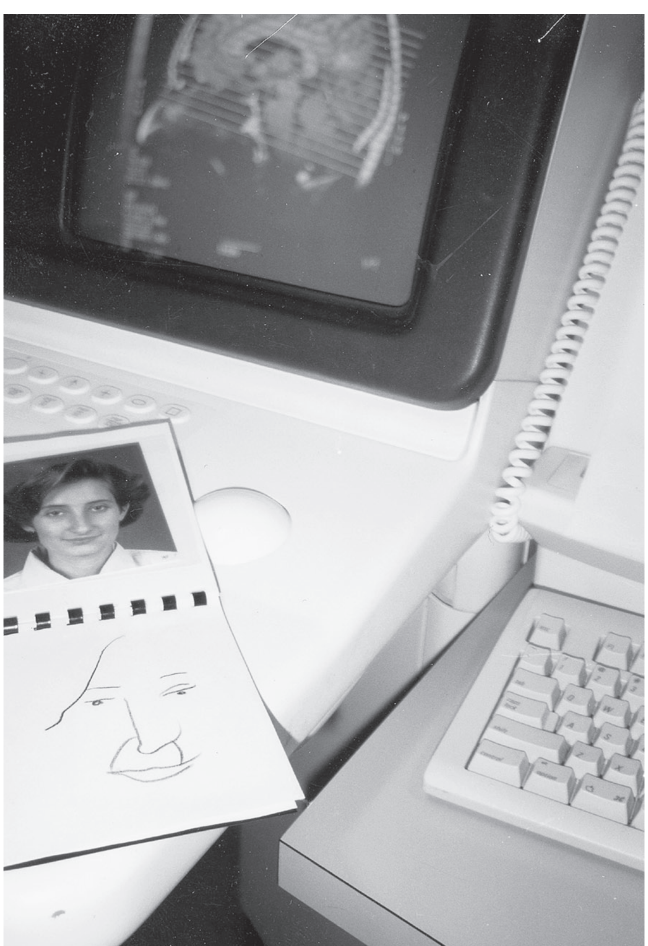


Fig. 2. Photograph showing sketch made by Humphrey Ocean during fMRI measurement and the computer setup. (Photo © Robert Solso. Sketch © Humphrey Ocean.)

Facial Perception

Specific work has addressed facial perception and hemispheric lateralization in humans [7]. Some studies are based, in part, on a type of visual agnosia, called prosopagnosia, in which patients exhibit the inability to recognize or differentiate among faces even though other visual objects may be correctly identified. Facial perception seems to be located in the right hemisphere, and case reports suggest that damage in the occipital regions and posterior parts of the medial temporal cortex affects facial recognition. In another case study [8] it was found that the more anterior regions of the right fusiform gyrus were involved in linking a particular facial representation to biographical information about the face. When a human being views a face, it is likely that a certain number of specific cortical cells are activated in the right hemisphere. Because facial perception is a complex phenomenon that engages memory (e.g. remembering what is the person's name, how it is pronounced, who he is, what is his relationship to the viewer and so on), motor centers and associative areas, complete analysis of faces engages many cerebral sites.

There are broader implications for the interest in facial recognition. The ability to recognize faces and comprehend the attributes of the person behind the face—determining whether he is friendly or threatening, for example—is adaptively important and has profound implications for social action and communication. The "reading of faces" and the emotions expressed therein may have provided information critical to the survival of the species throughout the evolutionary history of humankind.

In the case of portrait artists who are accustomed to perceiving faces professionally, we ask, what regions of the brain are normally associated with facial perception and to what degree? In addition, are other regions of the artist's brain activated that may reflect a "deeper" processing of this type of facial information? How does the brain activity of an artist differ from that of a non-artist?

The Present Study

Before the main experiment was conducted, a feasibility study was undertaken in which I performed a facial drawing task while in a whole-body MRI scanner. The stimuli consisted of six geometric figures (e.g. Fig. 1a) and six photographs of faces (e.g. Fig. 1b) that I copied as they were held above my face.

Although the space above the face of a person in the MRI scanner is very limited, we found that placing the notepad directly over the eyes using Velcro attachments and supporting the person's arms and elbows with foam pillows allowed a reasonable degree of comfort. All three subjects (the artist, the control subject and I) reported that their drawing and thoughts about drawing were similar to those that might occur outside of the scanner. Data from the collective scans of faces were subtracted from the data from the collective scans of the geometric figures. The results of this study indicated that clear data could be collected in this arrangement and the experiment reported herein was initiated.

Participants

The artist selected for this task, Humphrey Ocean, is a British portrait artist. His work is exhibited in the National Portrait Gallery in London, as well as in other galleries, and he has received numerous awards. He specializes in portraits and has spent 3–5 hours a day drawing faces over the past 20 years. He is a right-handed male, 47 at the time of testing. The non-artist, who served as a control subject, was a graduate student in psychology at Stanford University, a 32-year-old right-handed male with no formal training in art. Both subjects gave their informed consent.

Materials and Procedure

Ocean was outfitted with a dental-molded bite bar and placed in the full-body MRI. An 8-×-10-cm non-magnetic spiral notepad with six standardized faces [9] and six complex geometric figures was attached to the upper part of the MRI tube and appeared directly over the subject's face. The notepad was affixed to the upper portion of the MRI tube by Velcro strips. The faces and figures appeared on alternating pages; half were female and half male. Ocean was instructed to draw the portrait for 30 seconds and then flip the page to the next figure and to copy the geometric figure. The task continued with the next portrait drawing, the figure drawing and so on until the entire series of 12 sketches was completed. The control subject received identical instructions. A photo of the computer set-up is shown in Fig. 2.

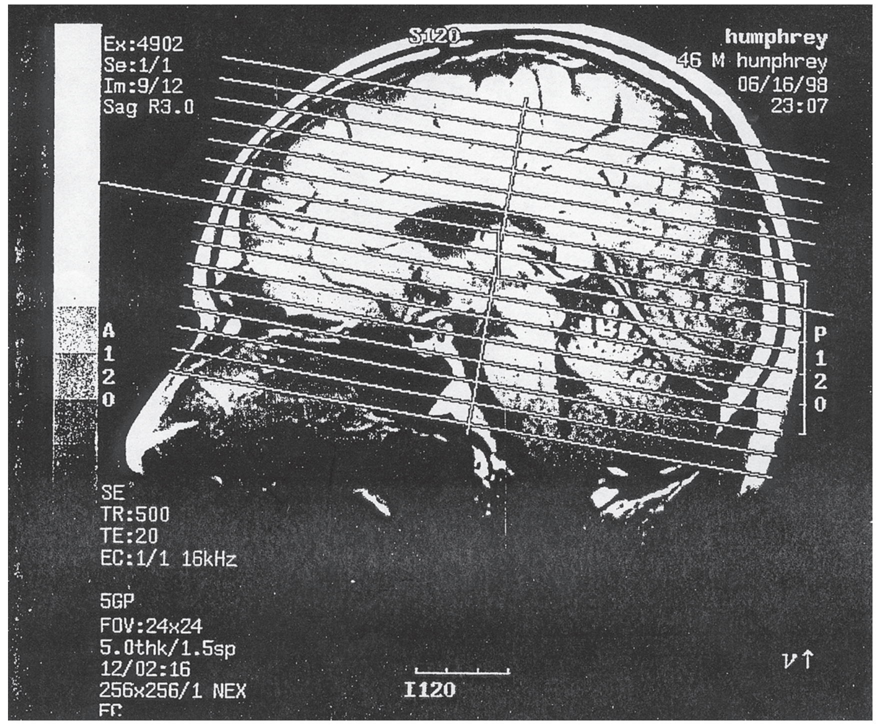


Fig. 3. Brain regions sampled in Humphrey Ocean. (© Robert Solso)

For each of the 12 faces/geometric forms, 125 fMRI images were acquired continuously over the 6-minute session; TI-weighted, flow-compensated, spin-warp anatomic images were acquired for the 16 sections that received functional scans. Sections of the brain sampled are shown in Fig. 3.

Results and Discussion

The results of the data collected for the geometric figures were subtracted from the results collected for the faces to control for motor activity, known visual operations (e.g. primary visual cortex activity) and other perceptual-motor activities. These brain scans for the artist and novice are shown in Color Plate B No. 2.

Of particular interest is the increase in blood-flow activity in the right-posterior parietal in the novice compared to the expert (see Color Plate B No. 2, column A, top and bottom). In this site we would expect to find facial processing activity. The contrast between the right-middle frontal areas (columns C and D) is to be noted: in the artist these areas are clearly implicated; in the novice this is far less so.

In both the artist and novice the right-posterior parietal was activated (see Color Plate B No. 2, column A). However, the degree of activation in the novice appeared greater than in the artist. These results are of interest in two respects: First, they confirm that an area of the brain frequently associated with facial identification was specifically activated. This contrasts with data on the visual processing of geometric figures. Second, the lower level of activation seen in the artist indicates that he may be more efficient in the processing of facial features than the novice. The artist, who sees and thinks about faces professionally, may require little involvement by this area of the brain normally associated with facial processing. The novice may require greater involvement, suggesting he is processing faces at a "lower" level, which deals with features rather than the "meaning" behind the face. In effect, the novice seems to be "copying" the face; the artist is "seeing beyond" the features. While our results are based on the observation of a single artist, it is plausible that other portrait artists may exhibit similar cerebral activity but that other types of artists (discussed below) may not. Also, because only a single non-artist control subject was used, we interpret these data cautiously. Care was taken to match the control subject with the artist, but the results need to be interpreted with care as they could reflect the unique way this particular control subject processed faces and figures. Further studies with a larger sample of non-artists as well as artists are needed to confirm our initial study.

The artist showed greater activation in

the right-middle frontal area than did the novice. This part of the brain is usually associated with more complex association and manipulation of visual forms, as well as with planning the fine motor responses of the hand. Thus, these two main findings considered together suggest that an expert portrait artist, who frequently sees and draws faces, dedicates relatively less energy to the processing of faces and more to the processing of these features in terms of their associated correlates. In a phrase, the artist "thinks" portraits more than he "sees" them. The involvement of the right frontal part of the brain suggests that this skilled artist engages in a "higher-order" interpretation of the perceived face and may rely on an abstracted representation of the face. Since the process of composing a replication of a face is a very complex matter—from seeing the face, to thinking about the face, to planning fine hand movements, to the actual motor actions—the implication of the visual cortex, the right-posterior parietal and the right middle frontal areas in the expert artist are consistent with what is known of the functions of these sites. Such consideration is consistent with the artist's own impression of his thoughts during the process and is mentioned here, in part, because it may be that different artists have different thoughts as they draw a picture. Also, it is plausible that other types of artists, for example, landscape, abstract and surrealist artists, may show different patterns of cerebral involvement than those exhibited by Ocean. We would expect less right-parietal involvement, for example, with a landscape artist than we found with a portrait artist. Experts from a wide range of areas, such as mathematics, music, photography, poetry and architecture, may exhibit specialized patterns of cerebral activity related to their expertise. Suitable studies—both situational and longitudinal—are to be encouraged, as we believe they will answer some important questions about experts, "gifted" people and the origin of talent.

Finally, the results of this experiment address a methodological issue in fMRI research. Because the data from our subjects reflect previously reported activation in the right-posterior parietal region, we confirm the reliability of using an interactive technique. In this study the subjects actively drew portraits, unlike many experiments in which subjects' responses are limited to pressing a button or squeezing a bulb or simply "thinking" about an event. We are encouraged that the results suggest that more ecologically congruent fMRI experiments, which produce reliable results, are feasible.

There are precious few studies that address the element of skill vis-à-vis brain processes. One PET study [10] did demonstrate that subjects who were skilled at a computer game performed game playing more efficiently than less-skilled subjects. In our experiment it appears that the artist engaged an area normally associated with facial processing to a lesser degree than the non-artist, which, generally, supports the idea of the efficiency of experts. In addition, the artist used an area of his brain that is normally associated with "higher-order" cognition. While it is premature to make a generalization to all creative experts on the basis of this observation of one portrait painter, the results suggest that other artists (perhaps even in other creative areas less focused on visual processing) might share such deeper associative processing of information. It appears that our artist was "thinking the portrait" more than "seeing the face." Other creative artists may implicate similar brain regions but, of course, that study is yet to be done. It is anticipated that this line of research, in which a skilled expert's brain activity is monitored as he or she performs a specialized act, will be emulated using a number of different experts in, for example, music, mathematics, architecture, dance and sport.

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References and Notes

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