

Henri Matisse Drawing: An Eye-Hand Interaction Study Based on Archival Film

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When Henri Matisse died in 1954 he left us with several thousand drawings made throughout his creative life. Among these were portraits that he referred to as *Thèmes et Variations* (Themes and Variations), which were drawn following a method he considered fundamental to his art [1]. The Themes were carefully worked out charcoal studies, usually made over a period of several sittings, whereas the Variations, which followed immediately in time the most recent Themes drawing, were sets of pen and ink portraits of the same model made one after the other and at great speed. Stylistically, the Themes were figurative representations of the model observed from nature, and the Variations were stylized interpretations, in which, however, the model's characteristic features were instantly recognizable.

RESEARCH OVERVIEW

Matisse described the Themes as:

[S]tudies made in a less rigorous medium than pure line, such as charcoal or stump drawing, which enables me to consider simultaneously the character of the model, the human expression, the quality of surrounding light, atmosphere and all that can be expressed by drawing. And only when I feel drained by the effort, which may go on for several sessions, can I with a clear mind and without hesitation, give free rein to my pen [2].

He clearly identified this preliminary work as leading to the Variations:

After prolonged work in charcoal, made up of studies which more or less interrelate, glimpses arise, which while appearing more or less rough are the expression of the intimate exchange between the artist and his model. From drawings containing all the subtle observations made during the [charcoal] work gush forth, as from a pond, the bubbles of interior fermentation [3].

Yet despite these and other descriptions by the artist, it remains difficult to understand how, in practice, he achieved the evolution from Themes to Variations, which transformed "all that can be expressed by drawing" into "the bubbles of interior fermentation."

A recently "rediscovered" archival documentary film made in 1946 throws some light on the question. Matisse is seen drawing four consecutive portraits of his grandson Gerard, the first two in the Themes style, the third and fourth, although still drawn in charcoal, much nearer to the Variations [4]. Part of this material was shot in long, unedited takes clearly

showing the painter's eye and hand movements as well as the portrait's progress. A frame-by-frame analysis of the film footage was undertaken with the object of defining the artist's characteristic eye-hand interactions and thus finding out more about the cognitive process governing his working method.

For most artists, the activity of drawing and painting from life is structured by alternating periods of looking at the model to acquire visual information and looking at the paper to render this information with pencil or brush. During the latter periods, when the painter is not seeing the model, it is commonly assumed that drawing proceeds from a visual working memory of the model or, more precisely, of a detail of the model. Alberto Giacometti held that "working from life is working from memory: the artist can only put down what remains in his head after looking" [5], and cognitive psychologists Phillips, Hobbs and Pratt wrote: "Since normal drawing involves looking away from the object being drawn any information acquired during perception must be remembered while actually drawing" [6]. Having put down on the paper the remembered bit of information, the artist's hand will pause while the eyes refer back to the model for the next bit, imposing in this way a rhythmic pattern to the drawing action. In this explanation, the artist's alternation of gaze between model and paper, commonly termed gaze shifts, is taken as characterizing a periodically refreshed working memory. I will refer to this mode and interpretation of the drawing task as the *conventional mode* and *conventional interpretation*.

Eye-hand interaction investigations made with artists drawing portraits lend some support to the conventional interpretation. In particular, several authors have documented the frequency of gaze alternations between model and paper. Using the term *cycle* to define the time lapse between two references to the model, Miall and Tchalenko [7] measured cycle durations between 5.00 sec for a 5-hour pencil portrait and 2.73 sec for a 2-minute pen sketch by expert portrait artist Humphrey Ocean. Lower durations were reported by other authors working with subjects of differing skills: Konecni found 2.40 sec [8], Tchalenko et al. 2.14 sec [9], Land 1.71 sec [10] and Cohen 1.67 sec [11].

Recently, the study of a particular kind of drawing from life questioned the universality of the conventional interpre-

ABSTRACT

Henri Matisse (1869–1954) attached fundamental importance to his drawings, in particular to the famous *Thèmes et Variations* series. These were accomplished following a precise method, starting with arduous life studies and evolving into brilliant spontaneous drawings. A 1946 archival documentary film showing the artist drawing four portraits of his grandson Gerard was shot in such a way as to allow the present author to undertake a detailed eye-hand interaction analysis of the drawing process. It was found that Matisse's temporal working rhythm and use of motor memory resulted in a more direct approach than that used by most painters. Taken together with remarks the artist made throughout his lifetime, these results provide a cognitive interpretation of his drawing method.

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Fig. 1. Matisse drawing the portrait of his grandson Gerard: Portrait C, camera position 6, film still. (© Succession H Matisse/DACS 2009)

tation. In direct copying tests, subjects were asked to copy an original contour drawing of a head placed next to the copy paper while their eye and hand movements were being monitored [12]. As in the conventional drawing mode, subjects alternated their gaze rhythmically between model—here the original contour drawing—and paper, this time using an even shorter cycle of about 1.10 sec. Most importantly, they continued drawing during the periods of reference back to the original. Other blind tests, where subjects could see only the original, showed that precise shapes could be drawn in this way without seeing either the hand or the paper, although exact positioning of these shapes required periodic references back to the paper. In consequence, the role of gaze shifts was different from their role in the conventional mode: in the copying tests, the eye focused on the original in order to draw blind the line on the paper, and then focused on the paper to continue drawing that line while controlling its spatial position. In effect, the eye-hand strategy in the copying tests avoided altogether the use of working memory by using the original itself as a sort of memory scratchpad. fMRI brain-imaging tests that were run in parallel with the eye tracker tests also suggested that drawing proceeded not from an encoded visual image but directly from a visuomotor mapping of the original [13]. I will show here that this mode and interpretation of drawing, which I will refer to as the *direct mode* and *direct interpretation*, are of immediate relevance to Matisse's *Themes and Variations*.

HENRI MATISSE— THE 1946 FILM

The 26-min documentary film *Henri Matisse*, directed by Francois Campaux, is remarkable for a section showing the painter drawing from life four charcoal

portraits of his grandson Gerard [14]. The painter is seen seated facing his easel, with the model seated at arm's length to his left (Fig. 1). All four portraits are drawn approximately twice life-size. The first two, referred to here as A and B, are studies made with a thin pencil-length charcoal stick held about 10 cm away from the tip and thus allowing the application of only moderate pressure. Portrait A outlines with lightly drawn lines the face's main features, while B is a detailed study in which the same features are drawn many times over to define their exact shapes (Fig. 2). Matisse sometimes termed this way of drawing "copying (or imitating) nature." The last two portraits, C and D, were drawn with a short waxy charcoal stump held between all fingers of the hand, allowing application of variable amounts of pressure. Both are stylized portraits representing the face and features with simplified contour lines. Comparing them to others in the *Themes and Variations* series, such as the ones illustrated in Louis Aragon's book [15], C may be seen as the last of the Themes and D as a transition between Themes and Variations. C was shot in one long uninterrupted medium shot (1 min 40 sec) showing the painter, model and easel, and D in an uninterrupted tight close-up (35 sec) showing the drawing's progress as well as the painter's shadow on the paper.

I made a detailed frame-by-frame

analysis of the drawing action on a digitized version of the film using film editing software [16]. At 25 frames/sec, this provided a measurement accuracy of 0.04 second. The close-up shots of the painter's head taken from camera positions 2 and 4 were used to establish the relationship between head and eye movements, and positions 3, 5 and 6, showing simultaneously the hand as well as the head, were used to investigate eye-hand interactions (Fig. 3). As far as can be ascertained, a single camera was used throughout all the filming.

MEASUREMENT OF GAZE SHIFT, DWELL DURATION AND CYCLE

In most visual activities, the eye displays rapid movements—the *saccades*—and periods of stable viewing—the *fixations*. In addition, a rotation of the head also takes place if the angular distance between two fixations as measured from the eye is greater than about 20°. A *gaze shift* is the overall movement resulting from the sum of an eye movement relative to the head plus a head movement relative to fixed spatial coordinates. A *dwell* is defined as the period of time during which a fixation, or series of contiguous fixations, remains either on the model or on the paper. The duration of a dwell includes the small saccades between contiguous fixations but not the larger

Fig. 2. Portraits of Gerard. Top: A and B. Bottom: C and D. Portraits C and D are shown just before Matisse drew the boy's right ear. (© Succession H Matisse/DACS 2009)



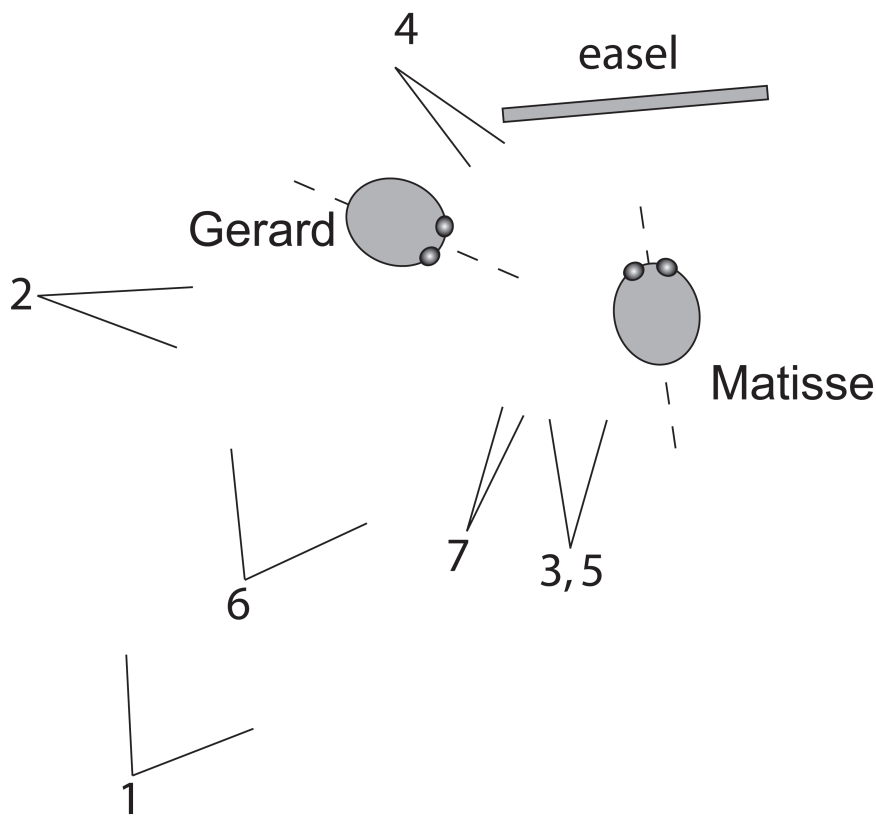


Fig. 3. Matisse's studio layout. Numbers indicate the camera's positions as derived from the film.

saccades between model and paper. A *dwell cycle* is the time lapse between two consecutive references to the model. It is important to note that measurement of average dwell cycles does not require precise measurement of dwell onset and termination as they can be calculated by dividing an interval of drawing time by the number of gaze shifts to the model occurring during that interval.

With close-up shots 2 and 4, direct measurement of dwell durations was obtained from eye and pupil positions that indicated whether Matisse was looking at the model or the drawing. Gaze shifts of approximately 50° between model and easel always started with the simultaneous initiation of a blink and head rotation [17]. The blink terminated midway through the shift, and when the eyelid opened again, the pupil was observed to

be located in the eye's leading corner, indicating that vision was now directed toward the new fixation location and that a saccade had occurred behind closed eyelids. The head then continued its rotation to its final stable position while the eye's vision direction remained basically unchanged, resulting in the pupil being brought back to a central position with respect to the eye's geometry. The fact that the new fixation had started before the end of the head's rotation meant that the new dwell duration would be slightly greater than the corresponding period during which the head would remain still. The end of the new dwell was marked by the simultaneous initiation of a blink and reverse head rotation.

Although the above is a common eye movement behavior not particular to Matisse, it allowed calculation of dwell

durations from timings of the head's rotation when the eye was seen in close-up. On the basis of 20 gaze shifts measured from camera positions 2 and 4, I found that eye and head movements remained remarkably consistent and that dwell durations were systematically longer by about 0.08 sec than the corresponding period during which the head remained still. Mean dwell durations are shown in Table 1. Portrait D shot in close-up of the drawing from camera position 7 did not include the painter's head but instead showed the head's shadow on the paper. This made accurate timing of individual dwell durations difficult, although cycle measurements were unaffected.

OBSERVATIONS ON THE FILM

Dwell and Cycles Durations

Dwell durations on the model increased from Portraits A to C (Table 1). C included two interruptions to the general rhythm while the mouth and the tie were being drawn (Fig. 4). If these interruptions are excluded from the calculations, Matisse's natural dwell durations C* on the model over the three portraits varied between 0.31 sec and 0.46 sec (average 0.39 sec). The shortest dwell durations measured directly from eye movements as well as deduced from head movements was 0.25 sec.

These dwell-on-model values are much lower than fixation measurements made in previous drawing studies. For example, an in-depth investigation of the painter Humphrey Ocean drawing a variety of portraits revealed fixation durations on the model between 0.60 and 1.00 sec [18]. Three other artists drawing their self-portraits averaged fixation durations on their mirror images of 1.10 sec, 1.40 sec and 0.75 sec [19]. Land measured fixation durations of 0.90 sec for very quick portrait sketches [20]. As a single dwell is made up of at least one fixation, the cited values may be taken as the minimum possible dwell durations.

Interestingly, Matisse's dwell durations approximated the "three to four"

Table 1. Time measurements for Portraits A to D.

C* is identical to C but excludes drawing of the mouth and tie. Camera positions are shown in brackets.

Portrait	Mean Dwell model sec		Mean Dwell paper sec		Total time considered sec	Number of cycles	Av. cycle duration sec
	Dwell	Stdev	Dwell	Stdev			
A [3]	0.31	0.06	0.86	0.20	7.80	6	1.30
B [3]	0.42	0.06	1.16	1.02	7.40	5	1.48
C [6]	0.54	0.14	1.09	0.26	75.50	36	2.10
C* [6]	0.46	0.13	0.80	0.25	64.20	34	1.88
D [7]					29.80	17	1.75

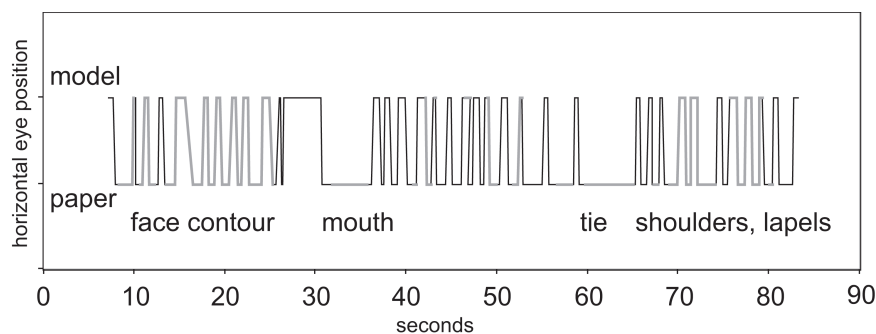


Fig. 4. Portrait C dwell time sequence. Periods when Matisse's hand was drawing are shown in grey.

fixations per second often quoted for everyday perception [21]. An immediate explanation would be that, for someone with Matisse's experience and expertise, gathering visual information for drawing was not much different from other daily tasks. However, it could also be that Matisse's eye-hand interaction strategy differed from the one used by the subjects for which we have eye movement data. We will return to this question further on.

Dwell durations on the paper calculated with C* varied between 0.80 sec and 1.16 sec (average 0.94 sec) and dwell cycle durations between 1.30 sec and 1.88 sec (average 1.55 sec). The latter compare with the lowest recorded to date with other subjects mentioned in the Research Overview section above.

The Drawing Action

In the film we see that Portrait A is drawn in faint short lines outlining the model's principal features, and Portrait B in superposed lines defining the features' exact shapes. Matisse's hand moves uninterruptedly throughout both portraits, usually passing several times over each short line before drawing it and not stopping while his eye is on the model.

Portrait C, for which we have the longest uninterrupted data, represents a first stylization. Each individual feature is drawn in a single bold line made in one stroke. For the longer lines, such as the face's contour, the hand slows down, but only once to a standstill, while the eye goes to the model and back. Altogether, drawing takes place 100% of the time during dwells on paper and about 55% of the time during dwells on the model. The impression is of a constantly renewed flow of information through the eye to a continuously moving hand.

In Portrait D, which may be considered the last of the Themes before an eventual Variations series, stylization is taken beyond C, the hand moving

faster and never pausing. Now Matisse is drawing 100% of the time, regardless of whether he is looking at the model or at the paper.

Evolution of the Portraits and Development of Signs

The evolution from naturalism to increasing stylization observed from portraits A to D is particularly apparent in the way that individual features are treated.

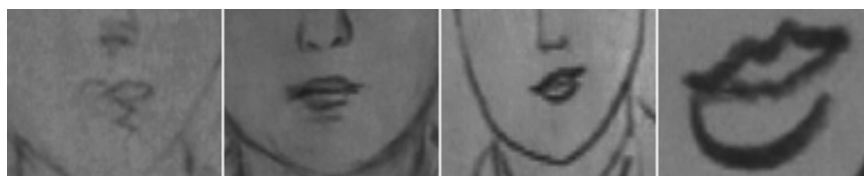
For example, the mouth is indicated in A with a vertical zigzag surmounted by a wavy line representing the upper lip (Fig. 5). In B, four separate lines are drawn several times over: the upper boundary of the top lip, the line between top and bottom lips, the lower boundary of the lower lip and the small horizontal depression below the lower lip. The effect is figurative. In C, Matisse pauses for 3.88 sec to have a good look at the model's mouth, leaning forward to do so (and thus changing his point of view), before turning to the paper and drawing the lips relatively slowly in 4.00 sec. The four lines of B have been simplified into one continuous line drawn in a Z-shaped movement: wavy top boundary drawn left to right, followed by a slightly curved right-to-left line, itself followed by an upward-curving bottom boundary left to right. In D, the Z-shaped line is drawn in precisely the same manner and shape, except that this time Matisse does not look at the paper either to place the lips or to draw them: His gaze, which had been on the model since drawing the picture's right eye, remains there until he has finished the lips. He draws them in 2.56 sec, which is about

twice as fast as in the previous portrait. This suggests that by the time of Portrait D Matisse had resolved the question of how the mouth should be drawn: The lips have become a sign—in Matisse's words: "a saving of time, the briefest possible indication of the character of a thing" [22]. Once learned, a sign, like a signature, can be drawn or written blind from motor memory and without seeing one's hand or the paper. A similar evolutionary trend from naturalistic study to stylized sign can be observed in several of the other features—eyes, eyebrows, nose, hair and facial contour.

With stylization and the creation of signs, the drawing pace accelerates. The face's contour in C was drawn in 8.60 sec (approximately 10 mm/sec), with six references to the model, during the last five of which Matisse's hand did not stop drawing. In D, the same features were drawn much faster, in 4.92 sec (approximately 15 mm/sec), with four references to the model and the hand not stopping at all. The effect of seeing this fast-flowing line emerging from Matisse's hand, holding a charcoal stump so small as to be barely visible, is extraordinary. He starts with the face's contour, counter-clockwise from the boy's right brow, and in one sweep reaches the left brow where, without slowing down, he continues the line into the three strands of the hair, which he draws with the stump at a flatter angle, making a thicker and rougher line, followed by a fourth and similar line representing both the hair and the top of the head and ending precisely where the line had first started (see Fig. 2).

Normally a drawing of this type would be followed by a Variations series. In this case, that never happened; however, with the help of Louis Aragon, we can imagine what such a session would have entailed. In March 1942, having sat for four Themes, Aragon wrote: "Sitting alarmingly close, an arm's length away, I saw Matisse's [pen] start off, take flight and pounce, the drawing completed at one sweep" [23]. The 34 Variations, drawn in quick succession, unmistakably show the same calm, composed and attentive man with elongated facial features and always the same signs—dreamy almond-shaped

Fig. 5. Development of the mouth sign from Portraits A to D. (© Succession H Matisse/DACS 2009)



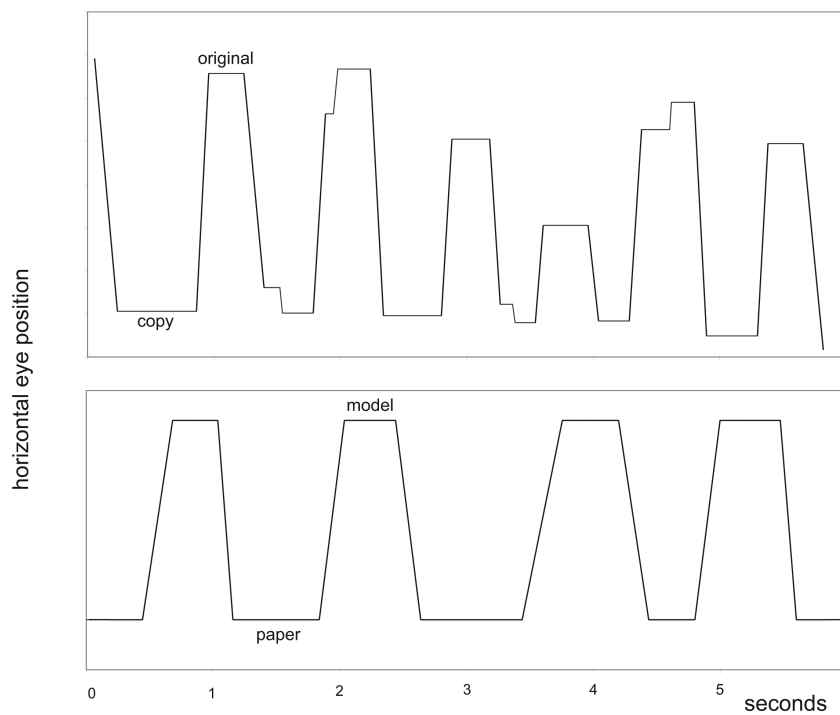


Fig. 6. Comparison of time sequence in direct copying tests (top, subject AG) and Matisse (Portrait C).

eyes, thin lips, symmetrical hairline and tie—a stylization process similar to the one seen in the film. In contrast, other features, such as the face’s outline, often vary considerably from one drawing to the next. As in Portrait D of Gerard, all naturalistic renderings have disappeared, and the line, whether in charcoal or in ink, demonstrates a fluidity characteristic of all Matisse’s Variations.

DISCUSSION

Eye-Hand Interaction

Observation of Matisse’s eye and hand movements shows that in all four portraits the painter continued drawing while his eyes were directed towards the model. In the last two portraits, for which we have the best data, no clear demarcation could be made between phases of visual information-gathering and phases of executing the gathered information onto paper. Instead, the impression was of a constantly renewed flow of information through the eye to a continuously moving hand—a strategy difficult to reconcile with the conventional drawing mode for which individualized segments on the model are selected, encoded to memory, retrieved and executed onto the paper.

Although drawing while looking away from the hand and paper has been previously noted in the case of an expert portrait painter [24], it has never been recorded as the governing strategy when drawing from life. The closest compari-

son would be with the direct copying tests described in the Research Overview section of this paper. In both Portrait C (this paper) and direct copying test AG051115 [25], the hand was drawing continuously, and dwell and cycle durations were comparable (Fig. 6). I suggest that in both cases a similar direct visuomotor process governed the transformation of perception into drawing without recourse to working memory. It should be noted that other skills, such as reading aloud, sight-reading music and driving, are equally direct visuomotor processes that do not involve the use of working memory [26].

From Themes to Variations

A cognitive interpretation of Matisse’s methodology in Themes and Variations may now be attempted by juxtaposing our results and Matisse’s own remarks about his working method. At the start of the Themes session, he positions the model as close as possible to himself, thus placing model, easel and painter in a single spatial unit. The object of the arduous Themes work that then starts is to gain “a deep knowledge of my subject” and to “give free rein to my faculties of observation” [27]. Matisse sums up this stage:

Here is where working intervenes, the process whereby the artist incorporates and gradually assimilates the external world within him, until the object of his

drawing has become like part of his own being, until he has it within him and can project it onto the canvas as his own creation [28].

During drawing, Matisse’s gaze shifts rhythmically between model and paper, with unusual eye movement parameters: references to the model are more frequent (every 1.55 sec), and dwell durations on the model shorter (0.39 sec) than documented to date with other painters. Furthermore, as work progresses from one portrait to the next, he is increasingly drawing “blind” during the periods in which he is looking at the model. In fact, because hand and eye appear to operate continuously and simultaneously, it is impossible to distinguish clearly between periods of acquiring information on the model and periods of putting this information onto paper. This eye-hand interaction suggests a way of drawing different from the conventional, in which a visual image is encoded to working memory before the artist turns to the paper to execute the drawing. Instead, Matisse’s approach resembles the direct copying mode, in which the visuomotor process transforms visual information directly into the executed drawing without recourse to visual memory or imaging; in effect, the model itself substitutes for the painter’s working memory, and it becomes more economical for the painter to simply refer back to the external model than to encode to, and retrieve from, internal memory. The directness of this approach is reflected in Matisse’s comparison of drawing a line with a slap in the face: “When you slap someone in the face, obviously you don’t do it limply, irresolutely. No, there is an impetus behind your movement. And that impetus comes not from decisiveness but from conviction. You give someone a slap with conviction” [29]. The use of the word “decisiveness” is relevant as it suggests that the line is not arrived at by a decision-making process but directly by putting down what he knows (sees?) to be there.

The portraits evolve. From “all that can be expressed by drawing” Matisse now selects “the line that will be the most fully expressive and carry the most of life . . . seeking equivalences through which elements of nature are transposed into the realm of art” [30]. Another change is the growing speed of drawing and the diminishing number of references made to the model. Increasingly, features such as the lips or eyes are developed into specific signs, which he now draws blind and probably from motor memory.

I consider I have made some progress when I note in my work an increasingly evident independence from the support of the model. I should like to do without it completely one day—I don't expect to because I haven't adequately trained myself to remember forms [31].

The painter is in fact ready to launch into the Variations, of which he says:

I am simply guided by an interior impulse which I translate as it takes shape, rather than by the exterior on which my eyes are fixed yet which has no more importance for me than a feeble glimmer in the darkness, towards which I have to make my way first [32].

The Variations series of drawings, not shown in the film, will

spring forth in one piece, constituted of elements without apparent coordination to the analysis that had preceded them; the multiplicity of sensations expressed in each of them seems impossible to execute, so great is the speed with which they are all brought together [33].

The Themes started with Matisse drawing what he perceived; by the time the Variations started, his hand had “learned” the subject matter and he was free to draw what he felt. Matisse’s cognitive method as illustrated in Campaux’s film broadens our understanding of the cognitive drawing process beyond the conventional visual memory interpretation. The postulated direct visual-to-motor transformation and the motor plan developed from one portrait to the next allowed him first to acquire, and subsequently to free himself from, the purely visual influence of his model and give full rein to his creative genius. Further studies will show how special this approach is to Matisse and whether other great artists adopt similar or different cognitive methodologies.

Acknowledgments

This work was supported by Sciria Research Unit, Camberwell College of Arts. I am grateful to Robert McNab and Jem MacKay for help with archive film and illustrations.

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14. *Henri Matisse*, director Francois Campaux; producer Andre Leveille; photography Lucien Joulin; commentary Jean Cassou. 26 min., B/W, 16mm. CGC 1946.

15. Aragon [4].

16. The film editing software Adobe Premiere Pro was used for the frame-by-frame analysis.

17. Blinks have been previously recorded in portrait drawing by Miall and Tchalenko [7] and documented for other visual activities necessitating large saccades: see C. Evinger, K.A. Manning, J.J. Pellegrini, M.A. Basso, A.S. Powers and P.A. Sibony, “Not Looking While Leaping: The Linkage of Blinkage and Saccadic Gaze Shifts,” Experimental Brain Research, Vol. 100, No. 2, 337–344 (1994).

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32. Matisse in Flam [2] p. 223.

33. Matisse in Flam [2] p. 223.

Manuscript received 10 March 2008.

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