Studies in Visual Communication

Volume 10
Issue 3 *Summer 1984*

Article 2

1984

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Recommended Citation

Braun, M. (1984). Muybridge's Scientific Fictions. *10* (3), 2-21. Retrieved from <https://repository.upenn.edu/svc/vol10/iss3/2>

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Introduction

If one were to suggest that the study of motion and speed in the nineteenth century was crucial to the attempt to understand the nature of time, then a central role in that study must be assigned to photography—itsself an invention of the nineteenth century. From tracing the intricate, slow motion of the stars and planets to defining the swift trajectory of missiles and birds, the camera quickly became the essential tool for stopping movement, capturing both what the eye could not see and what the hand could not accurately describe. For those scientists who early recognized its potential, the camera was employed to record motion in such disparate fields as astronomy, physics, chemistry, zoology, geology, and paleontology.

In the area of human and animal locomotion, where the camera was widely used to record what had hitherto been invisible, the two most noted investigators were the Anglo-American photographer Eadweard James Muybridge and the French scientist Étienne-Jules Marey. (Both men were born [in 1830] and died [in 1904] within weeks of each other.) Muybridge, who made his reputation with the photography of the Western and Central American landscape, took up the study of movement in 1872 at the behest of Leland Stanford, the governor of California and racing connoisseur, who utilized Muybridge's talents to acquire data that could be applied to the training of his horses. Marey, a physiologist who came to photography rather late in a scientific career filled with official honors, took up the camera after he saw Muybridge's photographs of Stanford's horses, which were published in the French scientific journal *La Nature* in 1878.¹ Subsequently, Marey refined and developed his photographic machines, making them a part of a long list of instruments he had invented to trace movement in men and animals since 1859.²

The difference in the backgrounds and formation of these two men has, until now, not seemed an important factor when comparing their work. We have always assumed that the contribution of both to the study of locomotion was a scientific one: objective, accurate, analytic, systematic. This assumption certainly holds for Marey. His experimental methodology, the widespread applicability of his results, and his eminent standing in the field do not conflict with the categories of thought or activity we attribute to scientific endeavor.

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The assumption is probably also valid for the photographs Muybridge made for Stanford insofar as Stanford had specific goals or theories he wanted verified and he, not Muybridge, directed the work that went on from 1872–1879 in California. But Muybridge's later work—that vast compendium commissioned by the University of Pennsylvania in 1883 entitled *Animal Locomotion* (Muybridge 1887)—is different. Although carried out under the rubric of science, Muybridge's method and conclusions are inconsistent with what we understand to be scientific experiment in the analysis of locomotion. These photographs show us the vulnerability of a number of our assumptions about the nature of science and movement. They also show us the dangers of believing what we see.

Background to the Pennsylvania Work

In 1879, Muybridge's work for Stanford was completed.³ He spent the next two years preparing a book on the subject (*Attitudes of the Horse in Motion*, published in 1881) and giving lectures that were highlighted by the use of his zoopraxiscope to animate and project the images he had made.⁴ In the summer of 1881 he set sail for Europe. The trip was paid for by Stanford, who had preceded him there, paving the way for Muybridge's introduction to the most eminent scientists and painters of the time.

The photographs of Stanford's horses had been widely published in Europe, and their appearance had caused a sensation; Muybridge, the author of these magical feats, was in turn greeted with enormous excitement and interest. Marey was the first to honor him, at a fete at his home in Paris on September 16,⁵ where he presented the American to such scientific luminaries as Helmholtz, as well as to the photographer Nadar and the French authority on horses, Col. E. Duhousset;⁶ in November a second reception was given by the painter Meissonier who introduced Muybridge to the Parisian art world; and in December, with Meissonier as interpreter, Muybridge presented his work to the Cercle de l'Union Artistique.

In London, where he arrived in March 1882, the enthusiastic reception continued, and he spent the month lecturing to the Royal Society, the Royal Academy, and the Savage Club, among others. These experiences—Muybridge's meeting with Marey and Meissonier in Paris, his introduction to the marvels of the dry-plate process by Marey, and the celebrity status accorded him everywhere he went—left him with an ever-increasing desire to expand the work begun in California, a desire that could only be satisfied by finding a new source of funding. Stanford could no longer be depended upon. For, on April 20, 1882, while Muybridge was lecturing in London,

Figure 1 Plate 509:*Shoeing a horse.*

Muybridge's notebooks show that originally twelve lateral and twenty-four foreshortened views of this action were made and that he subsequently redid eight of each. Only six remain, and these are arranged sequentially and numbered consecutively even though the missing phases of movement are quite apparent.

Stanford's account of the California project had been published. This version, *The Horse in Motion*, contained five of Muybridge's photographs and ninety-one lithographs made from the rest of his pictures, but it appeared without his name anywhere on the title page. Stanford had relegated Muybridge to the role of technician, and Stanford's chosen editor, Dr. J. B. D. Stillman, had relegated Muybridge's lengthy written introduction (which he had hoped to see published with the photographs) to the waste bin. The appearance of *The Horse in Motion* marked the beginning of Muybridge's break with Stanford and the end of the governor's patronage. Muybridge alone could not carry out the kind of comprehensive investigation of animal and human locomotion he had in mind. His only source of funds was the proceeds from his lectures and from the sale of individual photographs and zoetrope strips of the moving animals. No one in Europe seemed particularly interested in backing him. The possibility of "funds for an exhaustive investigation" from the Royal Society was subverted when the Society saw the Stanford book. It was futile to argue his part in the work: "no explanation could avail in the face of the evidence on the title page and in the book before the council."⁷ The suggestion of a collaboration with Marey, Meissonier, and

an anonymous capitalist (on a book "upon the attitudes of animals in motion as illustrated by both ancient and modern artists . . . which will hand the four of us down to posterity")⁸ never came to fruition.

In spite of all these setbacks, Muybridge's return to America in June of 1882 saw the beginning of an extended lecture tour on the east coast and no abatement whatever in his hope to expand the work. By March 1883, he had already produced a second prospectus for "a new and elaborate work upon the attitudes of man, the horse and other animals in motion," which was to include "photographs of actors performing their respective parts, works of art from the Museums, Picture Galleries and Libraries of Europe," an essay by Marey, and finally (if all that were not enough), the right on the part of the would-be subscriber to "send a horse or other animal or subject to my studio for a special photographic analysis of its movements which will be illustrated without extra charge" (Muybridge 1883).

At last, in the early summer of 1883, Muybridge's prospectus found a receptive audience at the University of Pennsylvania. Through the combined efforts of the painter Thomas Eakins⁹ and the sportsman-engineer-art patron Fairman Rogers, both of whom had heard Muybridge's lecture in Philadelphia

the previous February, the provost of the university, William Pepper, was persuaded to put the grounds of the newly created Veterinary Department at the photographer's disposal and to put together a committee that would guarantee, initially, \$5,000 to him for the undertaking.¹⁰ A formal invitation was issued in August of that year by the university, and after securing the necessary equipment, Muybridge began making photographs the following spring as soon as the weather was sunny enough. The work was completed in 1886 and subsequently offered for publication by subscription in 1887 under the title *Animal Locomotion*. Comprising 781 plates assembled from 19,347 single images,¹¹ this enormous undertaking proved to be identical in scope to Marey's locomotive investigations in Paris.

But unlike Marey, Muybridge was not trusted to carry out his investigations on his own. The university prescribed both the nature of the experiments and the conditions under which they would take place. It appointed a commission to oversee Muybridge: "it was represented to the Trustees of the University that several individuals appreciating the importance of the proposed work to art and science would unite in guaranteeing all expenses connected with the investigation if a University Commission would be appointed to supervise the entire affair and thus *insure its thoroughly scientific character*" (Marks, Allen, and Dercum 1888:5, my italics).

This was a very unusual procedure. Perhaps it was necessary because of concern about using nude human beings as subjects for either scientific or artistic investigations. (Eakins, for example, was fired from the Academy of the Fine Arts in 1886 for undraping a male in a mixed class.) It is also possible that the university officials had reservations about Muybridge's character.¹² Certainly they knew of his unsalubrious personal history: his trial for the murder of his wife's lover in 1874 and his reputation for "eccentricity." They also may have been aware that Muybridge conceived of and promoted himself as an artist rather than a scientist.

For indeed, Muybridge was not a scientist. He had no training in any scientific field and no knowledge of medicine, anatomy, or physiology. He was a photographer and a photographer of repute. When he found that Stanford had published what he considered his original work, the blow to his pride was enormous, so much so that Muybridge instituted a lawsuit against Stanford (which he eventually lost in 1885). Stanford had seen Muybridge as an employee.¹³ Muybridge saw himself as an artist, a perception supported and encouraged by the acceptance he found in artistic circles as he traveled and lectured: it was the artistic community that took the dominant interest in and benefit from his work after the first surprise of the photographs wore off; it was for the delectation of art-

ists and as entertainment for a paying audience that Muybridge used his zoopraxiscope (his lectures in London, for example, and the attendant publicity, made one commentator describe him as "the most talked about entertainer on two continents"); although scientific journals in America and Europe had published the results of the California work, it was not scientists but artists, "dilettanti" and "literati," who subsequently made up the audiences at his lectures and demonstrations and were the subscribers to the portfolios of his photographs. The scientific view was that Muybridge's photographs were inaccurate: Since he used more than one camera, the object was not photographed from a constant perspective or from a single point of view or at equal intervals of time. The intermediary phases of the movement were too hard to piece together from the ones that were pictured because the distance separating them was too large. Muybridge failed to represent the trajectory of the movement. He "could not avoid errors which inverted the phases of the movement and brought to the eyes and spirit of those who consulted these beautiful plates a deplorable confusion."¹⁴ Muybridge himself accepted the commission with aplomb—"I am neither a physiologist nor an anatomist [therefore they] are assisting in the work to give it additional *weight and value*" (Mozely 1979:xxxi, my italics). But the attempt by the university to ensure scientific accuracy (and perhaps short-circuit any indecorous behavior on Muybridge's part) would prove to be only partially successful.

The Photographs

To begin with, Muybridge's multicamera system¹⁵ did not produce images that gave the viewer a sense of ongoing motion. He photographed the subjects as they moved along a track with up to three batteries of twelve cameras each: one battery parallel to the subject (the resulting images are called "laterals") and the other two batteries at sixty degrees or ninety degrees to it (producing either "front," or "rear foreshortenings").¹⁶ Each photograph was made by a different camera (in tandem with the subject) against the same background as the one before and after it but from a subsequent vantage point. Thus the subject never seems to go by us. The two essential components of our perception of locomotion are missing: there is no sense of the space traversed by the subject and no notion of time passing. As the subject moves, the camera moves with it, or so it seems. The camera and subject moving in unison effectively cancel out the sense of movement; the only things that change are the gestures of the subject. Movement has to be reconstructed by the viewer from these gestures from frame to frame.

The primary aid in this reconstruction is actually the sequential structure in which the individual images are arranged by Muybridge in the final print. That is, Muybridge took the frames made by each camera and arranged them in rows. The resulting assemblage, which contained from one to six of these rows (and combined both lateral and foreshortened views in a number of variations that will be described below), was then rephotographed and printed. The print was to be read both horizontally (from left to right for the most part) and in the majority of cases vertically. The horizontal sequence provided a temporal succession, while the vertical row displayed a spatial ordering, i.e., the figure was seen from two or three different points of view that (supposedly) had been taken simultaneously.

This sequential ordering of the images dictates our perception of the relationship among them. The sequence endows its component parts with movement because we believe any sequence to be orderly, logical, and progressive. It is the sequence which cues us, in fact, to believe that the action represented was ongoing and that it took place exactly in the order in which we see it reproduced. Thus our perception is directed by our belief in this structure to dissolve in our imaginations the black borders marking off each individual part and then to fill in the missing parts—the gaps between the separate phases of the movement supplied by each single image. The sequence invites us to cooperate in creating the illusion of motion. Our faith in the sequence allows us to suspend disbelief.

Muybridge noted the temporal intervals between one image and the next in his prospectus to *Animal Locomotion* and also the exposure times.¹⁷ In the same pamphlet, however, are general and specific caveats he appended to these measurements. First, on page 9, he stated that the "perfect uniformity of time, speed and distance was not always obtained." And, among his twenty-four reference notes to the plates, he detailed eighteen possible irregularities in the exact measurements of the intervals between phases. These irregularities apply to 25 percent of the plates. Based on visual evidence only, I would hazard that an additional 10 percent are also irregular: these are sequences in which the images could not possibly have been taken at the stated temporal intervals. Such irregularities (noted or not) are evident only by an examination that discards the sequence and tries to recreate the relation between one single frame and the next. Otherwise the sequential structure has the effect of making them invisible.

Although there is absolutely no possibility of knowing if such an effect was intended, Muybridge did employ additional tactics which ensured invisibility and internal consistency. In Figure 1, for example, the

sequences seem, at first glance, logical enough. The images in each horizontal series are consecutively numbered, and the vertical numbers are identical for each phase of the movement. (This numbering is a crucial device in our acceptance of the arrangement as given.) Nevertheless, it is obvious that from frame 3 to 4, the smith has changed position to such a degree that we must surmise that a phase (or phases) of the movement has not been recorded. Moreover, the expectation that the missing phase in the lateral series would have been caught by the camera in a foreshortened series is frustrated: the views match up both in the subject's poses and in the numerical order. It seems too much of a coincidence that the corresponding cameras all failed at the same time and yet how else to explain why the identical phases are missing in each series? Only, I believe, by understanding that the system of consecutive numbers, as well as the alignment of foreshortenings and laterals, is a post facto assignment.

From the notebooks Muybridge kept on the work (now housed at Eastman House, Rochester), it is evident that with six exceptions he always made twelve lateral and twelve or twenty-four foreshortened views of each movement, yet in Figure 1 only six of each remain. Thus, although the frame numbers may belie it, phases are missing. And if a phase of the movement did go unrecorded (or if a negative was damaged), then the corresponding view also must have been removed. What remained was made congruent in its placement on the page and in its numerical order. Figure 2 makes this clearer. Like the first example, the plate is internally and numerically consistent. But in the last four frames of the bottom row, two sets of different numbers can be distinguished. Those in white, which are in reverse, were those from the original negatives, while the black ones were added after the frames were assembled to create the final print. In his juxtaposition and numbering, then, Muybridge created what seems to be (and what we have been led to expect to be) a rational succession. Once we begin to question this sequence, given not only the enormous gaps between the images, but also the conflicting numbers in some of the frames, the integrity of the whole plate becomes doubtful.

Then again, the logic of any sequence may be suspect. Figure 3 is a lateral series. Each of the twenty-four frames is consecutively numbered, but it has absolutely no continuity as a series, even though some groups of two or three look successive. It is a composite of negatives taken from three different picture-making sessions—the separate session numbers can be made out clearly at various points in the foreground. The plate demonstrates to us the vulnerability of our assumptions both about sequential structures and about what Muybridge was up to. Even though it

Figures 2 and 2a (detail) *Plate 504: Ascending and descending stairs.* Two distinct sets of numbers, one white, which belongs to the original negative, and one black, which has been added before the final printing to make the sequence look unified, can be made out in the last four frames of the bottom row. For similar occurrences see also plates 67, 164, 212, 277, 299, 444, 494–495, 498, 500, 505, 515, 517.

Figure 4 *Plate 498: Miscellaneous phases of the toilet.* The model (Miss Blanche Epler, who can also be seen in Figure 2) removes her chemise in the seventh frame only to find it on again in the eighth. See also plates 493–498, 501–503, 516–517, 660. For more of Miss Epler dressing and undressing, see plates 415, 425, 493–495, 497.

Figure 3 *Plate 299: Playing with ball.* This plate is a compilation of three sessions: 1482, 1483, and 1485. The notebooks show that four out of twelve cameras failed during session 1482. See also plates 321, 501, 503; and 776–779.

Figure 5 Plate 662: "Denver," refractory. An assemblage of mostly unconnected images, sequentially arranged and consecutively numbered. The irregular nature is accounted for by note 7 in the prospectus. See also plates 336–337, 349–354, 499, 504–515, 518, 651–652, 664, 779, 780.

looks right, there is no guarantee that any of its images are related to each other—formally, temporally, or logically—except in Muybridge's perception of a pictorially acceptable final print.

The necessity for congruency between lateral and foreshortened views often seems to override other factors we would take to be imperative in the analysis of motion, such as the recording of a complete movement or the capturing of all of its phases. The results are intriguing. Where gaps between phases are most blatant, the leftover pieces are still assembled, numbered consecutively, but titled "miscellaneous" (Figure 4). The direction given by the title in these cases (which are, in fact, only exaggerated examples of what is going on in many other plates) only partially neutralizes the direction given by the sequential structure. Of the twelve "miscellaneous" plates, nine are accounted for in the prospectus by note 4: "Isolated phases photographed synchronously from the various points of view"; while three are explained by note 3: "Successive phases photographed at irregular intervals of time synchronously from the various points of view." In practice, the difference is hard to understand.

It is even harder to understand just what criteria Muybridge used to title a plate "miscellaneous." Thirty-three plates in *Animal Locomotion* have notes 3 and 4 appended to them (or, in the case of a lateral series, note 7: "Isolated phases of motion from a single point of view") but no "miscellaneous" in their titles (Figure 5). And there is an additional group of fourteen plates that is as irregular as the "miscellaneous" plates but has neither a title calling our attention to this fact nor any notation in the prospectus whatsoever (Figure 6).

A subset of the "miscellaneous" plates illustrates successions not even of phases of movements but of poses (Figure 7). Yet these too are accounted for in the prospectus by note 4. The poses have been put into a sequence, but such a sequence resists any attempt at a reading for chronological succession. While the vertical relations may seem intelligible, the horizontal series is dictated not by time, but by the formal qualities of the figure and by the symmetry in which Muybridge has arranged poses, that is, by aesthetically rewarding juxtapositions.

The necessity for congruency or internal consistency does not always result in the elimination of a negative from one series when the corresponding negative in another series is lost. Instead, alternative strategies are deployed so that the viewer is prompted to overlook or not see that there are pieces missing. In Figure 8, a photograph of the empty backdrop, taken from a viewpoint consistent with the rest of the series, stands in for a missing foreshortened view. In Figure 9, two frames have been left uncropped so that they take up the space of one that is missing. In still a third example, an extraneous image has been inserted into a series (Figure 10). Again, that such disjunctions have remained unnoticed is not too surprising. The series are aligned with each other and on the page, obliterating any cues that would prompt us to compare them more closely. Also, we presume that if one sequence is "right," the others must be too.

Figure 6 Plate 150: *Descending stairs, stooping, lifting a pitcher, and turning.* The missing phases of movement among frames 5, 6, and 7 are not accounted for by any reference notes, though originally twelve lateral and twenty-four foreshortened views were made. See also plates 73, 150, 223, 308, 331, 381, 408, 412, 413.

Figure 7 Plate 530: *Various Poses.* The sequential structure and the consecutive numbering cue us to look for ongoing motion. The rhythm created by symmetrical juxtaposition, on the other hand, redirects our interest to a consideration of the pictorial elements and their interrelation within the page. The final two frames in each series are missing so that the intended symmetry of the arrangement is spoiled. See also plates 529, 531. [Ed. Note: Damaged frame is on original.]

Figure 8 Plate 34: *Walking and carrying a fifteen-pound basket on head, hands raised.* A view of the background has been inserted to substitute for the missing rear foreshortened view in frame 5. See also plate 119.

Figure 9 Plate 137:
*Descending stairs and
turning around.* The
second and third frames in
the bottom row have not
been cropped so that they
take up the space left by
the missing frame. For the
lateral series Muybridge
used a $4\frac{1}{4}'' \times 5\frac{3}{16}''$ plate
holder, exposing an area
of $3\frac{3}{4}'' \times 4\frac{5}{8}''$ on the
negative. Beginning in the
late summer of 1885, the
plate size for the fore-
shortened views was ca.
 $2\frac{1}{2}'' \times 3''$. Muybridge
cropped his negatives
according to the demands
of the page format and the
quality of the images. See
also plates 219, 274, 301,
429, 463, 548.

Figure 10 Plate 202:
*Dropping and lifting a
handkerchief.* Comparison
of the third lateral and
foreshortened views
shows that the hand-
kerchief's position is
different in each. The
foreshortened view is a
reprint of the first frame in
the series. See also plates
9, 69, 180, 202, 342, 616.

In Figure 11, no frame is missing, but the first five laterals seem to have been contracted. Here vertical and horizontal alignment has dictated the rupture of normal perspectival relations in the frame. The central portion of the image has been removed and the two remaining halves have been abutted so that the image is made the same size as the corresponding foreshortened views. The real distance between the two subjects has been changed in the lateral view, but the final print is again internally consistent.

These tactics—insertion, expansion, and contraction—are all useful in making one series look as if it belonged with another as well as look logical in its own right; the uniformity in the numbering of the images supports this seeming consistency. Surprisingly, Muybridge threw such attempts at caution to the winds in other plates. The missing numbers in two out of three sequences in Figures 12 and 13 are quite apparent. They signal to us that there are missing phases. Nevertheless, the structure of the whole ap-

▲ **Figure 11** Plate 448:
Woman descending stairs with goblet meets another woman with a bouquet. To make the lateral and foreshortened views congruent, the central portion of the first five laterals has been removed and the remaining halves abutted and printed. See also plates 45, 215, 330, 429, 447, 450, 452.

◀ **Figure 12** Plate 43:
Walking, sprinkling water from a basin, and turning around. The missing numbers in the two lateral series signal missing phases, but the structure helps us to overlook the gaps. We "see" relations that are not there.

► **Figure 13** Plate 300:
Football, drop kick. The lateral series is the only one relatively complete and is printed first. See also plates 301, 341, 429, 566.

pears rational and the gaps remain unseen. In both cases the one unbroken sequence is printed at the top of the page, the sequences are aligned on the page, the internal relations are perceived as legitimate.

While each sequence determines our perception of the images contained within it, the structure of the whole plate—Muybridge's disposition of more than one series on the page—determines our perceptions of the relations among sequences. The most common arrangement—a lateral series printed on one line with a rear foreshortened view beneath it and a front foreshortened view under that—is only one of the thirty-six variations he has devised.¹⁸ These variations tell us what to look for and what to overlook. For example, when the continuity of a lateral series is interrupted on the plate by a foreshortened series, the reconstruction of the event in time is made difficult, and the viewer is thus persuaded to focus on the vertical (or spatial) relations. This may, in fact, be precisely the point, because missing phases, renumbered or unnumbered images, and disjunctions between frames are then made less visible. The opposite operations are involved in those cases in which the front and rear foreshortened views are printed to-

gether but on a different plate than the laterals to which they belong (Figures 14 and 14a). Here the lateral series is complete, but the foreshortened views have pieces missing. As they are printed on separate plates, they cannot be compared. Figure 15 is an example of another variation and its use. It seems to consist of three lateral sequences, yet the bottom row is not a sequence of movement but a series of "track shots" (described below). The arrangement of the plate helps us perceive movement where there is none.

Perhaps this extraordinary variety of arrangements could be explained in terms of a common narrative structure: the chronological succession of events differs from the path the author chooses to disclose those same happenings. In other words, what we may have is the equivalent to the literary distinction between "plot" and history: Muybridge may be telling a story. But because the photographic sequences exist all at once before our eyes, the path of disclosure is created not only by Muybridge's disposition on the plate (his plot), but also by choices made by the viewer.

Figures 14 and 14a *Plates 349 and 350: Fencing.* The irregular foreshortened views are printed on a separate plate so that comparison with the laterals cannot be made. See also plates 336 and 337; 338 and 339; 340 and 341; 565 and 566.

The degree to which cosmetic, aesthetic, or narrative requirements supplant the need for analytically verifiable data can be located in the "stepped prints" and the "track shots." In the former (Figure 16), one series is printed out of alignment—either to the left or the right of its counterpart. This pattern usually hides missing frames or an incomplete series and forces the viewer to consider each sequence as a discrete entity. The track shots (I have borrowed the name from cinema) are groups of pictures in which the subject never moves but it seems that the camera has. Muybridge arranged his cameras in a semicircle around the subject; they go off simultaneously, providing a 180-degree view of one position. As with the stepped prints, finding correspondence between lateral and foreshortened views is not an issue, for there are no laterals or foreshortenings per se.¹⁹ Yet, because Muybridge has printed more than one series on the page, the viewer is prompted to construct some kind of arrangement or strategy that will incorporate all the individual frames and the separate sequences into an intelligible unit. Some possibilities are illustrated in Figures 17 and 17a.

In the illustrations discussed so far, and inferentially in all the pictures Muybridge made in Philadelphia, we cannot on the basis of visual perception alone, and without additional contextual information, be sure that what is seen is not a tableau—preconceived and choreographed gestures of what continual movement would look like in fragmentary stages portrayed by actors and actresses. Since so many of these pictures are demonstrably fragments, what guarantee do we have that any of them were made either simultaneously or sequentially? What guarantee is there that the images in these plates were not made days or even weeks apart and then assembled to approximate what we would expect the photographic notation of movement to look like?

In spite of the anonymity of the gridlike background in these pictures, the seeming objectivity of the camera and authenticity of results, and even in spite of the evident seriousness of the direction under which the work was carried out,²⁰ these pictures are incongruent with what we understand to be scientific analysis of locomotion. The unsystematic and inconsistent aspects of the photographs effectively obscure any knowledge of the underlying laws governing the me-

Figure 15 Plate 487: A: Ascending step; B: Lifting a handkerchief from the ground; C: Walking; D: Running. A and B are phases of one movement each, C and D comprise six shots each of one position photographed simultaneously—the model does not move. Arranging the series in which movement has been photographed with one in which there is no movement provokes a tendency to see movement in the latter. See also plates 321 (a combination of a sequence and a series of poses), 483, 486, 488–492, 519, 555–557, 651, 776–778 (combinations of different lateral series).

Figure 16 Plate 356: Kneeling, firing, and rising. There are eight frames in the top row, seven in the middle, and six in the bottom. Stepping the lateral and foreshortened views makes it easier for us to overlook the anomalies. See also plates 167, 247, 254, 303, 463, 635, 694.

Figures 17 and 17a Plate 527: A–C: Spanking a child; and Plate 520: A–C: Wrestling; D: Sparring without gloves. The sequential structure helps us to endow the images with movement. Actually, no ongoing motion has been photographed. Some movement may be determined by reading plate 527 vertically, but the subject was posed. Plate 520 is made up of sequences containing one phase of a movement captured at one instant by a battery of cameras. All of the “track shots” were made in the summer of 1884. The grid background was not yet in place, and only six cameras were being used. See also plates 520–528.

Figure 18 Plate 464: Woman chasing another with a broom.

Figure 19 Plate 455:
Throwing self on a heap
of hay.

chanics of movement. In many cases the moving limbs are hidden by drapery. The very movements that have been chosen for scrutiny—in the human realm at least—are often unrepresentative. The scientific purpose served by a study of one woman chasing another with a broom (Figure 18) or a girl falling into a pile of hay (Figure 19) is impossible to fathom without directions. And are we to understand that there are constant factors that govern “fancy dancing” (the subject of Plates 187–189 and 191–194) or practical applications that can be derived from “chickens being scared by a torpedo” (the final plate of the set)?

But while the photographs may not be scientific experiments in the mechanics of locomotion, they are certainly a treasure trove of figurative imagery as well as a compendium of social history and erotic fantasy. Indeed, Muybridge often used his camera not as an analytic tool at all but as an instrument of representation, and the results are at least as absorbing as what he was ostensibly producing. Take, for example, sexual difference. In these pictures, both men and women walk, run, jump, and lift objects (men concen-

trate on big rocks and poles, while women spend an exaggerated portion of their time with jugs and vases). Both men and women are depicted throwing buckets of water (ad nauseum: Muybridge's fascination with “freezing” drops of water in midair provides an obsessively recurring motif [Figure 20]), but the men also wrestle, box, play baseball, fence, and do “men's work”: carpentering, laying bricks, and horseshoeing. In addition, they play leapfrog and tip their hats with evident seriousness and enjoyment. As we might expect, the women sweep, dust, wash and scrub floors, dance, arrange their drapery, flirt with their fans, dress and undress extensively, stumble, and fall. This going about the occupations deemed natural to each by social mores is only part of the story. The women also engage in particularly awkward or ungainly actions and what were, at that time, certainly forbidden activities.

Figure 20 Plate 406:
Woman pouring a bucket of water over another woman. This event occurs three times in *Animal Locomotion*, in plates 406, 407, and 408. Originally, the titles were "Miss A. giving Miss C. a bath." Muybridge seems as interested in "freezing" the motion of water as in the movement of pouring. See also plates 398, 399, 400–404, 409, 440, 462, 485.

Figure 22 Plate 247: *Sitting down and placing feet on chair.*
 See also plates 239, 245.

Figure 21 Plate 452:
Woman kneels and drinks from the water jar of another woman and both walk off. See also plates 182–184, 203, 445, 453.

Figure 23 Plate 429: *Woman disrobing another.* The notebooks show that Muybridge's original title for this and for plates 427 and 428 was "Inspecting a Slave (white)." The theatrical bent of Muybridge's imagination is also evident in the costumes in *Animal Locomotion*—they include "peasant" and "Greek" girls—and in the scenarios, which include "crossing a brook over stepping stone," "walking in a gale," and "relinquishing drapery for nature's garb," which is the notebook title for almost every sequence of a woman undressing.

◀ **Figure 24** Plate 73:
*Turning around in surprise
 and running away*
 (original title: "Ashamed").
 Muybridge's interest in
 human expression calls to
 mind the numerous
 photographic studies of
 normal and abnormal
 expression that were
 being done in Europe
 around this time (see Didi-
 Huberman 1982). See
 also plate 55.

Figure 25 Plate 268: ▶
Arising from the ground.

Muybridge used his camera to disclose those aspects of human activity that usually remained unseen: unseen, not because invisible to the naked eye, but because social conventions and morality dictated that they remain concealed except in the imaginative world of private fantasy. The photographs objectify erotic impulse and extend voyeuristic curiosity in a language we now recognize to be taken from the standard pornographic vocabulary (Figure 21). Naked women meet and kiss, kneel in supplication, crawl around on their hands and knees and on all fours. They disrobe each other, pour water down each other's throats and dump buckets of it over each other's heads. They also smoke—a practice confined at that time to actresses or other "loose" women. And "smoking" is the only description given in his notebooks for these plates, even though Muybridge's public titles declare that the subjects were engaged in other activities (Figure 22).

Conclusion

Muybridge's concern is with stories, not with movement. We are invited to share in this concern. The setting in which the photographs were made, by dint of its familiar three-dimensional construction, stimulates more than just an interest in the rhythms of gesture and posture. Each sequence and each single image within the sequence invites us to transform the models into *dramatis personae* frozen into unaccustomed postures of beguiling attraction (Figure 23). We are not limited to a purely formal consideration of the contours of the body or the shape of any action but are impelled beyond, into the world of dramatic narrative and biography. Light and perceived depth (the strong modeling and the vigorous foreshortening) call our attention to the human interest of the subjects and the photographer's artistry in putting them through their paces, while titles such as "Turning around in surprise and running away" ("Ashamed" in the notebooks) help to establish the tale (Figure 24). The faces demand scrutiny; the concentration with which they go about their tasks and the sheer individuality of each cajole us into a psychological identification with them.²¹ We are compelled by the subject's fascination with his or her own performance and by the photographer's fascination with them.

the camera cannot lie, has been extended by the viewer to include the arrangements. Muybridge's claim to science thus rests on the viewer's belief in the objectivity of the camera and the structure of the sequence. As such, it is suspect. But if the explanations and representations of movements that make up *Animal Locomotion* are not scientific, they are still the most convincing *illusion* of natural movement that had hitherto been achieved. They call for a shifting of our belief in the nature of the work so that Muybridge the artist might rival or displace Muybridge the scientist.

Acknowledgments

David Wooters, print archivist at Eastman House, Rochester, Joel Snyder, professor at the University of Chicago, and Blake Fitzpatrick drew my attention to a number of facts contained in this article. Financial assistance for the research was provided by the Social Sciences and Humanities Research Council of Canada.

This study began under the direction of Hollis Frampton, who sadly is no longer here to thank.

Muybridge's fascination is made clearer in the description of his models from the prospectus. Males were cataloged by profession (including the photographer himself as an "aging athlete") and females by marital status, weight, and age. In the notebooks, one can also find hip, bust, and even shoe size. Although Muybridge may have been aware that the mechanical nature of the medium in which he was working provided a distance that dematerialized the nakedness of the female body, the singularity of such individuals as the 340-pound naked lady (age twenty and unmarried) attempting to stand up cannot be diminished by his stated photographic purpose (Figure 25).

We have always assumed that Muybridge was photographing movement in time, that he was showing us how humans and animals get from one place to another by stopping time and freezing motion. But what seems evident is that he was telling stories in space—giving us fragments of the world that we could construct into people's lives, into dramas or jokes or fantasies—so that we would immediately recognize what we have never seen before. Muybridge, under the guise of offering us scientific truth, has, like any artist, made a selection and arranged his selection into his own personal truth. Why this has not usually been seen or commented upon²² seems clear: the contract between the viewer and the single photograph, which is based on the unshakeable belief that

Notes

- 1 "Dear Friend,
I am in admiration of M. Muybridge's photographs published in the issue before last of *La Nature*. Could you put me in touch with the author? I would like his assistance in the solution of certain problems of physiology so difficult to resolve by other methods. For instance, on the question of birds in flight, I was dreaming about a kind of photographic gun for seizing the bird in an attitude, or better, in a series of attitudes which impart the successive phases of the wing's movement. . . ." (Marey to Tissandier in a letter written on December 18 and published in *La Nature* on December 28, 1878.) Muybridge responded, and he did make pictures of birds, which he brought with him in 1881, but the results were so disappointing (see note 5) that Marey immediately got to work on his photographic gun and had it operating successfully by the winter. Mozely 1972 and 1979 translates "je rêvais"—"I was dreaming" or "I was musing"—as "I have devised," which inaccurately pushes back the invention of the photographic gun by more than four years.
- 2 For the development of Marey's cameras, see Braun 1983; Frizot 1977; and Marey 1895.
- 3 Muybridge's California work is fully documented in an excellent study edited by Anita Ventura Mozely; see Mozely 1972.
- 4 Muybridge's zoopraxiscope comprised a magic lantern that illuminated and projected revolving discs upon which were painted images from his photographs, giving the illusion of movement. This instrument is thought to substantiate his claim as the "father of motion pictures." But Emil Reynaud had already "invented" animated film (i.e., drawn or painted images on strips and a projecting mechanism that gave them the illusion of motion) in 1877. Moreover, Reynaud's films had sprocket holes in their sides so that they could be advanced evenly. Later Muybridge did use photographs in his zoopraxiscope, and in his desire to establish his position in the history of cinema, he felt it necessary to request that his painted discs

be "utterly destroyed so that no remnants of them will remain. I now much regret having made them as they are not calculated to enhance my reputation. The original figures photographed from life are those I prefer to leave behind me and I shall feel more comfortable when you write me of your having completely destroyed them" (letter of June 16, 1899, to E. Faber, University of Pennsylvania archives).

- 5 On his part, Muybridge presented Marey with the photographs of birds Marey had requested three years previously. Marey's reaction to this picture was not wholly positive—Muybridge had frozen a group of pigeons in midflight rather than the successive positions of the wing of one bird. Marey invited the American to his laboratory at the Collège de France and out to the Bois de Boulogne, where his physiological station (where he would carry out his photographic experiments) was being constructed. In a letter to Frank Shay, Muybridge changes the ownership of the physiological station: "make me a visit to my [sic] Electro Photo studio in the Bois de Boulogne and I will give you a welcome" (Dec. 23, 1881, Huntington Collection, Syracuse University). Muybridge was taking a risk with his invitation, because the station was not finished until the late summer of 1882.
- 6 All of Muybridge's lectures—which compared the treatment of the horse in art photography—were taken from Duhoussset's 1874 book and Marey's 1878 article in *La Nature*.
- 7 Transcription of Muybridge letter to Stanford, May 2, 1892, in the Bancroft Library, University of California, Berkeley.
- 8 Muybridge to Shay, December 23, 1881, Huntington Collection, Syracuse University. The many requests to Marey to participate in this venture are documented in the transcripts of four Muybridge letters to Marey in the California State Library, Sacramento.
- 9 Eakins had been in correspondence with Muybridge since 1878 when he had written Muybridge a letter urging him to develop and use a more accurate system of photography (Alta, California, November 21, 1878).
- 10 This committee (not to be confused with the supervisory commission described below) consisted of C. C. Harrison, future provost of the university; Thomas Hockley; Samuel Dickson; Edward Coates, chairman of the Instructional Committee of the Academy of the Fine Arts; J. B. Lippincott, the Philadelphia publisher; and Pepper. Originally Muybridge was given \$5,000, which came either out of Lippincott's pocket (Haas 1976:146) or directly from Pepper (Mozely 1979:xxvi). Then each of the six members advanced \$5,000, probably at the time of the formation of the supervisory commission (Mozely 1979:xxvi). According to Hendricks (1975:153) the committee comprised one Joseph Harrison, a philanthropist; George Barker, physicist; Lippincott; Coleman Sellers; and Pepper. Dr. F. X. Dercum, a participant in the Pennsylvania work, stated that Pepper "secured the co-operation of Mr. C. C. Harrison, Mr. Edward Coates, and Mr. Hockley. . . . These four gentlemen formed a pool giving the sum of \$10,000 each toward the expenses of the undertaking" (letter to G. Nitzsche, May 10, 1929, University of Pennsylvania archives). As for the total cost of the work, again reports differ: in another (undated) letter in the University of Pennsylvania archives from E. Faber to Nitzsche, the sum is fixed at \$35,000, of which Muybridge repaid \$30,000 from sales of the portfolios. According to the Provost's Report of October 1887, "the outlay for lenses apparatus and other purposes exceeded \$30,000" (although in his introduction to *Animal Locomotion: The Muybridge Work* . . . , Pepper states that the outlay was "nearly \$30,000"). Hendricks gave the total cost as more than \$40,000 (p. 154), and Mozely put it at \$50,000 (p. xxxiii). Muybridge himself did not say how much he received, but the sales of the work were too low to repay the outlay: "I am not very high in favor with any of my guarantors and perhaps shall not be until they have recouped the thousand ⁴ dollars or so they are each of them out of pocket as contributors to the world's knowledge and the Universities honor" [sic] (letter to Jessie Burk, August 5, 1895, University of Pennsylvania archives).
- 11 Muybridge made a diapositive from each of the original negatives provided by his cameras. From the diapositives a composite gelatine negative was made, and a final collotype positive was then printed. The collotypes varied in dimension from 12 × 19 to 6 × 18 inches. They were printed on 19 × 24-inch linen paper and sold by Prospectus to subscribers at \$100 for a portfolio of 100 plates. Six hundred dollars would buy all eight portfolios, as the extra 181 plates were included free. Only thirty-seven perfect sets of the complete work were produced. Sales of the work in this form were a failure. Later Muybridge published selections of the work in book form in London: *Animals in Motion* (1899) went through five editions; *The Human Figure in Motion* (1901) went through seven editions.
- 12 The university sent a formal invitation to Muybridge on August 7, 1883; the commission was formed in March 1884. Usually these events are understood to have happened at the same time. In his acceptance letter to the university of September 3, 1883, Muybridge reiterates the terms of the university's invitation, but the commission is not mentioned. Therefore, its establishment is most likely the product of some hesitation or doubt on the part of the university.
- 13 "The actual facts are from beginning to end he was an instrument to carry out my ideas" (Stanford to Stillman, January 1883, Huntington Collection, Syracuse University).
- 14 Marey 1899, my translation. For similar views, see Gastine 1897:13ff and Eder 1888:ch. XXI.
- 15 Muybridge began his photographic work at Pennsylvania using three systems. The first, a single camera and lens with a slotted-disc shutter (or two, revolving in opposite directions on a single axis), originated with Marey (the shutter was called a Marey wheel). It was used extensively by Eakins, who perhaps imposed it upon Muybridge, since it afforded greater accuracy than his multiple cameras. The second was a single camera with eight lenses in a corona and a slotted-disc shutter. Muybridge had already written to Marey in July 1882 describing a similar machine. He told Marey he was going to patent it but apparently could not do so (transcription of this letter is in the California State Library, Sacramento). Finally, Muybridge used his own multicamera system but without much success. By August 1884, he still had "not yet done any work with his series of lenses and I hear they do not work. The shutters are too clumsy and slow. The university people are dissatisfied with the affair as he cannot give them the result they expected. Which was to photograph the walk of diseased people paralytics etc. so that by means of the zoopraxiscope (help!!!) they could show their peculiarities to the medical student. This it seems however cannot be done even with the best known contrivances So they would like to fire the whole concern but they have gone too far to back out" (from Thomas Anschutz to J. Wallace, August 1884, Archives of the Pennsylvania Academy of the Fine Arts. Descriptions of the various cameras used are to be found in this letter and one dated June 18, 1884.). There seem to be only fourteen plates in *Animal Locomotion* from the summer of 1884. See Figures 17 and 17a.
- 16 The foreshortened views have their genesis in the work done for Stanford, in which Muybridge photographed a phase of the horse's (and man's) gait simultaneously from up to five different viewpoints. The results, however, were not published in a sequential arrangement (Muybridge 1881: photographs 110 and 187–191). In the same volume Muybridge published fifteen separate athletic poses (photograph 123), which, like the separate poses in *Animal Locomotion*, are arranged together in sequences on one page.
- 17 By 1885 Muybridge had incorporated a tuning-fork chronograph to measure the intervals between exposures (a full description is given in Marks, Allen, and Dercum 1888:26). However, the times given in the prospectus cannot all be found in the notebooks Muybridge made during that year. The notebooks do show, however, the range of inaccuracies to which his system was prone: out of 778 experiments recorded, there were 118 without any time record, 52 camera failures, 28 chronograph failures, and 95 darkroom-related mishaps, such as fogging, breaking, etc.

- 18 Where L = lateral view, F = front foreshortening, and R = rear foreshortening, these variations are: LFR, LRF, LR, LF, LRLR, LFLF, LLR, LLF, LLRF, LLFR, LLRR, LLFF, LLLRR, LLLFF, LLLF, LFF, LRR, LLFFR, LLFFRR; FL, FLL, FF, FFFF, FR, FRR, FFR, FFRR, FRFR, RR, RLL, RLF, RFF, LL (one continuous series or two different series), LLL (continuous and/or different series), LLLL ("") LLLL (""), as well as the "track shots."
- 19 Even though they are listed in the prospectus as being constituted by six laterals and three each of front and rear, sixty-degree and ninety-degree foreshortenings. Since no one photograph is on the same perpendicular line in any of these cases, such a listing makes rather a mockery of all the designations.
- 20 In the end, the supervisory committee seems not to have given Muybridge that much help or supervision: "Such help as I was able to give Muybridge was at the inception of his work in aiding in perfecting his then rather crude apparatus and subsequently by suggestions regarding technique, topics etc." (Reichart to G. Nitzsche, undated, ca. 1929). Dr. F. Dercum, who was responsible for the photography of abnormal locomotion, reported that except for himself and Eakins, everyone else was on summer vacation while Muybridge was working (letter to Nitzsche, May 10, 1929), although we know that Dr. Andrew J. Parker, professor of physics, was present at the work done at the zoo in 1885. Eakins worked with Muybridge the first summer of 1884 but soon became fed up with both the work and the man: "In fact, Eakins seems at this time to have been disenchanted with Muybridge's method and one feels with Muybridge himself whose showmanship was so at odds with his own public reticence" (Mozely 1979:xxix). When the work was finished, the university decided to issue a companion volume of three essays written by William Marks, the engineer responsible for the chronograph Muybridge used; Harrison Allen, physiologist; and Dercum, respectively. All three damned Muybridge's work with faint praise. Marks and Dercum emphasized the advantage of Marey's single-camera system, while Allen wrote that many of the statements in his essay "could have been deduced from data already accessible to the writer but since he wrote the paper immediately after the inspection of the photographs his conclusion may be said to be based on them" (Marks, Allen, and Dercum 1888:35). But the last word should go to Pepper, who instituted the commission and funding. In his introduction to these essays, he noted: "The mass of novel material presented in this work is so great that it has not as yet been possible to subject any considerable portion of it to critical examination" (p. 7).
- 21 By contrast, Marey's models are anonymous and depersonalized. His photographs are obviously and overwhelmingly graphic and two dimensional. There is no measured-off backdrop in the images to suggest space, and no clue to depth or recession can be perceived within the frame.
- 22 None of the authors who has written on Muybridge in this century found any anomalies in *Animal Locomotion*. MacDonnell thought that "It is doubtful whether [Muybridge] approached the work quite as seriously as is sometimes supposed" (1972:127), and "he probably thought it all pretty hilarious" (1972:10). Hendricks found that "sometimes [Muybridge] was hard put to decide what to have his models do," and "[he] decided a light touch might do the publication some good" (1975:186, 187). But like Mozely, for whom "Muybridge was a man who assumed a scientific attitude very gradually" (1979:xxxi), none of these writers has drawn any implications for the work from these comments.

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