The Complexion of Two Bodies. Part One: Nuance Drawn Out

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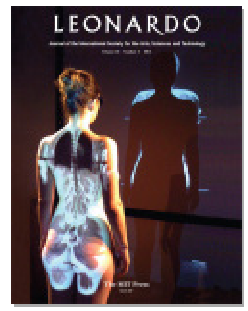

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ABSTRACT

Motion capture, eye-tracking and digital image capture technologies are rapidly replacing traditional life drawing practice. We are led to believe that such technologies provide high-quality movement-analysis resources, yet these new tools are only in the early developmental stages. The author employed cutting-edge movement-analysis technologies and traditional drawing practice to create a series of "transparent" key-frame drawings based on Muybridge-style movement sequences, depicting specificity of the skeleton and musculature at key anatomical landmarks as though seen through the skin to stimulate perception of both movement and structure simultaneously.

Drawing Room

This is the first half of a two-part essay [1]. These essays present 10 years of research in England funded by the British Council, Leverhulme Trust, Arts and Humanities Research Council (AHRC) and Natural Environment Research Council (NERC) to conduct a series of art-science collaborations with two foci—to use conventional drawing practice with medical science technology to create new resources that reveal nuances of the perception of human movement, and to use drawing practice combined with physical science methodology and technology to enhance visual literacy about land preservation. Both foci use conventional and intuitive means of mapping appearance and movement to investigate how drawing functions as a means of holding and transferring information integral to our everyday and professional lives.

The January 2012 issue of *Tate Etc* magazine features an article that is particularly relevant to both foci of my research. In that article, Katharine Stout reviews the first of a series of ongoing exhibitions on "Contemporary Drawings in Great Britain" at the Tate Gallery. Stout writes:

> The way in which these artists and their peers in the United States are testing the limits of how drawing can reinvent ideas of representation is perhaps reflective of a growing number of artists concerned with the specific material qualities of their chosen discipline. . . . They share a disregard for clichéd ideas of drawing as being best suited to tentative gestures of immediacy and spontaneity, instead investing time, skill and preparation into the production of their art. . . . The legibility of the image breaks down as the eye is drawn to the detail of the delicate lines that make up the forms. The viewer is pulled between the spatial depth of the image depicted, then back to the surface of the paper by the detail . . . an action that one critic has described as oscillating between the "microscopic and macroscopic." The investment of the material nature of drawing . . . is not a nostalgic return to modernist notions of "truth to materials," as it is tempered by a multidisciplinary approach and an adherence to an intellectual pursuit of how images carry meaning [2].

The State of the Art

Motion capture, eye-tracking and digital image capture technologies have rapidly replaced traditional art practice such as life drawing. However, these new tools are only in the early developmental stages. Those who no longer have the perceptual skills to scrutinize images created with these elaborate movement-analysis tools are led to believe that the software provided within them are high-quality resources. Current movement-analysis training has the tendency to prioritize development of expertise in the technology and not in the underlying movement, and as a result we are often left with poor-quality simulation of movement.

Motion-capture, for example, is a precise data-collection tool with the potential to become a valuable cross-disciplinary movement-analysis resource, yet much of the accompanying animation software is substandard and systemically difficult to rectify. For example, the standard virtual "Polygon" skeleton provided within most motion-capture systems is incomplete, disproportionate and poorly jointed. Axial rotation is derived from the central volume of the torso instead of rotating naturally around the spine, causing the thorax (ribcage) to shrink drastically as the subject bends forward and to swell well beyond the body contour when the subject bends backward (see Fig. 1). This anomalous juxtaposition of such an inaccurate skeleton provided within the most current and sophisticated motion-capture systems is presented and often accepted as accurate, even within advanced scientific research and application [3].

It becomes increasingly critical that we monitor and enhance the quality of these new tools upon which we have come to rely. The nuanced movement-analysis learned from past methodology can help us to monitor the quality of the technology that we are so eager to embrace.

Cause and Affect

Causal effects of technology on movement-analysis and perception might be due in part to the cumulative result of generations of reliance upon computers. One of the pioneers of computer art, the French artist of Hungarian origin Vera Molnar, felt that, although the computer can encourage the mind to work in new ways, artists often pass far too quickly from the idea to the realization of the work [4]. There is a persistent belief among art practitioners and educators that the perceptual and technical skills gained from traditional forms

Jeanine Breaker (artist), 39 Loraine Road, London, N7 6HB, U.K. E-mail: <jeanine.breaker@gmail.com>.

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Abridged versions of this essay were presented in January 2012 for an Arts and Humanities Research Council *Beyond Text* Research Conference, "Capturing Movement," at the London Knowledge Lab, Birkbeck University of London and the Institute of Education, and Queens College, University of Cambridge.

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Fig. 1. Image of a model composited with the standard disproportionate and poorly jointed virtual "Polygon" skeleton provided within most motion-capture systems used for scientific research. (© Jeanine Breaker)

of movement-analysis such as figure study have become obsolete for simulating human movement. In my experience, this belief has been caused by, and has contributed to, an increased reliance upon appropriation of substandard computer models.

Stanford University professor Robert Harrison writes,

> All the evolving devices and apps draw [students] into their blinkered personal realms. . . . This retreat from the natural world is most evident in the young, but it is not a generational phenomenon. Instead the ubiquity of the computer is changing the very essence of the human animal [5].

A July 2008 *Independent* article in citing research from the University College London [6] suggests that "we now expect to take in information the way the net distributes it: in a swiftly moving stream of particles . . . chipping away the capacity for concentration and contemplation" [7]. As media theorist Marshall McLuhan pointed out in the 1960s, media supply the stuff of thought but they also shape the process of thought [7].

Such research suggests that prolonged and constant use of personal computers has caused our thinking to take on a "staccato quality" [7] particularly disruptive to the ability to understand and depict the figure and figural movement with ease and assurance [8]. Given such diminished fluidity, it stands to reason that the critical ability to perceive, simulate and scrutinize fluidity of figural movement is likely to decrease with each generation of learning and teaching.

Acceptance of gross inaccuracy and distortion from movement-analysis technology is pervasive in the entertainment industries. Early and long-term exposure to the distorted representations of the body in video games has the potential to contribute to "virtual dysmorphia," particularly when such distorted models are prevalent in preadolescent games that re/present these models as idealized bodies. The image shown at the left in Fig. 2 is a traced outline of a popular games avatar presented as a virtual "beauty queen"—the associated inset depicts a normally proportioned body for comparison [9].

Animation studios have increasingly replaced highly skilled traditional animators with computer animation programmers, leaving animated feature films populated with animals, fish, avatars, robots and toys instead of human beings. When human characters are simulated, natural proportion and nuanced movement are replaced by the awkward, simplistic waddling of infantile cartoon characters such as those in *South Park* and *The Simpsons*. Popular virtually immersive environments feature distorted, robotic, fetishistic personifications such as those in *Second Life*. (The drawings in Fig. 2 center and right are traced outlines of avatars from *Second Life*, shown with an inset of a normally proportioned body scaled for comparison).

Such distorted models and substandard movement are also used in Wii games, encouraging poor and potentially harmful sporting technique that can erode the nuanced movement of sport mastery and the physiological benefit and pleasure gained from acquiring such skills—real and virtual. Ultimately, "humans are exquisitely sensitive to how other people move. When a character's visual appearance creates the expectation of life and it falls short, your brain is going to reject it. . . . Players have to relate to the characters they are holding in the palm of their hand" [10].

Experts such as psychotherapist and psychoanalyst Susan Orbach suggest that the extreme body dysmorphia that permeates our media—"a look that only ten years ago had the power to evoke horror in us"—is not the only possible outcome of a digital and hyper-saturated image culture. "The very tools that have given rise to a narrowing aesthetic could be redeployed to include the wide variety of bodies people actually have." In fact, "it may benefit these same industries to celebrate diversity and variety and to make it their ethical aim to transform the body distress so many experience today" [11].

Movement-Analysis Research

The movement-analysis research that I conducted and describe in this essay is informed by the heuristics of 30 years of visual art practice and pedagogy as well as an ongoing international master class lecture circuit specializing in the anatomy of movement. I was invited by the Royal College of Art (RCA) to conduct a series of such master classes in 2001. The acquisition of skills such as those used in life drawing had already encountered pedagogic devaluation in the U.K., and life drawing courses had disappeared from most U.K. college curricula. Yet depiction of the human body continued to permeate the visual arts in one form or another, and students and practitioners in a range of fields continued to search for adequate visual resources to aid in their understanding of the nuances of figural structure and movement.

Although understanding and depicting convincing figural structure and movement generally involve some sense of basic anatomy, it is often difficult to find accurate and consistent resources that provide a clear picture of figural movement. Even highly regarded reference books of anatomy for artists describe human structure with static and often rigid illustrations that are riddled with inaccuracies. Reference texts broadly used in fields that simulate movement, such as animation, dance and even biomechanics, are commonly illustrated with stick figures, providing little information about the subtlety of structure or the manner in which internal structure drives movement. In my experience, as practitioners and students increasingly struggle to access adequate resources to help them understand and simulate figural movement, they also lose the ability to scrutinize it, and as a result the critical ability to perceive, simulate and scrutinize figural movement decreases with each generation of learning and teaching.

Some artists/educators worry that knowledge acquired from life drawing study would compromise individual creativity with a propensity for representational art. The acquisition of such knowledge and skill can intentionally or unintentionally take precedence in an artist's visual repertoire during an intensive period of study; however, output is ultimately a matter of choice. Concern that too much knowledge eliminates choice seems the most likely way to compromise choice. An announcement for a recent exhibition at the University of the Arts London, entitled "The Perfect Nude," stated:

> The idea of the nude has been in decline in art-school: life drawing is no longer widely practiced. Ideas and research are currently preeminent. . . . Would it not be apposite, then, to look at this neglected genre? The nude seems ripe for reawakening: It is an implicitly psychological genre, tapping directly into the artistic psyche. . . . The artists hope the show will create a rich network of images that will establish a context for representation of the body in contemporary painting [12].

As a result of a perceived need for the information that I presented in my RCA master classes, I was invited to conduct a research fellowship in 2002–2003 to create resources that visually describe and preserve methodology for understanding figural structure and movement [13]. My research and output, collectively called "*moving*drawings," have been documented in a number of publications [14,15].

are examples of extremity of torso action and axial balance during locomotion.

As discussed above, the crude Polygon skeleton generated by motion-capture software provides poor anatomical fit with the corresponding subjects, particularly as they move, and as subjects vary in size and proportion. After much experimentation to adapt a range of existing virtual skeleton models to be used with my motion-capture data, collaborative research at the Filmakademie Baden-Württemberg in Germany [17] resulted in the greatly improved virtual skeleton described below.

A computer animation plug-in was created that generates exact digital bone replication from full-body MRI scans of any live model. Full-body MRI scans were created of the model filmed for my research project, outputted in 1,000 micro-thin computer-generated images. An exact digital virtual replica skeleton was derived from the filmed model's MRI-scan data, which was depicted in a 100-frame turntable. (One frame of that skeleton turntable is illustrated in Fig. 4, left.)

A bespoke rig was meticulously fitted to the virtual replica skeleton, through which its movements are driven, and then integrated with the motion-capture data. The rigged replica skeleton and simultaneously captured video footage of the model were imported from the movement sequences and composited (see Fig. 4, right) and created into short movies. (Simultaneously captured composite stills of a catwalk are illustrated in Fig. 5.)

These composites of the MRI scans and films of the subject enable much more precise movement simulation than does the crude Polygon skeleton. Yet in spite of the improved anatomy of our replica, the subtlety of movement would have been greatly compromised had the image integration relied solely upon current motion-capture technology and existing software to accommodate the rig that drives the skeleton. Synchronization of the model's replica skeleton with her simultaneously captured video footage required manual manipulation by the designer of the software. When the technology advances, new motion-capture and/or rig animation software will need to be designed to accommodate the potentially subtle, naturalistic movement of our virtual replica skeleton.

I used the composite stills as resources to select and draw key-frames that describe the anatomy of each movement sequence. The hand-drawn key-frame drawings were animated to elucidate nuances of the basic movements. One of the benefits of these drawings over the video/skeleton overlay movies is that they illustrate precise movement and musculature at key anatomical landmarks as though seen through the skin without one layer obscuring another.

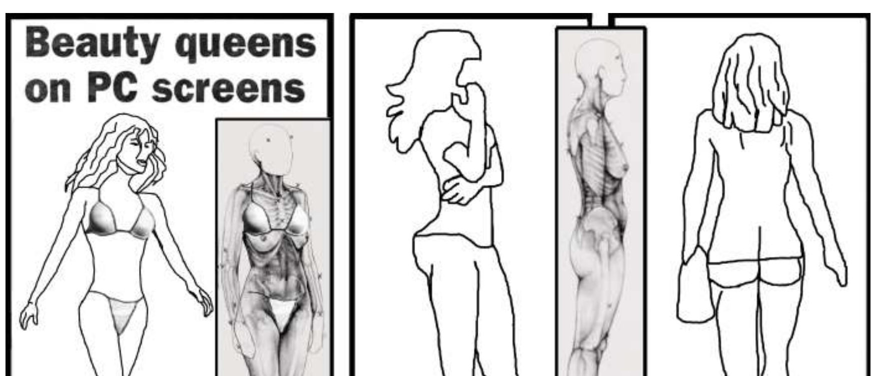
The *moving*drawings provide cognitive benefits as well. The *moving*drawings research is intended to stimulate perception of movement and identification of structure simultaneously—two functions that are processed in very different parts of the brain. The modicum of key-frames that compose each of the *moving*drawings

RESEARCH METHODOLOGY

Movement and detail are perceived in different parts of the brain [16]. My research aims to bridge that cognitive gap through simultaneous stimulation of both levels of perception. I created a series of key-frame drawings depicting Muybridge-style movement sequences that articulate anatomical specificity of balance negotiation within a movement stream. A modicum of key-frames were selected and drawn to appear transparent, revealing the specificity of the skeleton and musculature at key anatomical landmarks as though seen through the skin (Fig. 3).

A nude model was simultaneously filmed with video and motion-capture while performing brief fundamental movement sequences such as bending, reaching, twisting, sitting and walking. The walk sequences that I chose to depict

Fig. 2. Left: Traced outline of a popular game avatar presented as a virtual "beauty queen." Center and right: Traced outlines of virtual world avatars from *Second Life* (insets are of normally proportioned bodies for comparison). (© Jeanine Breaker)



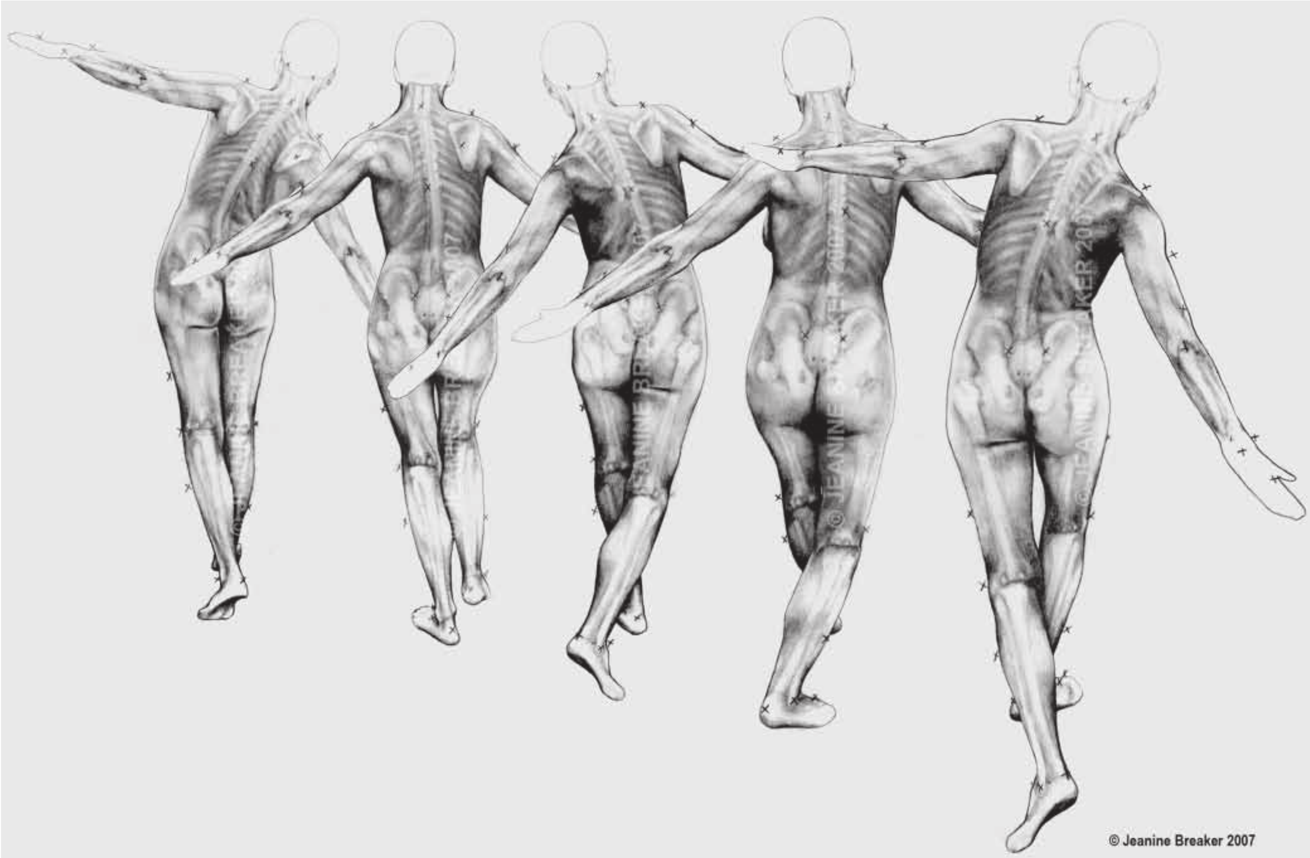


Fig. 3. Transparent "*moving*drawing" key-frame drawings created from filmed Muybridge-style movement sequences, drawn by Jeanine Breaker through support from the Arts and Humanities Research Council. (© Jeanine Breaker)

sequences presents the anatomy of only the substantial weight shifts from each movement stream. Each is held static and then refreshed, causing a "jerky onset of attention" [18] with the presentation of each new key weight shift. The efficacy of this reasoning is clarified below.

Underpinning Research—The Science of Perception

Richard Gregory wrote in his seminal 1979 book *Eye and Brain: The Psychology of Seeing*:

> The present drama of the science of perception is that cognitive phenomena seem to be very important. . . . When physics-based machines started to rival and take over cognitive tasks from humans, and beat us at chess, both the machines and humans came to look different—touched with magic. We owe to computer science making the magic of cognition respectable, simply because computers are clearly physics-based and yet work effectively with symbols, whose rules and laws are not those of physics. Physics-based computers . . . represent alternative universes, as the physiology-based brain does every minute of the day for perception. . . . This means that cognitive machines, our own brains and information technologies, are on their own; neither restricted nor guided by the physics of the universe. Artists have known this all along [19].

Gregory's research, along with more current neurological [20,21] and eye-tracking research [22,23], shed light upon the complexity of visual perception and how these complexities affect our visual literacy. Tim Hodgson states, "Our vision is akin to watching a fuzzy old black and white television set where the picture keeps cutting in and out rather than a wide screen high definition monitor" [23]. We are not consciously aware of this and the other optical defects and impurities in our vision because "it is not our eyes which see the world but our brains" [23].

"Visual search involves the coordination of 'looking' and 'seeing'. These two aspects of visual search are distinct from one another because high-acuity vision is possible only in a small region at the center of gaze, and only when the eyes are stationary" [24]. To sample detailed information, the eyes must move abruptly (saccade) from one location to another, typically three to four times per second. The efficiency of visual search—how rapidly and accurately a target is identified—is typically measured by the time that elapses between the first glimpse and target detection. This entails a direct trading relation between seeing (processing the information available) and looking (making saccades to new locations):

> Longer fixations increase information fidelity from each location at the cost of exploring fewer locations, whereas quickly exploring many locations results in reduced fidelity at each one. . . . [Studies comparing] human oculomotor behaviour with an ideal psychophysical observer have indicated that many participants come close to optimizing this trade-off in search [24].

Offering passive instruction encourages participants to prioritize "seeing," whereas active searching places emphasis on "looking." Recent studies have shown that "participants who are instructed to search passively search more efficiently than those who are instructed to search actively" [25]. Participants instructed to search passively look less and see more, spending more time on each fixation and thereby processing the acquired information more deeply, allowing the target to "pop into mind" [24]. The improved performance of participants instructed to search passively "is the result of more efficiently processing information and calm consideration of the information" [24]. They wait longer before beginning to move their eyes and make fewer saccades than do actively searching participants. "Moreover, the passive advantage stems from more efficient use of the information in a fixation, rather than from a wider attentional window" [24].

Underpinning Research—The Perception of Motion

Many animal species depend on visual motion perception for survival and, therefore, the ability to estimate the spatial-temporal trajectory required for interception or avoidance of a moving target. The neural underpinnings of visual motion processing for constant-speed targets have been studied extensively both in the monkey and in man [25].

Perceived movement is "not a retinal process . . . but a cortical process" [26]. Humans take in only about 20% of what our eyes see, and our brains construct the rest, often depicting a preconceived expectation of an object or scene to make sense of what is presented to us visually [27]. The success of the result—of what we understand, depict or simulate—depends upon our knowledge as well as our expectations. Gregory's "hypothesis testing" model [28] characterizes visual perception as a dynamic search for the best interpretation of the available information. The influence of preconceived notions of an object or scene is referred to in psychological research as "subject matter bias" [29] and has been the focus of recurring discourse among artists, theorists and teachers such as Leonardo da Vinci, Leon Battista Alberti, Ernst Gombrich [30] and John Ruskin [31].

"Research on the attentional effects of moving objects has shown that motion per se does not capture attention" [18]. Moreover, current studies prove that "the onset of motion does capture attention, and that motion-onset critically depends on motion jerkiness—that is, the rate at which the moving stimulus is refreshed" [18]. Furthermore, jerky movement is "aided by a richer context for memory by holding a subset of items static and allowing them to remain visible" [32]. Two experiments conducted for a study in which a continuous-motion-onset and an abrupt-onset stimulus are compared showed that motion onset captures attention only when subsequent motion is jerky, not when it is smooth. An example of this is the visually "smooth" motion of film when compared to the jerky motion of a *moving*drawings sequence: The latter allows the anatomical information to remain momentarily static and visible before it is refreshed. Another experiment, which replaced motion onset with continuous motion, showed that motion jerkiness did not affect how continuous motion is processed [18].

Further, "the memory link required to make sense of temporally discontinuous input" [33] is achieved through "perceptual filling-in" [34] and "anticipatory eye movement [whereby] the saccade to the next item is planned during an earlier gaze, rather than during the current gaze" [35]. This research supports the hypothesis that people rely on prospective memory while performing visual search, and when subjects are denied the opportunity to use prospective memory under dynamic conditions, they were more likely to reexamine an item than they were under static conditions.

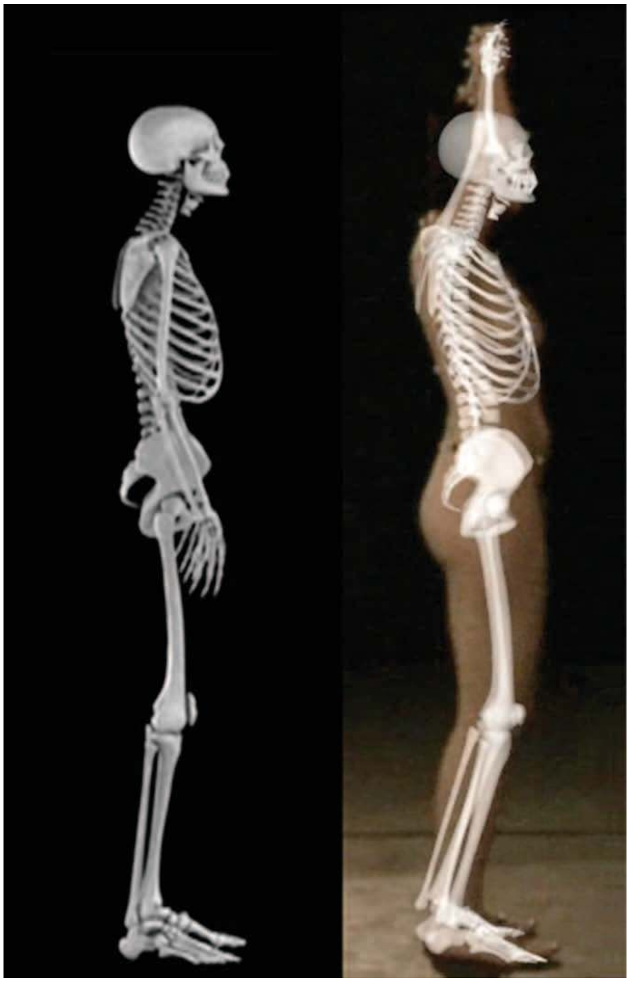


Fig. 4. Left: Computer-generated virtual replica skeleton model, an exact digital bone replication created from a full-body MRI-scan of a live model. Right: Composite of the filmed model and her virtual replica skeleton. (© Jeanine Breaker)

Practical and Pedagogic Application

The intent of the *moving*drawings sequencing is to simultaneously stimulate both perception of movement and identification of structure, which are processed in very different parts of the brain. The modicum of key-frames that compose each of the *moving*drawings sequences present the anatomy of only the substantial weight shifts within each movement stream. Each of the *moving*drawings movement sequences is represented by a set of 2–6 anatomically descriptive key-frames. Each key-frame is held static and then refreshed, causing a "jerky" onset of attention when each new key weight shift is presented. Sequences are looped to allow for repeated cycles of inspection—the eye stops and examines the most important elements [36] of each balance negotiation—and to encourage anticipatory perception and perceptual filling-in.

The *moving*drawings, then, stimulate perception of movement, although the viewer actually can see only a few static key-frames within each movement stream. I provide both visual and verbal passive instruction regarding the

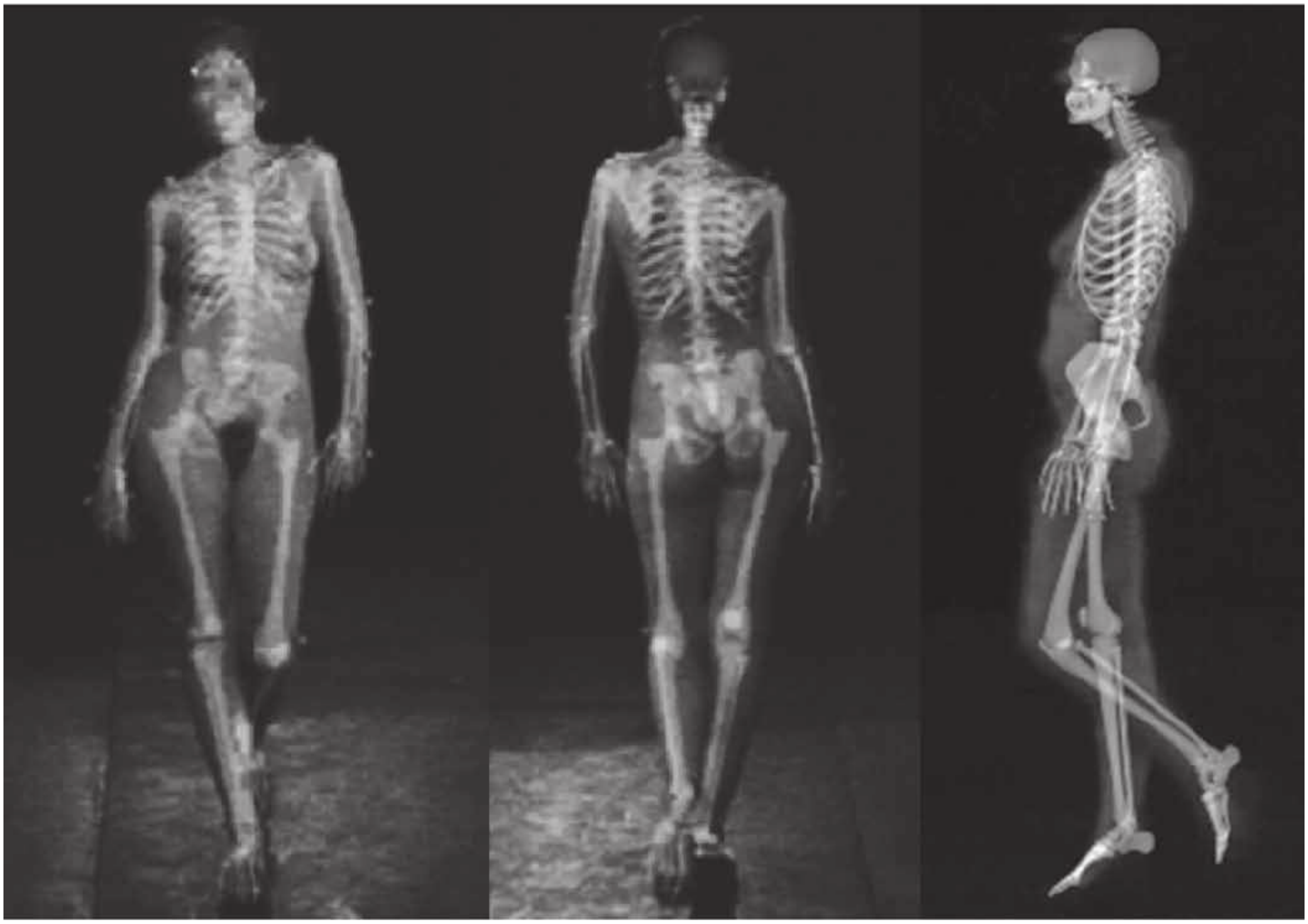


Fig. 5. Three views of a model performing a Muybridge-style (catwalk) motion sequence composited with the model's MRI-scan-based virtual replica skeleton. (© Jeanine Breaker)

nuances of each movement during preparatory lectures for the *moving*drawings master classes, and again while participants are drawing from the live model.

My *moving*drawings research was further developed in collaboration with scientists at Imperial College and the Medical Research Clinical Sciences Centre (MRCSC) at Hammersmith Hospital. Collaborative dissemination with Imperial College culminated in 2008 with *Body Perspectives*, a technology-based public event presented at the Science Museum in London [37]. I presented a *moving*drawings master class to a group of 80 artists and scientists from the general public. Vertical MRI scans of a male and a female model were intermittently projected onto the models as they posed nude (see Color Plate C and issue cover), depicting the internal anatomy as though visually "slicing through" the models' bodies.

Further *moving*drawings research with medical science clinicians and neurological researchers at Johns Hopkins University Hospital and the University of Chicago focused on perception and simulation of the anatomy of movement from neurological and sociological perspectives as well as through visual acuity [38].

Conclusion

Paralympic athletes now run faster on high-tech prosthetic legs than Olympic athletes can run on flesh and bone. Full-body X-ray scans are used in airport security to identify the slightest threat. Looking into the human body and studying its movements will undoubtedly be tied with unimaginable new technologies in the future; however, new technology never remains new. Moreover, as art borrows technology from science, and science borrows from art, the subtlety, if not the integrity, of the practice being replaced can easily be lost.

We can elect to hard-wire new perceptual propensities with an over-reliance on new tools, erode our ability to recognize, understand or even value subtlety and ultimately lose the ability to scrutinize authentic, nuanced movement—or we can choose not to become victims of our own devices. If we negotiate with our technology rather than become dominated by it, free of an addiction to the keyboard, these tools—whether old or new, simple or sophisticated—can serve, rather than subjugate, the processes of creativity and invention.

We can choose to demystify our new tools and not feel threatened by sophisticated use of the old ones, enabling artistic maturity to form as a cumulative process. To elaborate on a John Ruskin quote, if we can balance "the head, the heart, and the hand" [39] to make work with care and intelligence in a way that need not disavow the past, we can carry that wisdom forward with visual literacy.

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