Understanding Material-Based Imagination

Cognitive Coupling of Animation and User Action in Interactive Digital Artworks

ABSTRACT

We argue, from a perspective integrating cognitive science and the arts, that interactive animated visual graphics, *as embodied images whose understanding relies on users' perceptual and motor apparatuses, connect both mental and material notions of images. Drawing upon cognitive science theories of conceptual blending and material anchors, recent neuroscience results regarding mirror neurons, and phenomenological approaches to human-computer interaction, we bridge the gap between visual perception and bodily interaction in digital environments – calling this process as "material-based imagination" (in contrast to the general notion of imagination as purely a mental activity).*

Animated images trigger a reflective process in which material-based imaginative construction and elaboration can take place. When this process, enabled by today's real-time control and rendering technologies, becomes instantaneous and continuous, it mobilizes a motor-sensory feedback loop. This type of user experience constitutes embodiment *of meaning and intention through interaction with digital media artifacts.*

This kind of embodied understanding is pervasive in today's digitally mediated environments. Through analyses of digital artwork, we show the important role of imaginative blends of concepts in making multiple levels of meaning through embodied expressiveness with motion-based motor input. The implications of these analyses collectively form a step toward an embodied cognition approach to animation phenomena and toward recentralizing understanding of artistic and humanistic production in cognitive research.

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by

Kenny K. N. Chow & D. Fox Harrell

Kenny K. N. Chow
School of Design
The Hong Kong Polytechnic University
sdknchow@polyu.edu.hk

D. Fox Harrell
Comparative Media Studies Program &
Program in Writing and Humanistic Studies
Computer Science and Artificial Intelligence Lab (CSAIL), Massachusetts Institute of Technology
fox.harrell@mit.edu

1. INTRODUCTION

"Image" has many meanings. It literally refers to the pictorial images that exist in material forms, like sketches, photographs, or lithographic prints. It also refers to what we see, but do not consider to be fundamentally material, such as shadows or film projections. However, the term "image" has also been extended to mean that which occurs in our minds when we think of something, perhaps recalling something seen in the past. Sometimes, the term image can even refer to an imaginative construct shared by a group of people that may be more about emotional impressions and associations, like the general image of a corporation or a rock band. Hence, the term spans both the material and the mental.

However, in the field of semiotics many thinkers (e.g., Roland Barthes) have tended to separate the material image (e.g., a sound, a graphic symbol, or a picture) from the mental image, which refers to abstract ideas in our minds. Such theorists typically focus on how people make and share meanings of images. There is a substantial volume of literature on how to relate an internalized idea to a shared belief among a group of individuals. Most such arguments rest on articulating socially or culturally established relationships, stating that any symbol, whether verbal or visual, is just conventionally linked to its meaning. [1][2][3][4] Such ideas affirm a notion of mental images as abstractions.

Meanwhile, other thinkers question the idea that mental images are purely ephemeral abstractions. The philosopher Ludwig Wittgenstein asserted that images inside our brains (mental images) are no more abstract than images outside (material images), because we always think in terms of what we have already perceived, or what we are pointing at, regardless of whether they are verbal symbols or visual images. [5] We find that this view parallels insights from embodied and distributed perspectives on cognition, which are in direct opposition to mentalist perspectives

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(often based in Cartesian mind-body dualism). [6] [7] For example, the cognitive scientist Edwin Hutchins thinks that many physical tools in our everyday lives provide us with material images for mental operations.

Regarding animated images, the interplay between the material and the mental is more active. Moving images can be tools to think with, exhibiting material transformations in their own right, while viewers also feel visceral sensations and experience elaborative fantastic visions laid atop the material marks. In the tradition of Hutchins's instrumentally oriented examples, take the case of a compass in a cockpit where a pilot imagines where the needle should be in contrast to where it is. The rose is stable, but the turning needle may be seen as an animated image dynamic and contingent. In the case of artistic production, animated images may be much more creative, evocative, fanciful, and elaborative. They consist of material patterns enabling forms of imagination in which the image provides a constantly changing representation that is combined with the viewers' elaborating cognitive processes. This results in a tight connection between motor-sensory apprehension and imaginative experience. It is these more contingent cases of material-based imagery that interest us. Instead of concentrating on goal-specific computation, we explore material-based, open-ended imagination through cases of fluid and flexible representations in the form of animated visual images that could be called *elastic anchors* for imaginative elaboration.

Animators are well aware of this embodied form of imagination. In digital environments, animation becomes generative and interactive. Viewers of animated images are engaged not just through sensory perception, but also motor-based bodily interaction. A viewer makes meaning through this engagement of sensory and motor apparatuses with the system, echoing the embodied cognition idea that meaning-making processes involve both perception and motor action. On one hand, animated visual images constitute embodied understanding of sensation, for example they convey information about the physical world such as the effects of gravity or motion. On the other hand, bodily motor action often embodies intention, (directedness and dispositions toward the world). The two sides conjoin a motor-sensory feedback loop between the system and the user. Far from merely differentiating the qualitative difference between interpreting moving images produced using the stroboscopic effect from individual frames (though this is important), we are interested in articulating the locus of the sense of liveliness accompanying the perception of animated images. This involves seeing the gestural nature of movements, and the way that moving images exist and express in time. We believe animated systems entailing this motor-sensory connection are able to give users an embodied experience of an expanded illusion of life.

This article presents multiple cases of material-based imagination in animation and articulates a case for the new construct of elastic anchors through these illustrative examples. Toward this end, we first present a theoretical framework clarifying our perspective on what animation is and how it functions, and necessary cognitive science ideas upon which our ideas are grounded. Ultimately, our paper serves a humanistic end. We believe the insights from animation studies and the arts are central to understanding and designing new and pervasive forms of computational media cultural artifacts. Furthermore, these insights can drive development of new and transformative art forms based upon the uncanny ability of humans to interpret animacy in the moving inanimate.

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2. THEORETICAL FRAMEWORK

Our theoretical framework is strongly interdisciplinary. Its vantage point is strongly influenced by that of Paul Ward, one of the animation researchers who assert that animation should be studied as a discursive field integrating multiple areas of knowledge. [8] Following is an account of the areas that we integrate in our analyses.

2.1 Animation Studies

In this section, we present a brief survey of approaches to studying animation from film-based and computer graphics-based perspectives. We then characterize the inadequacies of these approaches by highlighting their over-reliance on considering the medium-specific image in animation as the central object in their investigations. These medium-centric approaches inevitably fail to cope with the new paradigm of digital animation enabled by emerging technologies and has failed to accommodate the material-based and imaginative cognition perspective that motivates this article.

2.1.1 Film-Based Approaches

In humanities disciplines, animation is often seen as a marginal type of film. Scholars in the humanities have predominantly drawn on two approaches to animation research, namely contextual and textual analysis. [9] The former looks at production contexts, including the historical, industrial, technological, economic, cultural, and even national situations in which individual works can be understood. The latter approach, usually more theoretical and ahistorical than the former, investigates the meanings of many canonical texts of the specific medium by performing close readings of works and comparative studies such as semiotic, genre, narrative, and other analyses. While this cursory overview certainly does not encompass the entirety of film-based approaches to animation, it captures at least a sketch of the prevalent and historical approach within the field.

2.1.2 Computer Graphics-Based Approaches

In computer science, animation usually refers to the digital synthesis of a sequence of images. Early research areas included hierarchical modeling and rendering in computer graphics, and development of efficient standards and encoding for multimedia. These concerns have been expanded by later studies to develop works including computer representation of physical objects and materials, photorealistic rendering techniques, simulation of physical phenomena, developing algorithmic approaches to generate organic behaviors such as flocking or other self-evolving patterns, implementing artificial intelligence (AI) programs to create animated behaviors, and much more. Initial application domains were primarily scientific, medical, architectural, and cinematic, yet the marvelous illusions generated by computers has spread to other communal and personal entertainment platforms, including television, digital billboards and signs, notebook computers, and hand-held devices.

2.1.3 Definitions of Animation

Animation theorists, interested in marking a new territory that centralizes animation as a field of study in its own right, began to isolate their area of inquiry by attempting to define "animation." The majority of these theorists have focused on production processes and industrial practices, unanimously arriving at a definition that centralizes the frame-by-frame manipulation of images (Small, Levinson, Solomon, et al.). [10] Others, however, defined animation in terms of styles (Furniss, Wells). [9] [11] In contrast, the Canadian animator Norman McLaren (1950) offered what has proved to be the most influential definition of animation. He defined it as about essence rather than process: "animation is the art of movements that are drawn." This idea, prioritizing movement over images or drawings, marks a major step toward the illusion of life. Yet, it still positions animation as sequential images in a particular medium (typically film), which is inadequate

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in addressing the emerging phenomena pertaining to animation across multiple media, such as experientially how and why humans perceive and imbue artifacts with the illusion of life.

2.1.4 Beyond Single Medium: Toward A Broader Perspective Based on Animacy, Interactivity, and Generativity

Hence, we call for a "movement" away from any single medium to a phenomenon-oriented approach to the study of animation. This movement brings into consideration human perception, cognition, and bodily interaction when dealing with animated artifacts, addressing the aforementioned discipline- and medium-centric problems. It shifts our focus from medium-specific images to diverse kinds of media artifacts imbued with an illusion of life, spanning a range from the nineteenth-century optical animation toys to computers in the late twentieth century. In fact, the close relationship between animation and many early experimental artifacts creating moving images has been respectively marked by some theorists (Cholodenko [12], Manovich [13], et al). Cholodenko's recent insights are exceptional in that he draws attention to the apparatus in addition to the animated image. [14] The "animatic apparatus," by which he refers to mechanical apparatuses that generate moving pictures, including the phenakistoscope and the zoetrope, manifests a double definition of animation: simultaneously meaning "endowing with life" and "endowing with movement." One could interpret as animistically giving life to inanimate images through mechanical movements like spinning, flipping, and illuminating. The tension between the illusion of life created and the mechanical movement in the apparatus is a useful analogy to the tension between digital animation (including various characters in CGI, or the moving icons in GUI) and the implementation techniques used to realize the visual interface elements we find in operating systems like Microsoft Windows or Macintosh OS X today.

Following Cholodenko, we add another double definition: interactive and generative animation incorporates a tension between motor input and sensory feedback. Animation should not only refer to visual imagery, it also includes the operation of the apparatus, which performs the embodied and material realization of animation. Early animatic apparatuses seem on the surface level to involve only visual perception. Yet in practice, a certain degree of motor action on the viewer's part is required, from the simplest action of peeping in, to more engaging physical operation to "generate" and "maintain" the moving images. Hence, it should be recognized that motor-sensory interaction is essential to the operation and reception of animation.

2.2 Perception, Cognition, and Bodily Action (Cognitive Semantics)

Cognitive semantics, an area of cognitive science within the field of cognitive linguistics, offers theories that propose the existence of an array of mental processes that operate pre-linguistically and often even pre-consciously in the construal of meaning from verbal text, pictures, and even films. [15] These processes, such as metaphorical projection and conceptual blending, highlight issues of context and situatedness rather than grammatical construction. [16] Cognitive semantics-based analyses of animation exploring how "meaning" is uniformly and optimally generated by mental processes, pose a challenge.

2.2.1 Physicality of Images: Hutchins's Material Anchors

Being one of the initial major proponents of the idea of distributed cognition, Hutchins meticulously describes many of our everyday practices and instruments, such as queuing and analog timepieces, in which physical structures of images represent elements for conceptual processes. He asserts that material structures and patterns, like marks or diagrams,

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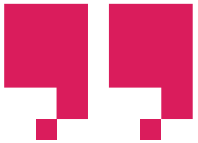
The major advantage of anchors to cognitive processes is that one can reduce memory and processing loads by building the constraints of the task into the physical structure of the artifact.



can provide us with stable images for complex mental operations, such as calculation done on paper or navigation with a compass. He calls these images material anchors, which "hold" information in place or incorporate constraints for mental manipulation. [17] It follows that a material image, for example, marks on paper or a compass rose and needle, can act as a direct input to the cognitive process, in which the world is used as its own representation (observers can offload cognitive processing onto objects in the world rather than holding representations in their heads). In Wittgenstein's words, we compute by manipulating the marks or diagrams in our minds. While Hutchins's analyses cover mostly goal-specific, instrument-oriented tasks, the material image of each artifact or instrument is equivalent to the mental image for manipulation. The major advantage of anchors to cognitive processes is that one can reduce memory and processing loads by building the constraints of the task into the physical structure of the artifact.

2.2.2 Spatiality of Images: Image Schemas

While material anchors represent the distribution of concepts onto physical structures of images, image schemas reciprocally suggest that many concepts are built upon our experiences with spatial structures of perceptual images. Based on numerous examples in our everyday use of language, George Lakoff and Mark Johnson show that metaphors not only allow us to communicate abstract concepts by projection of similarities but actually structure largely our ways of thinking through entrenchment. [15] Many of these metaphors are based on our bodily and perceptual experiences in space. [6] These metaphors are so conventional and entrenched that they often just gone unnoticed, and the corresponding mental images are so embedded in our minds that exist as extremely skeletal and schematic images, what cognitive semantics calls "image schemas." [18] In other words, only structural patterns are preserved in the schemas for spatial reasoning.

2.2.3 Integration of Images with Concepts: Conceptual Blends

Gilles Fauconnier and Mark Turner have built upon the insights of theories of mental spaces and conceptual metaphor to result in conceptual blending theory. [19] The theory describes a basic mental operation that

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generates new meaning by integration of concepts. The operation constructs a partial match between multiple input conceptual spaces and selectively projects from those input spaces into a novel "blended" conceptual space. Blending is a dynamic process and successive blends give rise to an emergent integration network, which is pervasive in everyday life, as well as other creative feats like rhetoric, reasoning, gameplay, and even interface design. [20] Fauconnier and Turner's analyses also resonate with Hutchins's distributed cognition analyses as they examine everyday objects like watches and money to illustrate how our minds interact with the world. Their discussion even extends to cover written, spoken, and sign languages. [19] To this, Hutchins contends that the arbitrary relations in most linguistic signs make them a very weak type of material anchor, because not much analogical information is held in the material form of these signs. [17] To Fauconnier and Turner, a material anchor can just be a structural constant or perceptual identity for a concept, like money notes. In contrast, Hutchins demands more information loaded onto material anchors.

2.2.4 Matching of Images with Motor Action: Glenberg's Meshes

Although there are nuanced differences between Fauconnier and Turner's interpretation and Hutchins's view, material anchors for conceptual blends mark an indispensable link by which part of human memories can be projected onto world objects. In fact, Arthur M. Glenberg has also investigated the connection between memory and the world in a way related to Lakoff and Johnson's observations regarding the embodied mind. [21] His article repositions memory as a cognitive apparatus to combine, or in his words "mesh," perceptual patterns projected from the environment with patterns of interaction from bodily experiences. The two patterns are compatible because they are both "encoded" in terms of one's body. One can recognize a walking path as the "path home" using a match of patterns between the perceived environment and embodied motor knowledge in one's body memory. If material anchors suggest a "download" of structural information from memory to artifacts by perceptual processes, Glenberg's notion of mesh recalls an "upload" of spatial and functional meaning from the environment to memory through embodied interaction. The two ideas highlight different portions of a mind-matter continuum, but they definitely do not draw any boundary. Instead, they mobilize interplay between mind and matter through the body.

3. MATERIAL-BASED IMAGINATION: ELASTIC ANCHORS

3.1 Animated Images as Embodied Images

Hutchins's arguments for material anchors mainly focus on human-performed instrumental and operational tasks, so his material images have to be stable and faithful representations of the elements to be manipulated in the cognitive process. However, this faithfulness does not necessarily apply to cases in which the outcome is not a priori clear and task specific, such as process-driven imagination-laden creative activities. For example in filmmaking, a storyboard is not strictly a faithful representation of the mental image inside the director's mind, but is also a device used for contingent reflection on a creative work-in-progress, projecting evocative sensation onto the work that goes beyond the physically represented information, and allowing that work to trigger generation of subsequent imaginative images.

Animated visual images transgress the boundary between the original and the imaginative even more strongly, mobilizing viewers' motor-sensory connections and constituting embodied understandings of sensations. Consider that the storyboard of a film in progress projects the director's approximation of the intended outcome. At some point, the director will need an animated visual image, technically called a "rehearsal," an "animatic," or a "rough cut," especially when one wants to elicit visceral sensations such as disgust, sorrow, nervousness, and others. There are many nuances to these "gut feelings" that static images may not be able to convey. Instead, they have to be performed as actions in animated images. For example, a viewer is able to distinguish an animated character's giggling from trembling, because the viewer perceives and understands it as exhibiting lifelike qualities previously experienced in her or his everyday life. This is quite different than the use of culturally specific symbolic conventions (such as trembling lines) without which a still image could not convey these distinctions.

While being careful not to overstate these claims, results regarding the activation of brain structures known as mirror neurons have been posited as suggesting that, when perceiving a performed action in a moving image, the viewer's interpretation relies upon evocation of the corresponding motor-sensory knowledge from a repertoire of her or his own embodied experiences. [22] The coupling of perception and action enables the viewer to "recall" the associated sensation. When we see someone jumping restlessly, we understand one's excitement, not by "reading," but rather "sensing." In short, animated images constitute an embodied cognitive process. Similarly, a movie director can "feel" whether an actor's performance is matching his or her mental image, or an animator can "detect" if an animated character is moving right. This kind of visceral understanding largely takes place at the immediate, or even pre-conscious, level – requiring minimal cognitive effort.

Cognitive semantics research also provides us with accounts of understanding sensation through perception. When discussing animacy, Mark Turner states that we cannot perceive others' sensations, so we can only infer their sensations by comparing their actions to our own reactions in similar situations. [16] He refers this analogical inference to a type of parabolic projection, or metaphor, in which partial structure of a source story of the perceiver, including action and emotion in particular, is projected to a target story of the perceived. It follows that the director or animator can infer the sensation by cognitively projecting her or his own experience to the perceived action. This act of "inference" seems to be suggesting that the projection takes place at a higher cognitive level, demanding conscious mental operation. In fact, some mental projections can be cognitively effortless. This point can be illustrated in terms of conceptual blending theory. The matches between two input mental spaces, what Fauconnier and Turner call "vital relations," [19] of some blends can be so tightly compressed that become automatic and unnoticed. Fauconnier has cited the computer interface phenomenon as an example of this kind of immediate blends. [20] In this regard, we add that for the director or animator, there is also a blend of an experience and a perceived action yielding an inferred sensation. The compression can be so tight that the animated image is immediately associated with the sensation. The image becomes an immediate and embodied input to the integration network.

As mentioned earlier, Hutchins coined the term "material anchor" to mean those material objects or images with stable patterns and structures "locking down" specific information in input concepts. We believe that animated visual images, as embodied images, not only "hold" information but also "embody" sensation or meaning, which trigger imaginative elaboration in blending.

3.2 The Material-Based Reflective Process

We introduce the term "elastic anchor" to describe these imagination-provoking artifacts. In the tradition

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of Hutchins's instrumentally oriented examples, material images and mental images are largely equivalent. The outputs of these blends, like the timepiece example, are fairly fixed as an entrenched cultural model. [17] [19] For elastic anchors, the subtle difference between the visceral sensation represented by the animated image and the mental image engenders nuanced imagination. A product designer needs to sketch out different views of his or her design (a mental image) on paper in order to further develop the idea after seeing the sketches (a material image). A calligrapher practicing Chinese calligraphy has to repeat writing and looking at the words, making continuous assessments and adjustments. Practicing animators are also well aware of this kind of iterative processes. For example, an animatic sequence might suggest a visceral sensation, with which the animator can compare an intended mental image, combining partial structures from the animated image and the mental image respectively to form a new imaginative image, and then triggering adjustment or modification to the material image. This reflective process iterates and ultimately approaches the imaginative interplay of the material image and the mental image.

Such nuanced interplay would go even more unnoticed when the reflective process becomes instantaneous. It can be illustrated by the case of shadow play. Consider the difference of natural moving images (e.g., incidental shadows) and author-intended animated images (e.g., shadow puppetry) (Figure 1). The two images can be materially the same. To Hutchins, neither representation may be valuable as a material anchor because they are not faithful representations of an object sufficient for offloading cognitive processes, they are just simple silhouettes. However, the latter can be an elastic anchor for conceptual blends in which the silhouette in action embodying a visceral sensation is blended with the viewer's mental image of an entity (whether human, animal, or even an anthropomorphic object) moving in a similar fashion, thus forming an imaginative understanding that the shadow is cast by an actual character in that mood. On the audience side, this blended image is the meaning of the puppet show. On the puppeteer's side, this might be an interim image with which the puppeteer would fine-tune for another animated shadow. In both cases, the material image blends with the mental image to give rise to next imaginative image.

Figure 1. Incidental shadow vs. intended shadow

It follows that material images and mental images have a very intricate relationship. In goal-specific computational operations, they can be regarded as largely equivalent. In creative mental operations, to give an illustrative analogy, they may seem like dancing or boxing partners irregularly approaching each other, whether collaboratively or oppositionally. Moving images can be a vehicle for reconciling our understanding of this intricate relationship, because they constitute a specific type of embodied cognition process. Animated images, with their distilled visual forms, evocative movements, and the material-based reflective process, serve as an excellent elastic input for conceptual blends because the flexibility and compatibility facilitate the partial structural projection between two images that gives rise to new blends and imaginative images.

3.3 Elastic Coupling of Animated Images and Motor Action in Digital Media

If the animated images are instantaneously reactive, as in shadow play, the elastic anchors include not only sensory perception, but also motor action. In digital interactive media, elastic anchors are even more adaptable and elaborative, because a user might interpret his or her motor input quite variably according to the perceived generative feedback. For an interactive system, generative animated feedback often defines, or re-defines, the meaning of motor input action. For example, when a user scrolls the view of a window using two fingers on the touchpad of an Apple laptop, the scrolling effect defines the action as moving the viewpoint because the scrolling direction is the same as the finger motion. When a user touches and moves a finger on an Apple iPhone screen, the contrasting scrolling effect (just in the opposite direction) redefines the action as moving the panel instead. A few other examples follow. Turning a new page on the iPhone screen by tilting the device defines the action as flipping. Leaving marks on a touch screen defines the touch-and-move action as drawing. A swarm of particles following a pointer defines the action of moving the pointing device as choreographing. Furthermore, the magnification effect of the Dock in

Figure 2. Use of the jog dial of a VTR

Mac OS X defines the mouse-over action as considering, and giggling human figures in a viral interactive advertisement defines mouse-over as tickling.

As Maurice Merleau-Ponty puts it, motility reveals our consciousness as "not a matter of 'I think that' but of 'I can'" move towards something. [23] In other words, motion-based motor action embodies our consciousness toward something, representing intention and meaning. An illustrative example related to machine operation is the jog dial of a video tape recorder (VTR). When a user spins the dial, the motion, including speed and direction, convey his various intentions of going forward or backward at variable speed (Figure 2). Likewise, in digital interactive media, motion-based motor input embodies users' consciousness "moving" toward animated feedback. Since the animated feedback is generative, programmable, and variable, the embodied meaning of motor action becomes adaptable. It follows that a coupling of animated visual images and motor input may yield adaptive and evocative meaning through imaginative blends. Consider the magnification effect of the Mac Dock. Both animation (the magnification) and action (mouse-over) may

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Figure 3. A participant holding "letter" raindrops in *Text Rain* (1999). Image courtesy of the artists (Camille Utterback and Romy Achituv).

seem non-representational, but the coupling is meaningful when it blends with some everyday experiences (e.g., an individual asserting "pick me!" from a line of candidates).

This coupling idea echoes what we mentioned the motor-sensory feedback loop that characterizes an expanded illusion of life. Motor action triggers animation that in turn incites further bodily engagement. This loop sometimes is delayed, like in hand-drawn animation pencil test, or computer animation preview that needs rendering. Occasionally, the loop is instantaneous and continuing, like that in shadow play or real-time interactive systems. This loop, which relies on the materiality of images that one perceives and acts upon, is the core of elastic anchors. And elastic anchors are elastic in the sense that the meaning is flexibly dependent on animation and bodily interaction. In summary, elastic anchors are characterized by the following properties:

- Material-based Imagining: They consist of material images;
- Imagination Triggering: They "hold" dynamic information or sensation in place for perceivers, yielding imaginative blended images;
- Action Inviting: They "invite" perceivers to take motor action, such as modification or interaction;
- Motor-sensory Connecting: They constitute iterative motor-sensory feedback loops, such as those in sketching of architectural designs, pencil testing of hand-drawn animation, practicing at writing Chinese calligraphy, engaging in shadow play, operating a zoetrope, previewing real-time animation, and so on;
- Spatiotemporal Patterning: When the motor-sensory feedback loop runs spontaneously and continuously, as in animated images, they provide not only spatial and structural patterns, but also temporal patterns.

We argued elsewhere that material-based imagination is pervasive in today's digitally mediated environments.[24] In this article, the analyses concentrate on two salient interactive digital artworks.

4. ANALYSES OF INTERACTIVE DIGITAL ARTWORK

Many digital artworks rely on simple animation and motor-sensory interaction to provoke imagination. Artists such as Myron Krueger were important precursors for later practitioners such as Wolfgang Muench, Scott Snibbe, and many others. Some of the works of such artists involve full-body motion while interacting with a human-size screen animation. Relevant to our argument here, installations in this area include Wolfgang Muench's *Bubbles* (2000), Scott Snibbe's works, and Camille Utterback and Romy Achituv's *Text Rain* (1999). We choose to concentrate on *Text Rain* here because it allows us to analyze at two distinct levels of imaginative understanding, namely the immediate and the metaphorical, as shown in the following paragraphs. The work shows a projection of animated letters falling like rain. A participant standing in front of the projection can move her or his mirror image on the screen to catch, lift, and then let fall any letters (Figure 3).

When a participant moves and sees her mirror image echoing those movements in the rain of letters, she immediately blends this elastic anchor experience with her remembered motor-sensory experience of actual rain. The elaboration of this immediate blend results in an imaginary space in which the participant can move and play in the virtual rain without getting soaked.

Since each raindrop is a letter from a poem, the participant can sometimes catch a word, or even a phrase, by accumulating letters along her or his silhouette. Whenever the participant reads the line held by the body silhouette and realizes the resulting verse, the experience may be interpreted as analogical to receiving a celestial message from the sky. The action of holding virtual raindrops may analogical to the action of embracing "divine light" from the sky. Each particular elaboration of the blend is not predetermined, however many viewers find that the work provokes a metaphorical narrative of someone receiving celestial and spiritual messages via the body and the environment. The animation of falling letters, and the viewer's interaction with them, generate what the artists might describe as an imaginative integration between body and ethereal content.

Like many works of art, *Text Rain* is exhibited publicly in an art gallery or similar setting. In contrast, another work to be discussed emerged in a strikingly different platform. It was originally intended to show on the Web. Since 1997, the Dutch comic artist Han Hoogerbrugge has used the Internet to publish interactive animated comics on his website Hoogerbrugge.com. The first work, *Modern Living* (1998–2001), featuring nearly one hundred short animated films, tackles small observations in his personal life, which also resonate users' lives. The collection can be seen as a documentation of his experiments with mouse-mediated interaction in which immediate blending helps us re-map mouse action to different intentions easily. For instance, in #43 'Itch', a click makes the character "itch" wherever the mouse cursor is located (Figure 4). In #54 'Jumpy', a mouse-over action "drives" the character jump forward. In #60 'New Religion', when the mouse moves across the characters, they stand up and then bend down forming a wave very much like the magnification effect in Mac Dock. In #61 'Drowning', one can move the mouse to play hide-and-seek

Figure 4. A screenshot of #43 'Itch' in *Modern Living* (1998–2001). Image courtesy of the artist (Han Hoogerbrugge).

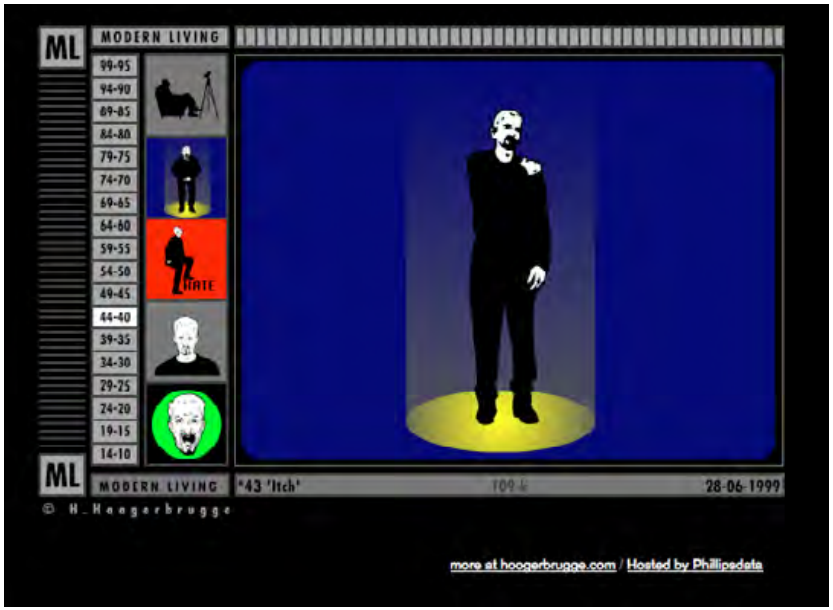

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Figure 5. A screenshot of #83 'Possessed' in *Modern Living* (1998–2001), which provokes immediate and metaphorical imagination. Image courtesy of the artist (Han Hoogerbrugge).

with the character. In #68 'Obedience', keeping the mouse over the character's head can "bend" him down to his knee. In #70 'Eternal Love', the position of the mouse determines the focusing point. Through these couplings of motor action and animated feedback, the work mobilizes motor-sensory connection and projects what we have called an expanded illusion of life.

Among numerous interactive pieces, some are more metaphorical. In #83 'Possessed' (Figure 5), the character moves his mouse in accordance with the user's mouse position. The immediate blend here lets the user easily control the character by moving to desired positions, like the mechanism of controlling shadow puppets by moving rods. The analogy between the character and a rod puppet is compressed into a concept of virtual puppet in the animated piece. Hence, when one moves the pointer, the virtual puppet moves his hand.

What makes the piece eccentric is that bizarre images keep appearing over the character's head and making curious sounds while the user moves the pointer around. This suggests one possible metaphorical blend of the animation (at least for the authors here) with an imaginative story in which people surfing the Web, including the user, often find their attentions wandering, diverted by a multitude of hyperlinks. In the blend, the mapping between the character and the user, both are moving a mouse, is compressed into a single identity. The animation becomes like a mirror reflecting the mental status of the user. This example shows a typical way of how *Modern Living* echoes our personal experiences through animation and motor action.

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5. CONCLUSION AND IMPLICATIONS

This article started with a trajectory of our thoughts about images, from visual to mental representations. We believe that images not only exist materially outside our brains and mentally inside our minds, but also emerge as imaginative constructs from a reflective process between material manifestation and mental operation. In this kind of material-based imagination, animated images work as elastic anchors for sensational, visceral, and elaborative conceptual blends, because they readily engage our embodied sensations through the coupling of perceived animation and motor knowledge. Furthermore, due in part to their liveliness and relationship to embodied forms of communication such as human body language, gestures, and facial expressions, animated images easily absorb viewers in affectively rich imaginative stories and worlds. In all cases, imaginative blends of concepts are the key to understanding the artifacts, at both the immediate and the metaphorical levels.

We believe our analyses of digital artwork reflect an emerging animation phenomenon that destabilizes the border of mind and matter unprecedentedly. Accounting for this requires a new embodied cognition model of movement and fluid images, which are topics currently underexplored in the theories of image schema and conceptual blending from cognitive science. Of course, for cognitive scientists, the elastic anchor construct ultimately should be pinned experimentally, and explained in terms of cognitive processes. However, for humanistic analyses in the tradition of cognitive poetics, new theory consistent with a convergence of results from fields including neuroscience and cognitive semantics is quite consistent with the enterprise.

This research also brings concern for humanistic interpretation back to the center of cognitive studies, in which today productivity or usability-oriented approaches are pervasive. As the digital visual culture theorist Andrew Darley put it in his keynote speech at the latest conference of animation studies, [25] the animation phenomenon persists in the digital age, bringing about a new meaning of "persistence of vision" by that vision is "visual imagination." Animation, the most "sophisticated and flexible" of modern media as (non-objectively) suggested by the animation theorist Paul Wells, [11] has become the "vehicle" of the kind of imagination that can be poetic and evocative. Currently, our work is speculative, but grounded in both humanistic interpretation and cognitive science results. In the future, we may elaborate the relationship of our constructs to the quite different, and at times apparently contradictory, epistemologies used in cognitive science and humanities-based media studies. We hope that this article sketches a potentially fruitful of reconciliation of both types of research concerns and values – and ultimately constructive and beneficial in our everyday lives. ■

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