Tagging with Movement: Somatic Strategies for Digital Image Classification

by

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Abstract

This dissertation presents an exploratory investigation of ways to incorporate somatic, or movement, experience into interaction with computers. The research centers on the concept design of a hypothetical application that uses movement instead of text to generate tags for digital content. These *kinesthetic* tags provide an alternate approach to interaction with digital images, one that prioritizes somatic perception over visual perception. Imagery has a long history of use in movement-based disciplines for teaching, conditioning, and heightening awareness of somatic experience. Kinesthetic tagging provided a focus for investigating this connection by providing insight into process through which people enact their relationship with visual media, exploring contents, concepts, and meanings.

The research study addressed a gap in the literature pertaining to the integration of functional and experiential movement. Although a kinesthetic tagging application was not developed as part of this research, the concept served to facilitate the exploration of movement experience and its potential use for interaction. This exploration took place in a two-day movement-based workshop in which participants focused on the investigation of movement qualities derived from the concept of *Effort* as defined in the Laban Movement Analysis (LMA) framework. LMA Effort factors describe the experiential content of movements through the expressive qualities they exhibit. This feature provides a systematic method for linking observable movements with peoples' somatic states, making the Effort factors useful tools for investigating movement experience.

The research workshop incorporated various methods from design, performance, and Somatics, and utilized a modified version of grounded theory for data analysis. The outcome of the analysis is a conceptual framework explicating how users' approach the task of enacting visual content using expressive movement. This framework identifies three modes of connection and seven mechanisms of interaction that inform a user's process. A set of hypotheses relating to the process of enactment are generated, as well as a set of design considerations for a kinesthetic tagging system. The dissertation concludes with the articulation of five areas that would benefit from the integration of functional and experiential movement.

Keywords: Human-Computer Interaction; Movement-Based Interaction; User Experience; Somatics; Tagging; Laban Movement Analysis;

Dedication

To my wife, Michelle, for her patience and support throughout my doctoral studies. To my parents, Ruth and Paul, for instilling me with a love of learning and always encouraging me to follow my own path. And to my son, Anders, for teaching me to think and move like a child again, and always being a source of inspiration and joy.

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Table of Contents

List of Tables

List of Figures

List of Acronyms

LMA	Laban Movement Analysis
HCI	Human-Computer Interaction
PD	Participatory Design
PI	Performative Inquiry

Glossary

Kinesthetic Interaction	A term used to differentiate interactive techniques that emphasize movement awareness from those that emphasize functionality (e.g. mouse and keyboard interactions).
Movement Experience	The subjective awareness of one's own body in motion
somatic	An adjective describing sensations pertaining to the body and its functioning
Somatics (the field)	A field that uses movement-based techniques to facilitate enhanced awareness of bodily functioning by highlighting the experiential aspects of movement.
Kinesthetic Tags	A form of metadata that utilizes movement instead lexical descriptors to classify digital content

Chapter 1.

Introduction

> *But for a very long time man has been unable to find the connection between his movement-thinking and his word-thinking. Verbal descriptions of movement-thinking found their expression only in poetical symbolism. Poetry, descriptive of the deeds of gods and ancestors, was substituted for the simple expression of effort in dance. The scientific age of industrial man has yet to find ways and means to enable us to penetrate into the mental side of effort and action so that the common threads of the two kinds of thinking can finally be re-integrated into a new form.*
>
> *Rudolf Laban (Laban, 1960, p. 17)*

1.1. Background

Full-body Movement as a form of interaction with computational devices has seen slow public adoption outside the field of gaming. Yet movement has the potential to overcome numerous challenges and to provide new approaches to interaction that can support ameliorative and adaptive user experiences. Smart phones and tablets differ little from their desktop counterparts in their reliance on text-based communication and limited support for full-body sensory engagement (Levisohn & Schiphorst, 2011). Current mainstream interface designs maintain the primacy of the screen during interaction, borrowing from desktop computing models that overlook the body's role in communication and experience. Smart phone technology has the potential to extend interaction beyond the screen, yet designers continue to develop applications that prioritize visual and aural content over other forms of sensory communication. This dependence on visual modes of input and output relies heavily on a user's attention, presenting problems if the user simultaneously performs common tasks such as walking or driving. In order to support human-to-human communication and interaction in complex social and physical environments, mobile computing has the potential to move beyond a reliance on visual

and auditory modes of communication and expand to include embodied forms of communication such as movement. Researchers working in the areas of tangible and ubiquitous computing are exploring a wide range of interfaces to overcome these limitations and expand interaction to the body. This includes investigating gestures that better support human cognitive processes and developing wearable interfaces that take advantage of tactile and haptic interaction.

There has been an increase in the number of gestural interfaces being developed, with depth cameras such as the Microsoft Kinect becoming available. Depth cameras are capable of tracking users and objects in three dimensions, facilitating unencumbered movement sensing limited only by the camera's line of sight. To date, these movement tracking systems have been used almost exclusively to track easily detectable gestures rather than to focus on the often more complex and subtle characteristics of the movements used by people in their daily lives. This omission is largely due to past limitations of the technology, which required designers to use gestures that were easily detectable; this focus on detectability reflects a technology-driven design process that is counter to the human-centered design practices espoused by contemporary human–computer interaction (HCI) practitioners (Mentis et al., 2014).

Current gestural interfaces also largely ignore the kinesthetic experience of the user. For example, the use of the arms or hands for deictic tasks such as pointing emphasizes the communicative and informational aspects of movement while prioritizing the observer's perspective. The kinesthetic experience of the mover becomes subservient to the communicative task, resulting in the experience of an "absent body" (Leder, 1990). This omission neglects a primary characteristic of the human sensory experience that supports knowledge recall and human cognition.

Over the last decade there has been a turn towards incorporating felt experience into the development of movement-based applications, particularly in the areas of tangible and ubiquitous computing, where movement is often prioritized as a significant component of interaction. This renewed focus on movement has generated a new research agenda investigating methods for designing for movement that take into accounts its contribution towards user experience, an aspect of interaction articulated by McCarthy and Wright in

"Technology as Experience" (McCarthy & Wright, 2004), which challenged traditional notions of usability by advocating an approach to designing technology that emphasizes the experiential aspects of interaction. This framework expanded the scope of interaction to include sensual, volitional, and emotional elements (McCarthy & Wright, 2004)that gained considerable attention since the publication of "Technology as Experience" by McCarthy and Wright in 2004 (McCarthy & Wright, 2004).

1.2. Approaches to Investigating Movement

As a topic of study, movement has been investigated by diverse researchers in disparate disciplines including kinesiology, dance, performance, Somatics, cognitive science, sports medicine, and psychology. Depending on the epistemological viewpoint of the researcher, different aspects of movement are highlighted for investigation. Historically, within scientific disciplines, movement has been approached as a functional trait, something that is measurable and utilitarian. In kinesiology, for example, the body is viewed as a set of functional parts comprised of sinews, bones, and muscles that can be corrected and adjusted for optimal functioning. Even in the field of cognitive science, which does not focus explicitly on the physical characteristics of the body, investigations still center on movement's contribution to the development of cognitive abilities. This is illustrated in the work of researchers such as Antonio Damasio (Antonio R. Damasio, 1995), who investigates the role of the body and emotion in decision making, and Shaun Gallagher (Gallagher, 2005), whose work directly interrogates the embodied nature of cognition.

Other approaches to movement, however, center on its experiential characteristics. These investigations are undertaken in areas that prioritize first-person experience and generally involve practice-based and reflective approaches to knowledge gathering. Within the disciplines of dance and Somatics, for example, awareness of one's own body is central to knowledge acquisition (Alexander, 1932; Bartenieff & Lewis, 1980; T. Hanna, 1976; Laban, 1963). The use of first-person methodologies affects not only the mode of inquiry but also the quality of the data collected. These methods, while still based on empirical observation, highlight the phenomenological aspects of experience for an individual.

Within the field of human–computer interaction, embodied theories of cognition have only recently begun to inform and transform researchers' historical adherence to representational models of cognition. Researchers in the areas of tangible and ubiquitous computing rely on theories of embodiment to investigate the felt experience of movement, turning to disciplines such as dance, yoga, and Somatics to inform their investigations. Their work has focused primarily on using movement to inform the design of technological artifacts that enhance user experience with the few exceptions (e.g. Alissa N. Antle, Corness, Bakker, et al., 2009).

Movement as a method of interaction has been considered primarily in functional terms. Movement has played a role in computational interaction since people used punch cards to access computers. The most common computational input devices, the mouse and the keyboard, use micromovements to facilitate efficient interaction. These tools, however, were designed for optimal use without the need for conscious attention—they in fact intentionally de-emphasize the experience of moving.

Researchers such as Thecla Schiphorst, Caroline Hummels, Kees Overbeeke, Jin Moen, and Lian Loke have applied theoretical frameworks and techniques from movement-based systems to the investigation of *felt* experience (Hummels, Overbeeke, & Klooster, 2007; L. Loke & Robertson, 2007; Lian Loke, Larssen, & Robertson, 2005; Lian Loke & Robertson, 2008; Moen, 2007; Petersen, Iversen, Krogh, & Ludvigsen, 2004; T. Schiphorst & Andersen, 2004). Their research uses methods such as Laban Movement Analysis (LMA) to contribute to the exploration and design of kinesthetic interaction. Findings from these studies have been used to develop applications such as Moen's Body Bug (Moen, 2005, 2007) that encourage the use of movement as the primary mode of interaction with technology. Rather than focus on utilitarian movement, these types of applications bring awareness to the act of moving and explore modes of interaction that emphasize the awareness bodily experience.

Movement experience, the subjective awareness of one's own body in motion, can be investigated using methods from areas outside of HCI, such as those utilized in the field of Somatics, a discipline that has developed over the last century and incorporates practices from theater, dance, and Eastern meditative practices. Somatic awareness

focuses on experiencing the body from the inside and highlights the embodied aspects of experience and their effects on human physiological, emotional, and cognitive well-being (T. Hanna, 1976). Somatic practices provide a way to interrogate the components of movement experience and to identify those that are relevant to technology design.

The investigation of movement experience has the potential to provide access to novel interaction methods that can address the challenges presented by the shift to the ubiquitous computing paradigm. In its original conceptualization, ubiquitous computing envisioned anytime/anywhere computing which emphasize human-to-human communication and interaction, focusing on the complex social and physical environments within which computers are embedded (Weiser, Gold, & Brown, 1999). One of the developments needed to facilitate interaction with computers embedded in the environment is a more robust form of communication that likely will not rely primarily on the use keyboards or other handheld devices. Movement interaction will become more important and computer systems will need to be endowed with a greater ability to analyze movement on multiple levels in order to ascertain linguistic meaning and infer user states. This knowledge will aid in the development of alternative means of representing and communicating information to support ubiquitous interaction. Gaining a better understanding of the contribution of movement experience to interaction will aid in the investigation of these elements.

1.3. **The Research Gap**

The two approaches to movement outlined above—functional on the one hand and experiential on the other—form the poles of a continuum (Figure 1). To date, there has been little exploration of the role felt experience plays in applications that provide utilitarian functions. My research lies in the area between these two poles and will explore possible ways to integrate them through the exploration of conceptual technology that incorporates both functional and experiential elements. To accomplish this, I will explore movement experience as a unique modality, like vision and hearing that is capable of transforming interaction.

Figure 1: Research Continuum

As other sensory modes such as vision and hearing have already been incorporated into HCI, it makes sense to use them as exemplars to guide the exploration of movement interaction. Sound can be used to create alerts, produce ambience, generate immersion, or sonify data, or it can function solely as an entertainment element. Rarely is one of these options used in isolation. In considering movement for interaction—whether functional or experiential—it is essential to remember that it will serve multiple functions, just as it always has in human lives. Like audio, it will usually function in multiple ways and produce crossmodal intersections.

Due to the multiple ways in which movement can be used for interaction, it is not surprising that there are multiple approaches to incorporating movement into interactive applications. Rather than view these various perspectives as opportunities to explore novel uses for movement, researchers have become polarized, with some investigating functional movement and others interested in felt movement. What is needed is research that bridges these two poles and begins to explore the myriad uses for movement that draw on elements of both approaches. My research takes this gap as its starting point and aims to explore this space through the investigation of the personal experience of movement.

1.4. Research Overview

The research described in this dissertation explored ways to employ individuals' kinesthetic, or movement, experience as a functional component of interaction with the goal of applying what was learned to design knowledge for digital technology. Due to the dearth of research in this area, the investigation was conducted as basic research and the outcomes presented as a set of hypotheses rather than designed digital prototypes. To

investigate the phenomenon of movement experience it was necessary to envision a conceptual application that incorporated both functional and experiential movement interaction. The use of conceptual design to explore a design space is described by Gaver and Martin (Gaver & Martin, 2000). The hypothetical application devised for this purpose involved the use of movement-based metadata, or *kinesthetic tags*, to index photos. Although the application was not implemented, it allowed for the interrogation of embodied experience and technology design in the context of movement-based interaction. This exploration took place in a two-day movement-based workshop in which participants focused on the investigation of movement qualities derived from the concept of *Effort* as defined in the Laban Movement Analysis (LMA) framework. LMA Effort factors describe the experiential content of movements through the expressive qualities they exhibit (Laban, 1960). This capability provides a systematic method for linking observable movements with peoples' somatic states, making the Effort factors useful tools for investigating movement experience.

1.4.1. **Kinesthetic tagging.**

Imagery has been used as a tool in dance to assist in teaching, conditioning, and choreography since at least the early 1900s (Nordin & Cumming, 2006a, 2006b; Overby & Dunn, 2011). Similarly, mental imagery has a central role in Somatic practices and is often used to describe the experiential characteristics of movement or to assist in augmenting bodily awareness (Eddy, 2009). Photos are regularly used during the teaching of Somatics to illustrate movement patterns and to train people in movement analysis. This association between movement and imagery suggests that there is a strong link between a person's visual sense and their embodied experience. A better understanding of this connection and its role in the creation and articulation of specific aspects of embodied experience could have implications in a variety of areas – including technology design. To investigate these connections I devised the concept of kinesthetic tagging.

Kinesthetic tagging is an alternative approach to attributing meaning to digital content for the purpose of indexing and searching. The use of an alternate modality for generating search queries will augment current approaches by making them more

inclusive of bodily forms of human intelligence and permitting access to forms of personal knowledge such as emotion and memory. Movement is a central component in various aspects of human development (Sheets-Johnstone, 1999) and as such is capable of retaining and expressing aspects of embodied experience. Kinesthetic tagging takes advantage of the ability of movement to encapsulate meaning and experience, and exploits this characteristic to ascribe unique significance to photographs. From a practical standpoint, kinesthetic tagging may extend current approaches to indexing digital imagery by proving more accurate search results, enabling faster queries without the need for typing, and facilitating entirely new kinds of searches to be made, ones that would be impossible using current lexical approaches. Within this research study, kinesthetic tagging was considered as a tool for organizing a user's personal collections of photos. This approach was selected in order to take advantage of the qualitative nature of movement experience and the personal meaning it encompasses. A kinesthetic tagging application will allow an individual to engage in a process of self-observation and meaning making through self-efficacy.

From an interaction design research perspective, this study aligns with Fallman's concept of *design exploration* (Fallman, 2008). According to Fallman, design explorations are activities that investigate opportunities outside of the current paradigm. This study meets this criterion by striving to incorporate movement experience as a functional component of human–computer interaction, something that has not yet been accomplished.

Although the exemplar movement-tagging application deals specifically with digital images, the findings will be generalizable to other media. Understanding how movement is experienced by a user will permit the development of applications that incorporate nonlexical aspects of gestural movement. This is significant because it addresses movement as an embodied experience that can be understood as a preconscious, semantic act that encapsulates meaning for the mover. This property permits kinesthetic tagging to bridge the experiential aspects of moving with the functional ones.

1.4.2. **Research design and questions.**

My research was conducted through a participatory workshop in which skilled movers (e.g., dancers and actors) worked with designers of interactive systems to explore considerations for the development of a system supporting the kinesthetic tagging of digital photographs. In the workshop the participants engaged in various activities relating to the enactment of images through movement. (The shorthand term *enactment* will be used throughout the remainder of this thesis to refer to the translation of images from the visual to the kinetic domain.)

The research objectives addressed two distinct goals: 1) an improved understanding of the role of embodied experience in the process of enacting imagery, and 2) the identification of design concerns relating to the development of the movement-tagging system. To address these objectives the study addressed the following research questions:

RQ1: In what ways can the LMA Effort Factors assist in investigating people's embodied experiences during the imagery enactment process?

- ***1A**: How do people determine which qualities of movement to use when enacting an image?*
- ***1B**: In what ways do qualities of movement reflect a person's embodied experience during the image enactment process?*
- ***1C**: In what ways do image features affect the quality of a person's movements in the image enactment process?*
- ***1D**: What factors influence a person's process of enacting images through movement?*

RQ2: How can LMA – as both a theoretical lens and somatic practice – be utilized as a tool to support the design of movement-based interactive systems?

- ***2A**: How can LMA as a somatic practice serve as a tool for designing a movement-based image tagging system?*
- ***2B**: How can LMA as a theoretical lens be used to support the design of a movement-based image tagging system?*
- ***2C**: What are the key design considerations for a movement-based image tagging system utilizing LMA Effort qualities?*

Throughout a two-day workshop, data was collected using video and audio recordings to capture the participants' involvement in movement exercises and discussions. The data was transcribed, coded, and analyzed using a qualitative methodology incorporating grounded theory. Throughout this process, relevant themes and categories were developed to explore relationships between constructs, generate hypotheses, and develop theories. These findings were then used to inform a set of design considerations relating to the implementation of a movement-tagging system.

1.4.3. Research Outcomes

The first research outcome was the development of a conceptual framework to model the process of enacting imagery through movement. This framework facilitated the answering of the two categories of research questions: those that pertain to the role of embodied experience in the image enactment process, and those that relate to the design of technology incorporating movement experience. These three separate outcomes are expounded below.

Conceptual Framework.

One of the primary research outcomes is a conceptual framework that described the various methods participants utilized in the process of enacting images through movement. A two stage temporal process was identified. In the first stage, participants connected to an image using one of three *Modes of Connection*: *Cognitive*, *Corporeal*, or *Affective*. These modes refer to the attentional aspects of the interaction and define the primary mode of awareness through which meaning was established with photographic content or form.

A *Cognitive* connection occurred when participant's awareness was primarily directed towards the observable elements of an image. The connection with the image was based primarily on cognitive elements. A *Corporeal* mode of connection involved the participant experiencing an enhanced awareness of their physiological experience including such elements as muscle tension, breath, and tactile sensation. An *Affective* mode of connection involved the participant findings meaning in an image by focusing on the affective quality of their experience.

The second stage of enactment described the approaches used by participants to interpret the LMA Effort Element present in an image. The Effort Element refers to the relative polarity of an Effort and sets it on a continuum between Condensing and Expanding. The seven *Mechanisms of Interpretation* were utilized to interpret the Effort Element following the initial connection via one of the three modes described above. These mechanisms are: Reaction, Analysis, Memory, Narrative, Immersion, Abstraction, and Transformation. These mechanisms and their role in the enactment process are fully described in Section 4.2.2.

Embodied Experience Outcomes.

Another outcome of the study related to the embodied experience research questions. These findings describe the experiential factors relating to the process of enactment. These include the types of enactment strategies used by participants, the relationship between the LMA Efforts and various image features, visual sorting strategies, and the challenges encountered. These outcomes are fully described in Section 5.1.

A second set of embodied experience findings was also identified and expressed as a series of six hypotheses:

1. The process of interpreting an image in order to enact it through movement is a two-phase process.
2. Individuals prefer using a particular mode of connection when enacting similar types of visual subject matter.
3. Specific modes of connection align with certain mechanisms of interpretation more than others.
4. The use of a particular mode of connection will determine the expressive quality of the movements used to enact an image.
5. Movements incorporating specific Effort qualities imply underlying cognitive processes that are alluded to by the modes of connection and mechanisms of interpretation.
6. Transforming the quality of an individual's movements can transform his or her cognitive state (e.g., help induce a new mode of connection).

Technology Design Considerations.

The design findings were articulated as a set of eight considerations that pertain to the potential and future design of a kinesthetic tagging application.

1. The image enactment process has multiple stages.
2. The enactment process often results in conflicting Effort interpretations.
3. 3. People have different preferences for laying out images on an Effort continuum.
4. People have personalized movement patterns.
5. 5. People's movement styles can transform over time.
6. Laban Movement Analysis Effort factors have the potential to be used as a movement schema within a computational movement recognition model.
7. Laban Movement Analysis can be used as a mapping tool for higher level semantic structures.
8. Most users will not have knowledge of LMA.

Application to Other Research

The findings from this research have application in number of research areas and domains. These are:

1. Improved gestural design.
2. Cognitive support through movement interaction.
3. Support Reality-Based Interaction (RBI)
4. Adaptive computing.
5. Integrate experiential and functional movement.

These contributions are fully discussed in Section 5.3.2.

1.5. Document Organization

This dissertation is divided into 6 chapters. Chapter 1: Introduction, outlines the context for the research, positions the study in relation to the current state of the field, and presents the research questions driving the inquiry. Chapters 2: Literature Review, introduces theoretical considerations and related work in the areas of embodiment,

Somatics, human–computer interaction, and image feature classification, respectively. Chapter 3: Methodology, presents the methodological considerations including the integration various methods, the structure of the workshop, and the coding process. Chapter 4: Theory Construction, details the development of a conceptual framework based on the results of the grounded theory inquiry. Chapter 5: Analysis, presents further scrutiny of the data to address the embodied experience and design objectives. Chapter 6: Conclusion, summarizes the contributions of the research and discusses future work.

Chapter 2. Literature Review

My research questions address two primary areas within HCI: 1) embodied interaction and 2) multimedia search and retrieval. My literature review begins with an in-depth look at embodiment, a philosophical concept that provides a strong theoretical foundation for the significant role of movement in human cognitive, social, and emotional development. The concept of embodiment provides the lens for my research and informed both my selection of methods and my outcomes. I then introduce the discipline of Somatics, a field that uses movement-based techniques to facilitate enhanced awareness of bodily functioning by highlighting the experiential aspects of movement. I discuss how Somatics has informed the development of embodied theories, and how Somatic practice – with its focus on attending to the active, moving body – provides an empirical method for interrogating movement experience. I follow this with an overview of the various approaches to movement within the field of HCI, emphasizing research investigating embodied interaction. Through this I highlight the ongoing shift in HCI from prioritizing movement as a primarily functional component of interaction, to emphasizing the experiential contributions of movement to interaction. The growing interest in the HCI community on the experiential aspects of movement interaction provides a context for my research focus and supports the relevance of my work to the field. In the next section I shift my focus to the area of image search and retrieval, highlighting the role of metadata in image feature classification, articulating the challenges created by current approaches, and contextualizing the use of movement for tagging purposes.

2.1. The Body's Role in Constructing Human Experience

The following section introduces the concept of embodiment, a philosophical perspective that offers an alternative view to the Cartesian separation of mind and body Embodied philosophy highlights the role of the body, and in particular the role of phenomenological factors, in constituting human consciousness and all aspects of experience. Until recently, design researchers largely ignored these experiential components of interaction in favor of a focus on human cognitive skills alone, placing the burden on the intellect during interaction (Hummels et al., 2007; Overbeeke,

Djajadiningrat, Hummels, & Wensveen, 2002). Expanding the scope of interaction to exploit a greater range of embodied abilities emphasizing the contribution of phenomenological experience, will ease this burden, add to the richness and depth of interaction, and support myriad human capabilities.

2.1.1. The Philosophy of Embodiment.

In the last several decades, the philosophy of embodiment has enjoyed a re-emergence, providing an alternate perspective to the computationalist and representationalist models of cognition that have dominated the field of cognitive science since its inception. Embodied philosophy provides support for considering the body as both a source of phenomenological experience and as a primary component of human cognition.

Embodied philosophy emerged from the work of Husserl, Heidegger, and Merleau-Ponty, who contributed to the articulation of the philosophical approach known as phenomenology. Their unique and varied perspectives have been interpreted by numerous designers and practitioners within the HCI community, resulting in various approaches to embodied interaction. (These approaches are elaborated in Chapter 4.) This chapter presents a history of the philosophy of embodiment in order to provide a foundation for understanding the central tenets of the philosophy, which are essential to contextualizing the impact of embodied philosophy on HCI and grounding my research.

Historically, the concept of embodiment developed in direct opposition to the long-standing Cartesian separation of mind and body, in which the mind was given primacy in the construction of experience and cognition. A central tenet of all theories of embodiment is that the body is the basis for the construction of conscious experience. Theories of embodiment do not dismiss the role of the brain in cognition but rather view it as one of the many organs that comprise the body (Rohrer, 2008). These theories emphasize the critical role of movement in the development of human cognition (Sheets-Johnstone, 1999). Over the last 20 years, theories of embodiment have become central to research investigations in a variety of disciplines including HCI, cognitive science, dance, performance, interactive art, and media studies.

Husserl.

The theory of embodiment originates for the most part in the phenomenological tradition first espoused by Edmond Husserl (Audi, 1999). Husserl developed phenomenology as an alternative to the scientific method in order to explore the structure of consciousness in an empirical manner. Phenomenology emphasizes first-person, subjective methods, which Husserl used to study preconscious experience, the structure of which he believed was common to all people (Husserl, 2004). He argued for a need to focus on direct experience without speculation or judgment.

Husserl was interested in explaining the workings of human consciousness by examining how knowledge of the material world is gained. In his work, he highlights the relationship between a perceiver and an object of perception. He argues that material reality is understood only through an act of *intentionality*, during which the perceiver constitutes the external objects within his consciousness (Kockelmans, 1994). The concept of intentionality is of particular importance to the development of interactive technology since it provides a starting point for considering the relationship between the user and the interface and how this helps constitute experience.

Heidegger.

Heidegger, who acted as a senior assistant to Husserl while at university, rejected the transcendental bracketing of experience that Husserl endorsed (Heidegger, 2000) due to the emphasis he placed on the perceiver. Heidegger instead viewed human activity as always occurring within a world and a context. He argued that all experience is already situated in the world, and he used the word *Dasein* (usually translated as “existence” or “being there”) to describe a particularly human awareness of being that considers the innumerable relationships such as between the self and the environment (Gorner, 2007). Heidegger’s position was that the concept of being had been misconstrued by philosophers since the time of Plato resulting in its treatment as an entity rather than as an experience.

Heidegger rejected the notion that phenomena can exist separately from activity and argued for a non-Cartesian approach to experience. Although he did not introduce the term *embodiment*, Heidegger introduced philosophical concepts and an orientation

that were instrumental in its conception. For example, one of Heidegger's most important contributions was the introduction of the terms *ready-to-hand* (*zuhanden)* and *present-at-hand* (*vorhanden*; Heidegger, 2000). He used these terms to describe different manners of awareness and of being-in-the-world*. Ready-to-hand* denotes a relation with the world in which objects have usefulness. It is contrasted with *present-at-hand*, which denotes an attitude of detachment, that is, one in which the world is observed rather than acted in. For example, someone actively using a hammer would experience the hammer as *Ready-to-hand*, as if the hammer were an extension of one's arm and hand. However, if while someone was hammering, the hammer were to break, the activity would be interrupted. No longer a "transparent" technological extension of arm and hand, the hammer would become present-at-hand, an object disconnected from one's body and actions. Heidegger claimed that it is most "natural" for us to experience objects in the world as *ready-to-hand*. The concepts of *ready-to-hand and present-at-hand* have had a significant impact on the design of tangible computing systems, providing a useful perspective for considering the constantly shifting relationship between the user and the objects of interaction. Heidegger's concept takes a prominent position in Paul Dourish's articulation of the concept of embodied interaction which uses embodied philosophy to prioritize the role action and context as essential components of the experience of interaction with technology (Dourish, 2004).

Maurice Merleau-Ponty.

It is in the philosophy of Maurice Merleau-Ponty that phenomenology fully comes to recognize the primacy of the body in the construction of experience (Merleau-Ponty, 1995).

Merleau-Ponty took the body seriously, not as a linguistic metaphor but as the very basis of meaning and being. For Merleau-Ponty, the mind, body, and world co-constitute experience in differing, always-changing ways. Further, Merleau-Ponty did not limit bodily experience to those aspects of which we are conscious, but also included those of which we are not aware, including motor intentionality and so-called inner processes. A multitude of theories of embodiment were informed by Merleau-Ponty (Antonio R Damasio, 1995; Depraz, Varela, & Vermersch, c2003.; Dourish, 2004; Dreyfus, 1990; Ihde, 1978; Todes, 2001; Varela, Thompson, & Rosch, 1991; Young, 2005).

Polanyi.

Another important figure who has contributed greatly to the literature on embodied ways of knowing is Michael Polanyi whose work focused extensively on the body's cognitive capacity. Polanyi articulated the concept of *tacit knowledge*, a form of inferred knowing that is based on direct action in the world (Polanyi, 1966). Tacit knowledge is often difficult to articulate and challenging to prove using traditional methods based in scientific objectivism (Polanyi, 1958). Polanyi suggested that people know more than they can articulate and that knowledge of the objective world comes from participation in it. He vehemently opposed the computationalist perspective embraced by cognitive scientists, in which the mind is reducible to a set of rules (Polanyi, 1958).

The concept of tacit knowledge demonstrates the body's ability to retain and recall knowledge through active participation in the world. This ability supports the notion that movement conveys meaning and knowledge that can be utilized in the process of movement tagging.

2.1.2. Embodiment and cognitive science.

The introduction of embodied philosophy to the field of cognitive science prompted a more scientifically driven approach to understanding the body's contribution to cognition. This resulted in a de-emphasis on the highly experiential focus that had been of primary concern to the phenomenologists. Cognitive science researchers are primarily interested in better understanding the mechanisms that underlie human cognition and its various components, including perception, intelligence, emotion, and reasoning. Researchers come from a diverse range of disciplines including psychology, computer science, linguistics, philosophy, and neuroscience. Despite the long history of embodiment in philosophical and Eastern spiritual traditions, acceptance of theories of embodiment by scientific communities did not occur until the 1950s, when they were used in the work of psychologists such as Jean Piaget and the biologist Jakob von Uexküll (Lindblom, 2007). An early theory of embodied cognition can be found in the works of William James, whose descriptions of psychological processes allude to the body's central role in the production of consciousness (James, 1985). His development of pragmatist philosopher along with Dewey has been highly influential on current theories of embodied cognition including the

work of F.M. Alexander, one of the principle founders of somatic training (Thecla Schiphorst, 2009), and has informed the development of the concept of embodied interaction within HCI (McCarthy & Wright, 2004). Various other cognitive scientists have demonstrated the body's contribution to human cognitive, emotional, and social development. These connections lend support to the investigation of movements as containers for personal meaning that facilitate the recall of embodied and tacit knowledge, memory, and emotion.

Cognitive development.

The connection between movement and cognitive development is highlighted in the work of Mark Johnson and George Lakoff, particularly in their concept of conceptual metaphors (Lakoff & Johnson, 1980). Conceptual metaphors provide a functional explanation for how the human body's capacity for certain types of movements and its embeddedness in an environment with specific constraints and affordances (e.g., gravity) facilitate the development of abstract thought. Lakoff and Johnson define conceptual metaphors as a subset of the larger class of metaphors that can be used as a cognitive resource to map from a source domain to a target domain. Embodied schemata constitute the source domain, which is linked via the conceptual metaphor to a target domain in the form of an abstract thought. The theory posits that through repeated patterns of experience, neural pathways are formed and reinforced. For example, the experiential nature of humans' upright orientation in the world provides the basis for an image schema based on vertical hierarchy. This leads to orientation metaphors that associate *up* with more and *down* with less. These metaphors also provide an alternate conceptualization of *up* as happy and *down* as sad. The use of these metaphors in linguistics is abundant. For example, the statement "He was feeling down" uses an orientation metaphor to denote sadness. Other categories of embodied schemata exist, including space, locomotion, containment, balance, and force (Lakoff & Johnson, 1980). Lawrence Barsalou's notion of a *perceptual symbol system* provides a complementary theory for the same phenomena (Barsalou, 1999).

The idea of conceptual metaphors suggests that movement is directly linked to human thought processes, perhaps on a level beneath conscious awareness. The theory also provides a mechanisms to explain how the body, and movement in particular,

embodies experience. Conceptual metaphors have already been used in the context of movement interaction in HCI ((A.N. Antle, Corness, & Droumeva, 2009; Bakker, Antle, & van den Hoven, 2009; Hurtienne & Israel, 2007; Macaranas, Antle, & Riecke, 2012). Their work suggests that movement embodies prior experience that can be recalled during interaction, supporting the use of movement for tagging purposes. It should therefore be possible to exploit conceptual metaphors in order to attribute meaning to images through the use of movement.

Emotional development.

Antonio Damasio, a neuroscientist, explored the connection between embodiment and emotions. One of his primary contributions was the identification of the foundational role emotions play in decision making (Antonio R. Damasio, 1995). Damasio's research in this area led to the formulation of the somatic marker hypothesis, which posits that contrary to the common perception, emotions are active bodily responses that begin prior to their manifestation as feelings in the brain. He argues that body states are induced by affective stimuli in the environment and the associations between stimuli and physiological responses are stored as markers in the ventromedial prefrontal cortex. In the future, when stimuli are encountered, all the markers associated with similar experiences are summed to generate a somatic state that manifests as a feeling (A. R. Damasio, Everitt, & Bishop, 1996).

By linking physiological states with specific somatic states (expressed as emotions), Damasio's hypothesis suggests that movement (as a component of human physiology) should also be capable of inducing emotional states. The use of movement for tagging would take advantage of these existing associations to attribute emotional meaning to images.

Social development.

A number of researchers have investigated the incidental impact haptic sensations have on people's social assessments. Researchers Williams and Bargh, for example, identified connections between bodily states and interpersonal connection by demonstrating that changes in body temperature can shift social assessments. Participants in one study were asked to hold a cup of either hot or iced coffee while

assessing a stranger's personality. The results showed that the presence of a cold stimulus induced a more negative assessment, while heat evoked a more positive one (Williams & Bargh, 2008). Ackerman et al. conducted similar studies examining the influence that various haptic qualities had on inferential thinking. They demonstrated that the weight, texture, and hardness of materials being held by participants also influenced impressions made of strangers (Ackerman, Nocera, & Bargh, 2010).

The ability of environmental factors and haptic stimuli to influence human cognitive states illustrates the extensive role of the body and the senses in transforming subjective experience. This would suggest that people are capable of inducing particular states through both unconscious and conscious means, including movement. Movement tagging would exploit this ability, enabling users to induce emotional states and recall experiences through their choice of movements, even if this process occurs on a subconscious level.

2.2. Considering Movement Experience

According to Sheets-Johnstone our primary embodied experience is constituted through movement (Sheets-Johnstone, 1999). Movement experience is defined in different ways depending upon a person's epistemological and ontological perspective. For the purpose of this research I will be primarily considering two types of movement experience: phenomenological and cognitive. Phenomenological experience focuses on an individual's physiological sensations and felt-experience, such as proprioception and haptic awareness; Cognitive experience emphasizes a person's emotional, social, and developmental experiences. These two perspectives should not, however, be considered mutually exclusive as they overlap in myriad ways. Investigating both types of experiences requires a perspective that addresses both. The field of Somatics provides this unique lens.

2.2.1. Somatics.

The field of Somatics, which has significantly influenced the development of contemporary embodied philosophy, provides a unique perspective from which to

investigate the body, movement, and their roles in human cognitive, social, and emotional development.

The field of Somatics developed in the late 19th and early 20th centuries, with roots in the Delsarte method as well as Eastern philosophical traditions (Thecla Schiphorst, 2009). The term *Somatics* was coined by Thomas Hannah in 1976 to describe the collection of disciplines exploring embodiment and sensory awareness. One of the earliest works on the subject, *The Use of the Self*, was published by F. Mathias Alexander in 1932 (Alexander, 1932). Numerous other practitioners have contributed to the canon since then (Alexander, 1932; Feldenkrais, 1981; Gindler, 1995; Thomas Hanna, 1995). Unlike other body-based practices, Somatics does not focus on the external body, but rather is concerned with understanding the soma, the experience of the body perceived from within. This orientation provides a unique outlook that differentiates Somatics from other body-based practices (Alexander, 1932; Feldenkrais, 1981; Gindler, 1995; Thomas Hanna, 1995).

Somatic practitioners are concerned with maintaining the health and balance of the body, which, they believe, affects an organism's whole biological system. In *The Use of the Self*, Alexander emphasizes the unity of mind and body, writing that "it is impossible to separate 'mental' and 'physical' processes in any form of human activity" (Alexander, 1932). For this reason, somatic practices are used to heal both the body *and* the mind by attaining balance in the body through directed focus on the proprioceptive senses (Thomas Hanna, 1995). Somatics is distinct from physiological and psychological approaches to healing because awareness is not mediated by third-person observations or abstract concepts but instead is achieved through direct experience of the body (Thomas Hanna, 1995). The basic tenet of Somatics is that through honed awareness of the soma, empirical knowledge of one's own body can be discovered (Alexander, 1932). Although various methods of practice have developed since Alexander first published *The Use of the Self*, they all share common perspectives on the soma and share similar techniques of practice. Some of the better known therapeutic approaches currently in use are the *Alexander method*, the *Feldenkrais Method*, and the *Hanna system of functional integration*.

To understand somatic practices it is essential to first understand the role of the soma, or body, and its functioning. According to Hanna, the soma is not unique to humans—plants and animals also have somata. What makes humans unique is the ability to focus awareness volitionally (Thomas Hanna, 1995). Hanna notes that the soma is capable of both first-person and third-person perceptions, allowing for awareness of bodily structures as well as internal functions. Another unique facet of the soma is that it is both self-aware and self-regulating. This means that when we observe our somata, we are simultaneously inciting transformations within them (Thomas Hanna, 1995). In order to become aware of these transformations, we need to use our sensorimotor system, which acts as a closed feedback loop within this system. Hanna notes that there is a reciprocal relationship between sensing and moving and that this is the key to enhancing awareness. Hanna points out that we cannot sense without acting and cannot act without sensing. Due to this, we can sense only those things for which we already have a pre-existing motor response. If we cannot react to something, it is pushed away from perceptual awareness (Thomas Hanna, 1995). Somatic practices teach people how to achieve this awareness in order to transform faulty motor responses acquired through the habitual use of the self (Alexander, 1932). The goal of somatic learning is to put the body into a “fair” state designated by optimal physical and mental performance (Thomas Hanna, 1995).

Although Hanna does not use the term *embodiment* directly, he does present an account of consciousness based on the soma. Hanna contends that consciousness is a basic property of the human soma. The soma designates the range of sensorimotor functions of which each individual is capable. These functions are acquired through learning starting at birth. The soma therefore determines both how many things we can do and of how much we can be conscious (Thomas Hanna, 1995). While Hanna does not suggest that the soma is the origin of cognition, this conception of bodily consciousness parallels the general theory of embodiment that accounts for consciousness and cognition through the interplay between an organism and its environment. Additionally, the internal focus of somatic practice is shared by Antonio Damasio, whose research focuses explicitly on the role of interoceptive awareness in producing somatic markers (emotions) and the role those markers play in decision making (Antonio R Damasio, 1995).

While Somatics is generally considered separate from more traditional phenomenological approaches to movement, the two disciplines share similar goals. Both phenomenology and Somatics aim to improve awareness of lived experience. Phenomenology has as its goal the awareness of preconscious, or precognitive, experience. In “The Embodied Mind”, Varela, Thompson, and Rosch outline a method for accessing such experience using meditative techniques based on mindfulness (Varela et al., 1991). Somatics provides another method for becoming aware of experience that is normally hidden from consciousness. The primary difference between the two approaches is that phenomenology is not specifically movement oriented, and so the meditative technique provided by Varela et al. inhibits movement in order to focus awareness inward. Somatics, on the other hand, uses movement as the means of focusing attention inward. Used together, these approaches complement each other, enhancing awareness and providing access to a wider range of precognitive experience.

Epistemological orientation.

Although somatic practice is focused on the experiential aspects of movement, the knowledge it acquires is, according to practitioners, objective and empirical in nature. Hanna considers somatic awareness an unmediated process of empirical observation, one that is as objective as third-person observation (Thomas Hanna, 1995).He criticizes the scientific community for ignoring the validity of this factual dataset solely because of the first-person perspective from which it was obtained. Somatics, he maintains, is inclusive of both first- and third-person perspectives, making it a more comprehensive approach to understanding health, the body, and experience (T. Hanna, 1976; Thomas Hanna, 1995).

Somatic practices were developed through experimentation. Alexander began with a problem and developed the practice as a solution. He relates his process of trial and error in *The Use of the Self* (Alexander, 1932).This aspect of somatic practice differentiates it from other body-based and phenomenological approaches to investigating movement. Somatics is by necessity practice based, and the theories it expounds are derived from direct experience of the body and the outcomes of experimental inquiry.

2.3. Movement Analysis

To support the investigation of movement, somatic practitioners have developed a number of tools in their practice and in their investigation of movement. One of the areas where the tools have been particularly well developed is for movement analysis. Although movement analysis techniques and frameworks have been developed in areas outside of Somatics, the approaches in this discipline are particularly robust and take into account numerous aspects of movement including experiential ones. The next section provides an overview of some of the movement analysis systems relevant to this research.

Movement analysis evolved from two separate streams, each with a unique focus. The first stream focuses on nonverbal behavior research and reflects findings from psychology, anthropology, and ethology. This stream tends to focus on action as a structure and has a principally quantitative perspective towards analysis. In this approach, movement is considered primarily as a physiological phenomenon, facilitating the compartmentalization and classification of the various systems involved. Examples of disciplines that use this approach are kinesiology and traditional forms of physiotherapy. A second stream, which developed out of the work of Rudolf Laban, is based in dance and performance and takes a more holistic approach that considers the effect of both the mind and body. Laban's approach emphasizes the importance of both the functionality as well as the quality and expressiveness of movement. His system of analysis is more focused on the continuing process of moving and has its grounding in somatic ways of experiencing the body (Maletic, 1987). The research presented in this thesis focused on the latter type of movement analysis.

2.3.1. Laban Movement Analysis (LMA).

Laban's approach to movement analysis begins with a unique understanding of movement as an inner impulse. Laban's framework takes a holistic view of movement by connecting outward movements with people's inner drives. Unlike other models of movement from the time, which approached analysis from a purely functional and efficiency-driven model, LMA considers both the mind and body. This method allows for a mover's intent to be considered based on four primary components: Body, Effort, Space,

and Shape (BESS). This system understands the dynamics of movement as encapsulating multiple perspectives. The first is an observational perspective (from both 1st and 3rd person perspectives), which defines movement characteristics based on a holistic integration of the senses, from vision to kinesthesia. The second, a somatic perspective, references the physicality of movement—the awareness of muscle, bone, sinew, and other anatomical elements that make movement possible. This second perspective goes beyond mere observation, necessitating closer contact (such as that of a physiotherapist touching a patient), but it is more fundamentally experienced by the mover herself through directed attention and awareness. The third perspective is the expressive quality of the movement that conveys the mover's inner experience—her intent and emotional state (Arnheim, 1981).

Kinesphere.

One of Laban's specific areas of interest was space, and he understood the various ways that it informed movement. This led to his study of choreutics (or space harmony), the understanding of space as an aesthetic construct of dance. As a trained architect, Laban saw dance as living architecture and was very interested in the relationship between a dancer and the space around him (Laban, 1966). Laban used the concept of the kinesphere as a tool to explore choreutics. He defined the kinesphere as the personal space within reach of the dancer that is accessible via his or her limbs. The kinesphere illustrates the possible relationships people can have with the space surrounding them; it can be understood as the gestural space surrounding a dancer or mover (Laban, 1966). Laban developed a set of "movement scales" based on the platonic solids that demonstrated movements he believed were universally harmonious and aesthetically pleasing. This also informed his notion of Shape, or the transformation of the form of the body during movement.

Effort.

The concept of *Effort* which is utilized as one of the key components in my research, was developed by Laban and F.C. Lawrence during a collaboration from 1941–1947 during which they analyzed factory workers' movement. The use of the term first appeared in their book *Effort* (Laban & Lawrence, 1947), and it remains a primary component of the LMA system to this day. In its original conception, Effort was connected

to the amount of energy expended by a particular person doing a particular task; it comprised both mental and manual energy (Maletic, 1987). Through their work together, Lawrence and Laban hoped to improve the working conditions, productivity, and efficiency of factory workers by identifying the optimal qualities of movement needed to complete specific tasks (Laban & Lawrence, 1947). Using their profiling method, they aspired to identify the best candidate for a specific job based on his natural movement inclinations. Workers could also be trained to move in ways that were conducive to the task they were completing.

The profiling system that Laban and Lawrence developed broke Effort down into four basic factors of movement: Flow, Weight, Time, and Space. These Effort factors describe the essential dynamic qualities of movement that together make up all actions (Laban & Lawrence, 1947).

Effort factors are comprised of two extreme polarities, one *expanding*, and the other *condensing*. Expanding implies exploration, whereas condensing implies resistance (Laban, 1974). For example, Free Flow, the Expanding Element for Flow Effort, is continuous and unhindered. Bound Flow, the Condensing Element, on the other hand is restricted, encumbered, and controlled.

Table 1: Efforts with Opposing Elements

Effort	Expanding Element	Condensing Element
Flow	Free	Bound
Weight	Light	Strong
Space	Indirect	Direct
Time	Sustained	Sudden

Flow.

The term *Flow* characterizes whether movement is open and continuous (Free) or tight, closed, and obstructed (Bound; Laban & Lawrence, 1947). In Free Flow, movements tend to be ongoing and unending, allowing a person to transition without stopping from one movement to the next. The experience is of an unbroken and ongoing series of movements that have no clear start or endpoints. Bound Flow, in contrast, is easily identified by the stopping and shifting of movements without smooth transitions. The overall impression of Bound Flow is of constraint and tightness (Maletic, 1987). Video examples depicting Free and Bound Flow Effort can be viewed here: http://www.sfu.ca/~alevisoh/efforts.

Weight.

The Weight aspect of movement characterizes the mover's experience activating their bodily weight with muscle tension. It can be either Strong or Light. Pushing against a heavy object (e.g., pushing a car) requires Strong Weight to move it. Threading a needle requires Light Weight on the thread to push it through the eye. It is important to note that Weight within the LMA framework does not have anything to do with a person's physical weight or level of fitness. A small child can move with Strong Weight just as easily as an adult bodybuilder can. And the bodybuilder can access Light Weight in the same manner as the child. Weight, in this context, reflects the quality of the movement as it is experienced by the mover. It is possible for a trained LMA practitioner to observe this inner experience via the tension and muscle exertion demonstrated during the movement (Maletic, 1987). Video examples depicting Light and Strong Weight Effort can be viewed here: http://www.sfu.ca/~alevisoh/efforts.

Space.

Space characterizes a mover's intentionality and focus. If movements are directed towards a single point in space or the mover is physically moving towards a point, then the Space Effort is Direct. If movers have multiple foci, then these movements are characterized as Indirect. Again, the Effort aligns with the movers' inner experience and should reflect their orientation and experience within the physical space that surrounds

them (Maletic, 1987). Video examples depicting Direct and Indirect Space Efffort can be viewed here: http://www.sfu.ca/~alevisoh/efforts.

Time.

The Time factor reflects the mover's subjective experience of time and is therefore, much like Weight, a relative rather than absolute scale. Time does not refer to the actual duration of a movement but rather the mover's relationship to that duration. If a mover is compelled to quickly surge forward as if startled, then Time is characterized as Sudden. If a mover is sauntering down the street on a cloudless summer day, then her experience of time is characterized as Sustained. The speed at which the mover is walking does not impact quality of Time; rather, it concerns whether her movements emphasize anticipation (Sudden) or relaxation (Sustained; Maletic, 1987). Video examples depicting Sudden and Sustained Time Effort can be viewed here: http://www.sfu.ca/~alevisoh/efforts.

Laban Movement Analysis States and Drives.

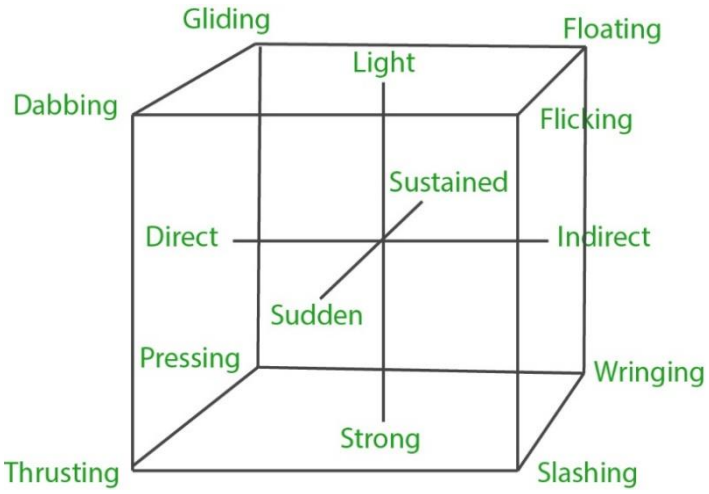
Laban and his collaborators were not just interested in developing a taxonomy of movement types, but also in gaining a better understanding of the relationship between specific movements and aspects of human experience. To investigate this they identified the various permutations and combinations of the Efforts and established links between these complex interrelations and subjective experiential states. One of the developments that came out of this was the classification of six *LMA States* (combinations of two Effort Factors) and the four *LMA Drives* (combinations of three of the Effort factors.) The LMA States are *Awake (Space and Time)*, *Dream (Weight and Flow)*, *Near (Weight and Time)*, *Remote (Space and Flow)*, *Stable (Weight and Space)*, and *Mobile (Flow and Time)*. The LMA Drives are the *Action Drive, Passion Drive, Vision Drive*, and *Spell Drive*. The States and Drives are significant because they illustrate the deep connection between movement, experience, and cognition, supporting the suitability of LMA as a tool for investigating the use of movement as a semantic construct that can support digital tagging.

Action Drive.

The Action Drive is comprised of a set of movement descriptors encompassing Time, Weight, and Space, but lacking Flow. (In the LMA model, Flow is not considered an

essential differentiator of action but instead affects the articulation of action.) The eight actions are: Dabbing, Gliding, Floating, Flicking, Slashing, Punching, Pressing, and Wringing (Laban & Lawrence, 1947). The Action Drive is comprised of the basic task-oriented movements that the human body is capable of enacting. These can be illustrated on a cube, with the axes representing the Weight, Space, and Time Effort factors (Figure 2).

Figure 2: Laban Action Drive



Passion Drive.

The Passion Drive is comprised of the Flow, Weight, and Time Effort factors but does not include Space. Due to the lack of Space, the Passion Drive is oriented towards personal experience and constitutes internal awareness, sensation, and timing (Laban & Lawrence, 1947; “What is LMA?,” 2011).

Vision Drive.

The Vision Drive lacks the Weight factor but includes Space, Flow, and Time. Due to the lack of the highly personal Weight factor, the Vision Drive is externally focused and concerned with outward awareness, searching, thinking, and planning (Laban & Lawrence, 1947; “What is LMA?,” 2011).

Spell Drive.

The Spell Drive includes Flow, Weight, and Space but has no Time Effort factor. Due to the absence of Time, the Spell Drive orients around the self in relation to the other. Spell Drive movements are not concerned with decision making or pace and can feel as though they occur outside of time (Laban & Lawrence, 1947; "What is LMA?," 2011).

Labanotation.

Another major contribution made by Laban was his development of a transcription system for movement. This system, known as Labanotation, provides a formalized method for documenting specific movement observations in a manner analogous to music notation (New World Encyclopedia, 2008). Labanotation is comprised of a staff that is read from bottom to top and on which the body is represented on the vertical axis and time on the horizontal. Labanotation provides a great deal of versatility, enabling the transcriber to add comments and details about specific movements and directions of movement and include Effort descriptors. The system has been used by choreographers, dancers, actors, and athletes.

Labanotation has been utilized as a tool in numerous HCI research studies in order to encode a users' movements during interaction. The conflation of Labanotation with LMA in the field of HCI has caused a great deal of confusion and has led to the misunderstanding and underuse of the experiential aspects of LMA. My research does not use Labanotation, but does include the somatic and experientially derived aspects of the LMA Effort Factors.

Bartenieff Fundamentals.

Irmgard Bartenieff, Laban's student, worked with him on the creation of the LMA system and was responsible for the development of the Body category (Hackney, 1998). Her contributions to LMA, the Bartenieff Fundamentals, are so extensive that they are now included and taught as an integral component of the LMA system. Bartenieff developed a set of exercises to assist in the exploration and articulation of body-oriented LMA concepts. These exercises, along with other innovations, made her work particularly beneficial in physical therapy, an area to which she made significant contributions

(Bartenieff & Lewis, 1980). Her system has been applied primarily to dance, physiotherapy, and dance therapy—the latter a field that she helped pioneer.

Warren Lamb.

Warren Lamb was a student of Laban's who expanded their work together to develop a profiling system for use in business management. Lamb was introduced to movement analysis, and LMA in particular, while working with Laban and the management consultant F.C. Lawrence on a project profiling factory workers. Laban realized that his work was applicable to areas beyond dance and performance and worked with Lamb to explore applications in the context of management. Lamb went on to develop the Action Profiling System (APS), sometimes referred to as movement pattern analysis, which provides a structured method for assessing people's intrinsic decision-making processes based on the characteristics of their movements (Davies, 2001). The Action Profiling System is commonly used now within corporations as a way of profiling upper management to assign roles within a company and to formulate teams based on compatible and supporting decision-making styles. Lamb also made some significant advances in the understanding the impact of gender differences on movement (Davies, 2001).

Judith Kestenberg.

Dr. Judith Kestenberg was a Freudian psychoanalyst who investigated the role of movement in child development and worked directly with LMA practitioners. She was interested in developing a method of movement observation that could be used to create psychological profiles and function as a tool for diagnosis. After pursuing her own methods for transcribing and analyzing movement, she was introduced to Laban and his student Warren Lamb and incorporated their work into her own. The resulting system, the Kestenberg Movement Profile (KMP), relies heavily on Laban's categories of Effort and Shape. Kestenberg and her colleagues created a detailed system that connects Freud's early developmental stages (anal, genital, etc.) with specific types of movement (Kestenberg, 1967). According to Kestenberg, the presence or absence of certain movement categories at specific age ranges can illuminate various developmental issues and disorders; the manner in which these movements present in an individual are used as markers to detect underlying psychological behavioral patterns (Amighi, 1999).

The KMP provides additional empirical evidence to support the validity of the LMA system as a tool for accessing individuals' inner impulses and motivations through movement (Amighi, 1999). Kestenberg was very concerned with the utility of the system she was developing, and she and her colleagues collected abundant data on the effectiveness of the KMP system, adjusting and modifying the parameters through practice. Kestenberg did note the struggle to get therapists to do research on the system due to the fact that its effectiveness in practice encouraged anecdotal reviews rather than experimental research (Amighi, 1999).

The various approaches to movement analysis presented in this section demonstrate the myriad ways that movement functions as an indicator of underlying cognitive processes. LMA was selected as the underlying lens for my research for its capacity to account for both external observation and internal experience, and for its basis in somatic practice. LMA also has a history of prior use in HCI, providing support for its inclusion as a method of investigating movement experience, and the use of movement for tagging.

2.4. Movement in HCI

In this section, I discuss the applications of movement in the context of technology design. I present major frameworks from the field of HCI that include a significant movement component. These frameworks are used to exemplify the changing approaches to the use of movement in HCI, as researchers move from primarily functional considerations to more experiential approaches to movement interaction. While there has been innovation and exploration in related fields such as interactive art, these are not considered here because they are outside the scope of this research.

2.4.1. Approaches to investigating movement in HCI.

Movement has always been a component of computer interaction. In the early history of HCI, movement was viewed primarily from a human factors perspective and was seen as a means of inputting information into a system using a keyboard or mouse. During this period, empirical research exploring the limits of two-dimensional interaction, such as

that of Paul Fitts (1954), epitomized this approach to movement. During this early period movement was limited primarily to the use of the hands and arms to control a mouse and keyboard. In the decades since, the use of movement for interaction has expanded to include new devices and increased bodily inclusion. These developments have led to the need for the HCI community address the role of movement in new ways, including a shift from thinking about movement primarily as a *functional* component of interaction to considering its *experiential* contributions as well.

2.4.2. **Embodied interaction.**

One of the major contributions to the increased attention to experiential aspects of interaction was through the introduction of the concept of *embodied interaction* to the larger HCI community by Paul Dourish in his book *Where the Action Is* (Dourish, 2004). The concept of embodiment had informed research in HCI, often implicitly, for over a decade before Dourish formalized the notion of *embodied interaction.* His concept of embodied interaction was based on trends in social and tangible computing to emphasize the ways in which users create meaning through action in the world. He advocated a model of computing that took into account the full spectrum of human skills. Dourish introduced the concept of embodiment by tracing its origins through the history of phenomenological philosophy, which is concerned with the ways that consciousness and subjectivity are structured and emphasizes isolating the phenomenon of experience through practices such as bracketing (*epoché*; Husserl, 2004). Since the book's publication, there has been a significant increase in the number of HCI researchers investigating aspects of embodied interaction, reflected in the inclusion of embodiment as an explicit component of the *Tangible, Embedded, and Embodied Interaction* (TEI) conference. Yet despite Dourish's focus on phenomenological experience, his work has often been used to support cognitive and social approaches to embodied interaction. This is likely due to the difficulties of conducting rigorous phenomenological studies using techniques such as those based in meditative practice (Depraz et al., c2003.). However, with the increased interest in user experience, there has been a resurgence of interest in Husserlian phenomenological techniques, as exemplified by the incorporation of somatic and meditative practices in research (Depraz et al., c2003; Thecla Schiphorst, 2011).

2.4.3. **Functional and experiential approaches to movement.**

The shift in awareness brought about by the introduction of Dourish's concept of embodied interaction to HCI is reflected in the numerous frameworks that have since been used to explore embodiment. These interdisciplinary theories empowered a greater number of researchers to transition from thinking about movement as a purely functional modality to considering its contribution to user experience as well. Although the functional and experiential components of movement are tightly coupled and ultimately inseparable, researchers in HCI tend to prioritize one or the other in their work. Researchers interested in *functional* movement focus on movement for task completion, tool use, communication, and expression. Researchers interested in movement as an *experiential* component of interaction emphasize the qualitative aspects of movement interaction, including kinesthetic learning, somatic awareness, aesthetics, and emotion. (Table 2).

Table 2: Uses of Movement in HCI (from Levisohn & Schiphorst, 2011)

Functional Approaches to Movement	Experiential Approaches to Movement
Task Completion	Kinesthetic Learning
Tool Use	Somatic Awareness
Communication	Aesthetics
Expression	Emotion

Movement Frameworks in HCI.

Table 3 lists some of the frameworks that have had a significant impact on how movement is considered within the field. The integration of multiple interdisciplinary perspectives attests to the complexity of movement as a phenomenon. The table also highlights some of the major shifts in focus within HCI, from tasks to activities to embodied cognition to user experience and to felt experience. The next sections provide a review of how these two approaches have been used by researchers to investigate embodied approaches to movement interaction.

Table 3: Interdisciplinary Frameworks Used in HCI (from Levisohn & Schiphorst, 2011)

Framework/ Approach	Application in HCI	Author(s)	Primary Orientation
Human Factors and Ergonomics	Tasks	Taylor, Frederick Winslow (1911) (R. P. Taylor, 2006)	Functional
Experimental Psychology	Tasks	Wundt, Wilhelm (1874)	Functional
Activity Theory	Activities	Leont'ev, A. N. (1959)	Functional
Affordances	Embodied Cognition	Gibson, J. J. (1979)	Functional
Image Schema	Embodied Cognition	Lakoff, George & Johnson, Mark (1980)	Functional
Pragmatism	User Experience	Dewey, John (1934)	Experiential
Phenomenology	Felt Experience	Husserl, E. (1913) Heidegger, M. (1927) Merleau-Ponty, M. (1945)	Experiential
Laban Movement Analysis	Felt Experience	Laban, R. von, & Lawrence, F. C. (1947)	Experiential

2.4.4. Functional movement in HCI.

This section presents common functional approaches to movement in HCI. These approaches highlight the role of movement as a resource for increasing productivity and efficiency and directly supporting human cognition.

Table 4: Functional Movement Approaches in HCI (from Levisohn & Schiphorst, 2011)

Cognitive Approaches	Affordances	Situated Action	Activity Theory	Embodied Schemata
Skill-Based Approaches	Skills Acquisition	Characterizing Skilled Movement	Movement as Bodily Knowledge	

Semantic-Based Approaches	Meaning Through Interaction	Culturally Embedded Meaning		

Functional approaches highlight the role of movement as a resource for increasing productivity and efficiency and directly supporting human cognition. There are four primary uses of functional movement within HCI: task completion, tool use, communication, and expression (Table 4).

Gestures.

The most common form of functional movement interaction in HCI is through the use of gestures. This section presents some of the primary uses of gestures for interaction order to highlight their limitations and to demonstrate the benefits of more somatically-driven approaches.

By the most general definition, *gesture* refers to the movement of a specific limb or limbs of the human body in a communicative or expressive manner. More specific definitions vary depending upon discipline of study. For example, in the fields of psychology and communication, a gesture is considered primarily a communicative act that accompanies speech (Gullberg & Bot, 2010). Most researchers investigating gestural communication focus on this characteristic and aim to understand how gestures function to augment linguistic communication.

Gestural interaction is generally defined as the use of abstracted movement types to control an aspect of computational interaction (Mulder, 1996). In practice, this generally prioritizes solely the use of the arms and hands and primarily considers movement as an alternative to haptic input or speech. The earliest explorations of gestural interaction were done by pioneering computer vision artists such as Myron Krueger, whose seminal work, *Videoplace*, allowed users to interact with virtual environments using their hands, arms, or entire body (Krueger, Gionfriddo, & Hinrichsen, 1985). Gestural interaction has evolved considerably since Krueger's initial endeavors, achieving widespread use via gaming systems such as the Nintendo Wii and Xbox Kinect.

Gesture classification systems.

In HCI, gestures are often used as a means of controlling an aspect of computational interaction such as the movement of a cursor or mouse pointer or the scrolling or turning of a page (Mulder, 1996). The use of gestures in this manner is a type of movement known as *ergotic* movement. Ergotic movement is movement that is done in order to manipulate the physical world. Although gestural interaction in HCI is used to manipulate virtual objects and not physical ones, the basic intention in both cases is identical.

Other types of movement are also commonly seen in gestural interaction applications in HCI. *Semiotic movements* are those used for linguistic purposes and include such things as gesticulation, pantomime, and sign language (Adam Kendon, 2004). Another type of movement, *epistemic action*, is also common, although more often in tangible interfaces than in purely gestural ones. Epistemic actions are external movements performed by an agent on the surrounding environment in order to make mental computation easier, faster or more reliable (A. Antle, 2012; Kirsh & Maglio, 1994; Malek, Harrison, & Thieffry, 1981; Mulder, 1996). This includes actions that support cognition by organizing elements within the environment into more easily understandable or memorable configurations, such as sorting cards during a poker game, manipulating puzzle pieces to see how they look in various configurations, or rotating Tetris pieces as they fall to understand how they fit with other pieces (A. Antle, 2012; Kirsh & Maglio, 1994).

Table 5: Basic Taxonomy of Gestural Movements in HCI

Linguistic	Movements used in place of or to augment language and speech
Ergotic	Movements used to manipulate object in the real (or virtual) world
Epistemic	Movements used to manipulate the environment to facilitate mental computation

The emphasis in HCI applications on these three types of gestures – *linguistic*, *ergotic*, and *epistemic* (Table 5) – limits the consideration of movement to a primarily

syntactic perspective, as an augmentation of or replacement for spoken language, rather than as a unique semiotic system with its own conventions and logic. Other researchers have devised classification systems that include a greater emphasis on movement's semiotic properties. Adam Kendon offers an alternate system that classifies gestures along a continuum from *spontaneous gesture* to *conventional sign* (A. Kendon, 1980). He postulates that gestures and speech are part of a single unified system and cannot be separated. Gesture types included in this system are *gesticulation*, *language-like gestures*, *pantomime*, *emblems*, and *sign language* (A. Kendon, 1980). Gesticulations are spontaneous and idiosyncratic movements of the hands and arms that accompany speech. Language-like gestures are similar to gesticulations but are more tightly integrated into the grammar of a sentence, replacing spoken language altogether. For example, a speaker relating how the weather was on his vacation might replace the "so-so" with an oscillating hand gesture (A. Kendon, 1980). Pantomime includes movements that communicate a story in the absence of speech. Emblems are a more explicitly language-like type of gesture, conforming to a standard of well-formedness and consistency that gesticulation and pantomime lack. For example, the V sign made by holding up the pointer and middle finger of the same hand is well accepted as a positive sign indicating either victory or peace (A. Kendon, 1980). Sign language includes a complete set of conventional signs that exhibit the traits of a full-fledged communication system.

David McNeill advances an alternate system based on Kendon's work that includes the categories *iconics*, *metaphorics*, *deictics*, and *beats* (McNeill, 1992). Iconic gestures have a close formal relationship with the semantic content of speech and are used to depict concrete objects or events. Metaphorics are similar to iconics but are used to depict abstract concepts. Deictics are pointing gestures used to reference actual or abstract people or objects. Beats are nonrepresentational gestures comprised of two phases (up/down, in/out) that accompany speech and are used to emphasize specific words to mark them as significant (McNeill, 1992).

While each of these systems provides insight into classifying gestures, which can then be used in the development of gestures for computational interaction, none address movement experience as a primary construct.

2.4.5. **Experiential movement in HCI.**

In contrast to functional movement, *experiential movement* prioritizes three primary areas of investigation. The first, aesthetic interaction, interrogates movement through the lens of art theory, the humanities, criticism, and practice; the second, affective computing, explores the connection between movement and emotion; and the third, movement as felt experience, focuses on the first-person qualitative nature of movement (Table 6).

Table 6: Experiential Movement Approaches in HCI (from Levisohn & Schiphorst, 2011)

Aesthetic Interaction	Craft of Movement	Aesthetic Interaction	Tangible Aesthetics	Graceful Interaction
Affective Computing	Sympathetic Interface	Supple Interaction		
Movement as Felt Experience	Somatic Awareness	Feel Dimension	Kinesthetic Movement Interaction	Poetics of Experience

Designing for Movement Experience.

Investigating the use of movement to tag digital images addresses the previously identified research gap – the need for greater integration of experiential and functional movement (Figure 3) -- by providing an exemplar conceptual application to facilitate exploratory research. In this section I discuss the various research endeavors that provide a foundation for my study and that highlight the benefits of incorporating movement experience as a components of functional interaction. I address research that explores various elements of movement including its role in the construction of somatic experience, support for embodied states, and role in the construction of meaning. These endeavors highlight some of the key features of movement interaction that relate to user experience.

Figure 3: Research Continuum

Somatic experience.

Somatic experience, or the first-person awareness of the body, is an essential component of movement interaction. The importance of somatic experience to interaction is highlighted in the work of various researchers who have investigated specific elements of movement-experience and their role in designing interactive systems. The role of proprioception in movement interaction is highlighted in Larssen et al's concept of the *feel dimension* of technological interaction (Astrid Twenebowa Larssen, Robertson, & Edwards, 2007). The proprioceptive sense provides information about how a body is positioned in space, relaying the position of limbs and joints. Larssen et al specifically address *actions in space*, and *movement expression*, both of which are essential components of a user's experience of movement interaction. Although a body's position in space is easy to calculate using depth sensors, the user's experience of their body is not as it is susceptible to various influences (Lackner & DiZio, 2005).

Danielle Wilde also addresses the importance and difficulty of incorporating somatic experience in the design of interactive experiences. In her articulation of the concept of *the poetics of experience s*he addresses the role of *attention* in movement-interaction, and its role in the construction of experience (Wilde, 2012). Attention plays a significant role in kinesthetic-experience since it affects what sensations are brought into conscious awareness (Leder, 1990). Investigating movement-tagging will assist in identifying the factors that influence somatic attentionality and inform the design of future movement-based systems.

Thecla Schiphorst, a dancer and researcher, explores somatic experience in both her artwork and her research. For the development of her project *Whispers*, she collaborated with Susan Kozel and Kristina Andersen in conducting participatory design workshops based on the concept of *experience modeling* (T. Schiphorst & Andersen, 2004). Experience modeling uses existing frameworks and methods from performance, dance, and Somatics to construct systematic models of movement from direct experience. For *Whispers*, Schiphorst and her collaborators were interested in devising ways to focus participants' attention on their physiological states and to find methods for transferring physiological data among people. During design workshops, they selected specific concepts and activities to aid in the identification of gestures for sharing physiological data.

They suggest that experience modeling can provide a methodological bridge between HCI and disciplines that focus on bodily experience, such as performance, dance, theater, and Somatics (T. Schiphorst & Andersen, 2004; Thecla Schiphorst, 2009).

Jin Moen provides an example of using somatic experience as a resource for designing interactive experiences. Her work emphasizes the need to train designers in movement and movement vocabularies to describe their bodily experiences (Moen, 2007). She uses the term *kinesthetic movement interaction* (KMI) to describe movement-based interaction that takes into account the entire human body rather than an isolated limb or set of limbs. Moen uses modern dance as a point of departure for her work, which focuses on the development of full-body, movement-based interfaces. She uses theories from dance and performance to ground her research, borrowing from Blom and Chaplin's movement descriptions which differentiate various complexities of experiencing and relating movement (Kjölberg, 2004). To demonstrate her design approach, Moen produced an artifact called the Body Bug, an interactive wearable device that responds to its user's physical movements. The device focuses on providing enjoyment through playful, unique bodily experiences, although without utilitarian purpose (Moen, 2005, 2007).

Embodied knowledge.

Astrid Larssen, Toni Robertson, and Jenny Edwards focus on movement as a form of bodily knowledge. They propose a continuum of knowledge developed from their ethnographically inspired field studies of yoga, pilates, and capoeira practitioners (A. T Larssen, Robertson, & Edwards, 2007). The continuum has five stages, advancing from *no knowledge* at one end of the spectrum to *knowing how to move completely* at the other. Larssen and her colleagues emphasize the experiential nature of bodily knowing and contend that if designers want to better use movement, they must become experts in movement by expanding their bodily knowledge through practice.

Robert Jacob et al. also focus on movement as a form of knowledge in their *reality-based interaction* (RBI) framework. Reality-based interaction emphasizes a user's pre-existing knowledge of the real world as an essential component of interaction. Jacob focuses particularly on four elements: *naïve physics, body awareness, environment*

awareness, and *social awareness* (Jacob et al., 2008). Jacob addresses the use of whole-body movement in his discussion of body awareness. Although not all of his other skill sets relate directly to movement, they all address aspects of human awareness and demonstrate the role pre-existing knowledge plays in developing technology focused on the experience of movement.

A framework that has gained considerable traction within HCI is the concept of embodied schemata, a theory posited by Mark Johnson and George Lakoff in their book *Metaphors We Live By* (Lakoff & Johnson, 1980). Their theory offers a nonrepresentational account of how human cognition and abstract thought develop unconsciously through sensory-motor interaction with the environment. The theory of embodied schemata posits that as humans develop, their sensory-motor interactions with the environment lead to the development of prelinguistic constructs known as embodied (or image) schemata. These schemata develop as experiential gestalts based on bodily movements, physical orientation, and interaction with objects (G. Lakoff & Johnson, 1980, 1980). Embodied schemata constitute a source domain, which is linked via a conceptual metaphor to a target domain in the form of an abstract thought. For example, the experiential nature of humans' upright orientation in the world provides the basis for an image schema based on vertical hierarchy. This leads to orientation metaphors that associate *up* with more and *down* with less. These metaphors also provide an alternate conceptualization of *up* as happy and *down* as sad. The use of these metaphors in linguistics is abundant. For example, the statement "He was feeling down" uses an orientation metaphor to denote sadness. Other categories of embodied schemata exist, including space, locomotion, containment, balance, and force (George Lakoff & Johnson, 1980).

Embodied schemata were first introduced to the field of HCI by Jörn Hurtienne and Johann Israel as a framework to assist in the design of intuitive interaction for tangible user interfaces. In their paper "Image Schemas and Their Metaphorical Extensions," they define a system as intuitive if "the user's unconscious application of pre-existing knowledge leads to effective interaction" (Hurtienne & Israel, 2007). Hurtienne argues that the foundation for intuitive interaction lies in the application of conceptual metaphors in the design of systems. Alissa Antle, Greg Corness, and Milena Droumeva investigated the

empirical basis for this claim in a study of children interacting with the Sound Maker application (Antle et al., 2009a; Antle, Droumeva, & Corness, 2008). The Sound Maker is a prototypical system that uses full-body movement for the production of music. In the study, participants interacted with the system under two conditions, one in which the interaction was based on correctly applied conceptual metaphor mappings (e.g., *up* made the audio louder, *down* made it quieter) and another where the mappings were applied arbitrarily. The study was inconclusive with regard to whether one of the conditions was more intuitive than the other; however, it did demonstrate the importance of discoverability in the design of ubiquitous computing applications that use kinesthetic movement interaction (Antle et al., 2009a).

Meaning construction.

Another important function of movement is its role in the construction of meaning. The researchers investigating this component of movement interaction consider how movement allows user to create meaning and express emotional states through responsive interaction.

Another approach to investigating the semantic nature of movement interaction is to look at the role culture and history play in the construction of meaning. Asokan and Cagan argue that design decisions are often made arbitrarily and that cultural factors can make interaction more meaningful (Asokan & Cagan, 2005). They define culture as a shared set of beliefs and assumptions that are reflected in common practices, artifacts, and interactions (Asokan & Cagan, 2005). In their paper "Defining Cultural Identities Using Grammars: An Exploration of Cultural Languages to Create Meaningful Experiences," they use a method called *movement grammars* to inform the design of interactive products. Movement grammars are developed from ethnographic field studies of specific cultures and represent the traditions, beliefs, and value systems inherent to a specific group. Using movement grammars, the researchers design interactive products that are tailored for use within a particular cultural setting.

Katherine Isbister and Kristina Höök note that the shift of computation into personal contexts and the availability of sensors for tracking human expression necessitate a reconceptualization of the essential qualities of interaction. They introduced the notion of

supple interaction, which relies on three primary elements: *subtle signals*, *emergent dynamics*, and *moment-to-moment experience* (K. Isbister & Höök, 2009; Katherine Isbister & Höök, 2007). Subtle signals take into account the richness of human communication and incorporate emotional cues, nonverbal communication, and kinesthetic engagement. *Emergent dynamics* reflect a system's ability to respond and adapt to users in order to co-construct meaning on the fly. Moment-to-moment experience highlights the need to prioritize engagement, enjoyment, and pleasure through interaction. Isbister and Höök observe that these characteristics allow supple interaction to better support emotional connections. The project *FriendSense* exemplifies the use of *supple interaction* principles to design a movement-based system that enables friends to share the physical sensation of emotional closeness (Sundström & Höök, 2010).

Sietske Klooster, Kees Overbeeke, and Caroline Hummels have collaborated on several projects exploring how meaning is constructed through interaction and have used these explorations to formulate design methods for developing movement-based products. One approach, called *design movement*, focuses on the integration of product design and dance improvisation, and is based largely on work done by J.J. Gibson (Klooster & Overbeeke, 2005). From the perspective of design movement, movement is understood as the embodiment of interaction. This concept allows the process of designing for movement to be considered the *choreography of interaction*. Choreography of interaction does not view the construction of meaning as occurring only between the user and the computer; rather, like previously mentioned cognitive approaches, it emphasizes the complex interplay between users, objects, and the environment (Hummels et al., 2007; Klooster & Overbeeke, 2005).

Ana Paiva et al. explore the idea of a sympathetic interface as a particular type of affective controller that responds to users' emotional gestures and touch (Paiva et al., 2002). They provide an example of this type of interface in their project *SenToy*, an input device in the shape of a doll that acts as a gateway into the role-playing game *FantasyA*. Players use the *SenToy* to engage with the game by enacting affective gestures that exhibit emotions such as anger, fear, happiness, surprise, sadness, or gloating. The concept of a sympathetic interface is based on Richard Lazarus's theory of emotion, which equates observable behavior with specific affective states (Paiva et al., 2002).

2.4.6. **Sensing technology.**

One of the challenges for designers attempting to incorporate experiential qualities of movement into HCI is the misalignment between sensing systems' capabilities and the designer's needs. Current sensing technology focuses almost exclusively on detecting the spatial transformations that define movement, omitting any elements relating to the *experience* of movement for the user. HCI designers investigating bodily-experience during interaction have had to appropriate and integrate existing sensing technologies in order to achieve their research goals (Mentis et al., 2014).

Traditional HCI gestures prioritize the use of the arms or hands for deictic tasks, emphasizing the communicative aspects of movement for an observer, not the experience for the mover (Adam Kendon, 2004). Yet research investigating gestural communication demonstrates that movement is not solely communicative; it has a cognitive support function for the performer and provides insight into thought processes (McNeill, 1992). In order to bring movement interaction up to the same standards as other forms of interaction, it is essential for initiate a dialogue between sensing technology developers and movement-interaction designers.

User-centered design (UCD) is the standard process by which HCI practitioners develop products and services in order to ensure that they meet the needs of the users (Norman & Draper, 1986). UCD prioritizes the identification of requirements through research and testing with human participants before beginning the implementation phase of a project. In the area of movement-based interaction, however, hardware remains the primary determinant of interaction

Researchers Michael Nielson et al. discuss two approaches to developing gesture vocabularies for interaction: a technical-based approach and a human-based approach (M. Nielsen, Störring, Moeslund, & Granum, 2004). The former approach relies solely on the development team to compile a set of gestures that is easy to identify, possible to accomplish, and appropriate for the task at hand. The human-based approach relies on the use of human participants to develop context-appropriate gestures. The authors note the benefits of using the latter approach for the development of a specific application,

arguing that there is no universal gesture vocabulary that will work in all situations (M. Nielsen et al., 2004).

Although the use of Nielsen's human-based approach to the development of gesture vocabularies is more in line with human-centered computing principles, the underlying approach itself—the emphasis on a preset vocabulary—leaves out multiple ways in which humans use movement for communication and expression. This distillation of movement into vocabularies that can be mapped to events is so deeply ingrained in the thinking of many researchers in HCI that when using this approach, they rarely make their intentions explicit. The use of gestures for this type of interaction has infiltrated mass media as well and can be seen in films such as *Minority Report* (Spielberg, 2002) and *Iron Man* (Favreau, 2008), in which sophisticated gestural interfaces exemplify an event-driven approach based on preset vocabularies.

The obvious benefit of using a vocabulary approach is that movements are easily detectable and classifiable and require no interpretation. Using sensors and cameras to identify movement qualities is a much more complex process because it requires a deeper, more implicit level of movement detection and interpretation. Rather than detect only the spatial configuration of a user's limbs, an approach that addresses the experiential aspects of movement requires identifying subtle characteristics of movement that allow for the inference of an individual's somatic, cognitive, emotional, and phenomenological experience. In addition, the mapping from movement to event is necessarily more complex when focusing on a user's experience. In this scenario one-to-one mappings are impossible due to the multitude of movement combinations as well as well as due to individual differences in performance. These two methods exemplify the difference between a functional approach to movement interaction and experiential approaches to movement interaction.

2.5. **Metadata, Tagging, and Image Feature Classification**

This section concludes the literature review with an overview of approaches to indexing digital image data for search and retrieval. This review summarizes the primary approaches to tagging photographic content or indexing, and the current challenges they

encompass. Furthermore, it provides foundation for the benefits of movement as a tagging mechanism.

2.5.1. Metadata and tagging.

Metadata is defined by the National Information Standards Organization (NISO) as "structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource" (NISO, 2004, 1). Metadata has been in use in Islamic libraries since approximately 800 A.D. as a means of categorizing content. It later became a codified feature of modern library card catalog systems, providing a standard method for browsing through an institution's book collection. With the advent of computers, the use of metadata was expanded and applied to digital databases, the World Wide Web, digital photographs, and myriad other forms of digital content.

Metadata can be of varying types depending on the aspect of data referenced. *Structural* metadata refers to how a resource is constructed. Examples of this type of metadata are the specific ordering of chapters in a book or the data structure containing the actual data (i.e., the schema). *Descriptive* metadata defines characteristics of a resource in order to facilitate identification and discovery (NISO, 2004). Other types of metadata that have been documented include *administrative* (NISO, 2004), *process*, *business*, and *technical.* Because this research is investigating the use of metadata for images, the focus will be on descriptive metadata relevant to photos.

Photographic metadata can be classified into two types: data that are automatically generated during the creation of the image and data that are added by the user at a later date (NISO, 2004). The former category includes metadata such as creation date, camera type, size, and dimensions. The latter includes a far wider range of attributes that can entail formal qualities of the image (e.g., color), objects depicted, emotional quality, and many others. For this research, the focus will be on user-generated metadata, often referred to as *tags*.

With the advent of Web 2.0 technologies—which allowed users to take a much more collaborative role in the creation of online content—came the concept of the *folksonomy*. Folksonomies are analogous to taxonomies except that the former are

collaboratively created by a large number of people while the latter are generated by an expert or automated system. Both taxonomies and folksonomies are used to classify objects and concepts based on item similarity (Oreilly, 2005). These similarities are identified through the use of descriptive terms in the form of metadata. Folksonomies are comprised of *tags*, a form of user-generated metadata. The verb *tagging* refers to the act of applying user-created metadata to a specific resource object. Tags allow users to overcome the limitations of metadata and the taxonomies generated from them by providing a much wider range of terms and overlapping associations (Oreilly, 2005). Generally, both tags and metadata take textual form. Throughout this document, the terms *metadata* and *tags* will be used synonymously.

Kinesthetic metadata.

In order to index images using movement as metadata I am positing the development of a unique type of classifier called *kinesthetic metadata*. Kinesthetic metadata are descriptors created through user-generated movement rather than explicit textual input. These movements provide an implicit reference to users' somatic experience and the underlying experiential and embodied meaning it personifies. In order to utilize kinesthetic metadata in this manner, algorithms for analysis and interpretation of a user's movements will need to be performed. A movement analysis framework such as LMA, can function as a scaffolding for the analysis and interpretation, providing pre-existing categories that can be used to define kinesthetic metadata.

2.5.2. Image indexing frameworks.

Image-based tagging for the purpose of searching has proven very difficult to implement due to both the number of different attributes that comprise a particular image and the lack of a concise yet specific query language for description (Jaimes & Chang, 1999). Attributes also occur on various levels of description such that a generic term such as *man* can contain much more specific characteristics such as what he is wearing, his weight, his height, his ethnicity, etc. (Jaimes & Chang, 1999). Another challenge is that common fields used in searches for text-based content are often not available or relevant to image searches (Jörgensen, Jaimes, Benitez, & Chang, 2001). Take, for example, the notion of *author*, a term that is commonly used in searches for textual materials. Although

this field might exist in relation to an image, it is generally not useful as a means of disambiguating an image's features or content, because there is generally little consistency among all attribute categories for a specific photographer's pictures.

One of the important findings from the research on image tagging is that people use different terms when describing images than when searching for images. This has led to a number of different taxonomies for image classification, depending on the applications for which they will be used. Some of the primary approaches are discussed below.

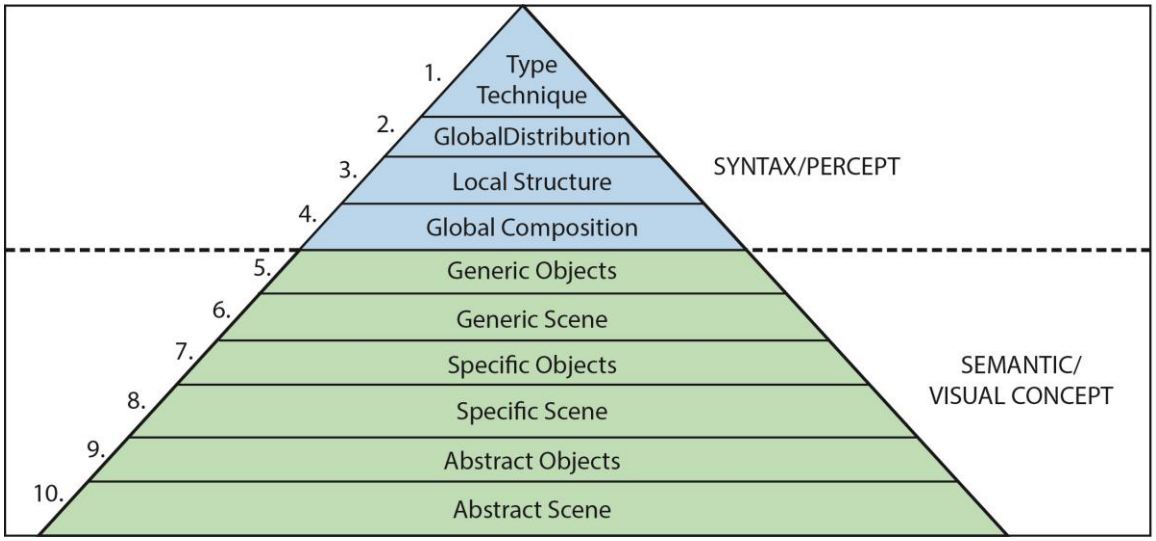
Jaimes and Chang.

A number of frameworks have been proposed to assist in the development of indexing schemes for images. One of the dominant frameworks was developed by Alejandro Jaimes and Shih-Fu Chang. This framework uses a 10-level pyramid model to illustrate the various categories according to which image data can be indexed. Of central importance to their model is the breaking down of image attributes into *percepts* and *concepts* (Jörgensen et al., 2001). Percepts are those characteristics of an image that are discernible based on visual input alone. Percepts include information about what is literally depicted in a photo or image—the subject and objects, colors, size, etc. Concepts are abstract ideas and interpretations based on prior knowledge and experience and thus can be highly differentiated among people. According to the authors, concepts also fall into two categories: *visual* and *general*. Visual concepts describe characteristics of a specific instance of the subject matter and answer the question "What does it look like?" Chang and Jaimes use the example of a ball as described by a volleyball player and a baseball player. The former uses descriptors such as *soft*, *lightweight*, *round*, and *leather*; the latter *hard*, *white*, *heavy*, *round*, and *leather*. Both are describing instances of a ball based on their knowledge and experience of them in the world. The general concepts associated with *ball* differ among people as well, and these answer the question "What is it?" Returning to the previous example, the volleyball player would use the term *yellow* to describe a ball, whereas the baseball player would use *white*. Both would include the term *round* as well (Jaimes & Chang, 1999).

In Jaimes and Chang's ten-level classification model, the first four levels deal with syntax and visual percepts. The next six levels cover semantics and visual concepts.

Jaimes and Chang use a pyramid to illustrate the overall structure of the framework, with the width of each level an indicator of the relative amount of knowledge required for indexing in a particular category (Figure 4). As this figure illustrates, classification of abstract concepts (on the higher numbered levels) requires a greater amount of real-world knowledge (Jaimes & Chang, 1999).

Figure 4: Pyramid Structure of the Index Categories



In Jaimes and Chang's framework, the top four syntactical categories deal with image attributes that require no knowledge of real-world objects. They cover attributes such as black-and-white versus color photographs (Type); dominant color and histogram information (Global Distribution); tone, color, and texture of individual components represented in the image (Local Structure); and layout of the components within the frame (Global Composition; Jaimes & Chang, 1999).

The six semantic levels on the bottom of the pyramid address the ways in which individuals use real-world knowledge to describe images. These categories are the most commonly used by individuals conducting search tasks (Jörgensen, 1998). They address generic objects present in the image, such as an apple or a car (Generic Objects); the general scene, such as mountain or sea (Generic Scene); distinct people and objects, such as the Eiffel Tower or Bill Clinton (Specific Objects); a particular place, such as Paris or Washington, DC (Specific Scene); interpretive knowledge of what the objects represent

for a particular individual (Abstract Object); and the viewer's personal interpretation of the atmosphere or emotional content of the image (Abstract Scene; Jaimes & Chang, 1999).

John Eakins and Margaret Graham.

John Eakins and Margaret Graham present a framework for use in indexing systems that addresses the different levels on which an image can be analyzed (Eakins, Graham, & Programme, 1999). They propose a three-level system in which the first level is comprised of primitive features such as color, shape, texture, and the spatial location of objects. The second level consists of derived or logical features, which includes specific object types (e.g., a bus) as well as specific landmarks or named instances (e.g., the Statue of Liberty). The third level contains abstract attributes that require higher complex reasoning and subjective assessments. This includes instances of specific activities (e.g., Scottish folk dancing), emotions (e.g., anger), and human constructs (e.g., suffering). Like Jaimes and Chang's framework, this model also differentiates between those attributes that are syntactic (Level 1) and those that are semantic (Levels 2 and 3).

2.5.3. Content-based image retrieval (CBIR).

Content-based image retrieval (CBIR) is a specific approach to image tagging that focuses on only the syntactical elements visible within an image. This approach is used as an alternative to human-centered tagging techniques such as folksonomies and makes use of computer algorithms to automate the task of detecting and distilling significant perceptual features from images in order to develop indexing systems (Eakins et al., 1999). CBIR is often considered a subfield of signal processing and computer vision, with a specific focus on the retrieval of images matching specific criteria from a substantially large collection (Eakins et al., 1999). This approach was developed in order to accommodate large databases (such as the World Wide Web) in which it would be difficult to manually tag every image.

The Semantic gap.

The ability of software to identify meaningful features from a visual image is an important aspect of any image-tagging system. The semantic gap refers to the variance in descriptions of an object due to the use of differing linguistic representations. It is best

exemplified in the discrepancy between the ability of software to easily extract low-level features (color, shape, size, etc.) from images, and the difficulty identifying high-level conceptual features employed by real people (Smeulders, Worring, Santini, Gupta, & Jain, 2000). A number of researchers have attempted to implement smart systems that are capable of crossing the gap between perceptual classification and conceptual classification with limited success.

Automated feature-identification techniques used in CBIR.

Ying Liu at al. identify a list of five approaches that have been used to reduce the semantic gap by automating the extraction of low-level concepts and aligning them with human-centered keywords and metadata (Liu, Zhang, Lu, & Ma, 2007). These techniques include the use of ontologies to define high-level concepts, the use of machine learning and artificial intelligence algorithms to align low-level features with users' query concepts, the use of feedback from users to determine query result relevance, the generation of semantic templates to aid in the retrieval of high-level image-features, and the merging of visual and textual information from HTML data for searches on the World Wide Web.

Object ontologies.

Object ontologies work by aligning low-level attributes identified by a computer with high-level concepts and keywords used by people. For example, while a computer algorithm can easily identify the RGB values of an image, humans are generally more comfortable using color names. The semantic gap is significantly reduced by mapping high-level semantic keywords onto the RGB values easily accessible to a computer. This process of mapping is known as *quantization*. Several researchers have explored the use of daily language as the basis for object ontologies. These include Vasileios Mezaris, Ioannis Kompatsiaris, and Michael G. Strintzis, who mapped low-level image features onto four user-accessible dimensions: intensity, position, size, and shape (Mezaris, Kompatsiaris, & Strintzis, 2003). Peter L. Stanchev, David Green Jr., and Boyan Dimitrov did similar research, developing a system for high-level color similarity retrieval using Johannes Itten's theory of color (Stanchev, Green Jr., & Dimitrov, 2003). Other researchers have addressed the identification of texture rather than color, but this proves

more difficult given the lack of common naming conventions for textures (Ravishankar Rao & Lohse, 1996).

Machine learning techniques.

Another method for conducting feature extraction on images is using machine learning. Machine learning techniques are divided into those that are supervised and those that are unsupervised. Some common supervised learning techniques used in feature identification and image retrieval tasks are support vector machines and Bayesian classifiers. These methods require a system to be trained to identify high-level concepts and therefore require a great deal of time in order to improve the system's accuracy. Aditya Vailaya, Mário A. T. Figueiredo, Anil K. Jain, and Hong-Jiang Zhang use Bayesian classifiers to identify high-level features in vacation pictures. They accomplish this by training the system to differentiate between indoor and outdoor pictures, then to further differentiate between city and landscape photos, and finally to classify landscapes into mountain, sunset, or forest imagery (Vailaya, Figueiredo, Jain, & Zhang, 2001). In another supervised learning approach, Rui Shi, Huamin Feng, Tat-Seng Chua, and Chin-Hui Lee use a support vector machine algorithm to annotate 800 images with 23 labels that identify the content of the photos. They included labels such as *people*, *animal*, *building*, *sky*, *food*, and *flower* (Shi, Feng, Chua, & Lee, 2004). Neural networks and decision trees have also been used as supervised training methods for image feature extraction (Hastie, Tibshirani, Friedman, & Franklin, 2005; Town & Sinclair, 2001).

Unsupervised methods for CBIR do not require systems to be trained and most often make use of image-clustering algorithms (Liu et al., 2007). In this method, images with similar features such as shape, appearance, occlusion, and relative scale are placed together in groups (Fergus, Perona, & Zisserman, 2003). One limitation of this approach is that without additional intervention, the system cannot know how to appropriately label these groups to make them meaningful to a user. An additional challenge is that most unsupervised feature-extraction methods require thousands of training images and are still only capable of identifying 10–20 categories.

Relevance feedback.

Relevance feedback techniques attempt to identify the user's preferences in real time. The most common approach is to present users with results from a query and have them interactively select the most useful or meaningful results. The system then applies machine learning algorithms to recognize the users' preferences and provide more relevant results on subsequent queries.

Yong Rui, Thomas S. Huang, Michael Ortega, and Sharad Mehrotra developed a CBIR system that uses relevance feedback to improve a user's query results for visual images. Their system directly addresses the challenge posed by the subjectivity of individual users by tracking perceptual subjectivity using dynamic weight values. These weight values shift over time as the system learns the user's preferences, allowing for more accurate and personalized results the longer the system is used (Rui, Huang, Ortega, & Mehrotra, 1998).

Kim and Rhee propose a variation on a relevance feedback system called the *intelligent information retrieval system* (IIRS). This system includes a user adaptation algorithm that learns a user's particular query patterns when searching for visual content (Kim & Rhee, 1999). Their system uses a decision tree in conjunction with a back-propagation neural network to align the user's expectations with the results returned by the system.

Huang et al. propose a personalized image semantic model (PISM) that aggregates information from multiple users and uses a Bayesian network approach to reduce the gap between low-level image features and high-level semantic concepts. They acknowledge that this method lacks the ability to personalize query results to a specific user, but it has the benefit of learning from a multitude of queries, making it faster to train.

Semantic templates.

The idea for a visual sematic template was introduced by Chang et al. as an advanced method for defining the relationship between low-level features and high-level concepts (Cheng, Chen, & Sundaram, 1998). Semantic templates consist of a set of exemplar images or objects that define a particular category of things. Once a template

has been generated by the user, the system is able to use machine learning algorithms to identify similar features in new visual content. This biggest limitation of this approach is that it requires the user to have an expert knowledge of image features.

Integrated visual and textual World Wide Web searching.

The final technique for CBIR expands on the solely text-based search functionality that is generally used on the World Wide Web. This method takes advantage of both existing metadata embedded within the HTML or web pages and merges it with data acquired through image feature extraction. The results provide an extra layer of context that can significantly enhance the relevance of image queries (Cai, He, Li, Ma, & Wen, 2004; Feng, Shi, & Chua, 2004).

2.5.4. Research supporting the prospect of kinesthetic tagging.

Although there is no prior precedent for using movement as a method of tagging images, researchers have implicitly illustrated various characteristics of interaction and perception that provide the theoretical foundations for the eventual design of such a system.

Interactionist Perspective

Gibson's *ecological approach to perception* argues that the senses are not passive receptors of stimulus, but rather are the result of an organism's active relationship with the environment (Gibson, 1983). From this perspective, kinesthetic tags can be viewed as an alternate approach to interaction with an image, one that prioritizes somatic perception over visual perception. Through the act of generating a kinesthetic tag, the user enacts their relationship with media, exploring contents, concepts, and meanings. In the same manner that visual, aural, olfactory, and tactile sensations produce differing, yet equally valid and meaningful accounts of experience, so too does kinesthetic sensation.

Aesthetic experience.

Kinesthetic tagging can account for the aesthetic experience of the user. Peterson et al. use pragmatist philosophy to define their approach to aesthetic interaction. They

provide three rationales for using the pragmatist theory of aesthetics: First, the pragmatist perspective does not consider artifacts in isolation, but rather understands them as part of a sociocultural and historical experience. Second, it views aesthetic quality not as a static visual trait but rather as a potential one, something that is dynamically created through use. And finally, due to the experiential nature of an aesthetic encounter, pragmatist aesthetics considers the cognitive, emotional, and bodily reactions a viewer has in response to the overall aesthetic situation (Petersen, Iversen, Krogh, & Ludvigsen, 2004). The authors suggest that using this approach to aesthetics interaction can shift design from being purely functional to "includ[ing] subtle poetic elements exciting imagination" (Petersen et al., 2004).By capturing a user's embodied experience, Kinesthetic tagging can account for a user's aesthetic experience in relation to visual content including aspects of including their cognitive, emotional, and bodily reactions to imagery.

Investigating of Movement Interaction.

In addition to facilitating new methods of interaction with computers, Kinesthetic tagging also provides an instrument for investigating elements of movement-based interaction such as those described by Klemmer, Hatrmann, and Takayama. In their article, "How Bodies Matter", they identify various themes for interaction design to consider in relation to embodied interaction (Klemmer, Hartmann, & Takayama, 2006). One theme, *thinking through doing, addresses* how *thought* (mind) and *action* (body) are deeply integrated and how they co-produce learning and reasoning. They also relate how research demonstrates that limiting mobility restricts people's thinking and communication abilities. The investigation of kinesthetic tagging has the potential to inform how movement functions in relation to these factors by providing insight into how movement acts as a medium imbued with personal meaning potentially capable of conveying memory, emotion, and other forms of embodied knowledge.

Another theme discussed by Klemmer et al that can be investigated through kinesthetic tagging is the concept of *performance.* For them performance describes the rich actions our bodies are capable of, and how physical action can be both faster and more nuanced than symbolic cognition (Klemmer et al., 2006). Exploring how people use kinesthetic tagging to represent meaning through movement will assist in the better

application of specific gestures and actions in the design of tangible and ubiquitous computing systems,

Bridging the semantic gap.

The eventual design of a system capable of implementing kinesthetic tagging should provide insight into the use of movement patterns to inform the development of more robust software systems capable of bridging the semantic gap. These hypothetical systems would likely work well supporting such methods of CBIR using machine learning and semantic templates.

Chapter 3.

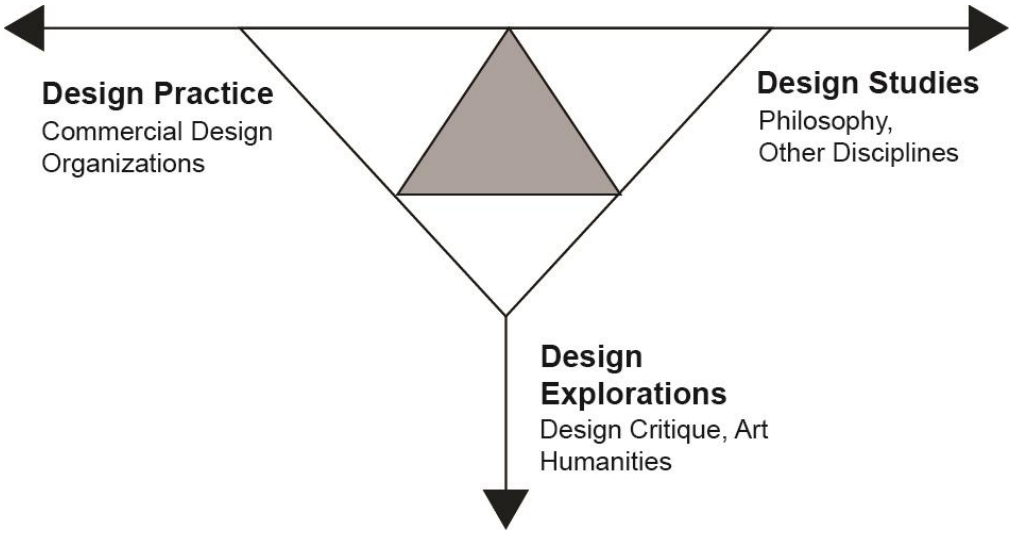
Methodology

Human–computer interaction's foundation in psychology has traditionally led to a strong focus on quantitative, experimental research approaches; however, as new modes of computer interaction have become possible, practitioners have had to turn to other disciplines for alternate research methods. The human-centered elements that are integral to contemporary HCI practice create a need for a greater emphasis on qualitative methods (Bødker, 2006; McCarthy & Wright, 2004). These methods have been procured from areas tangential to HCI, where they have already been vetted. Some of the more commonly used methods come from areas such as cultural anthropology (ethnography; Crabtree, Nichols, Rouncefield, & Twidale, 2000), design (Buchanan, 1992), and art (cultural probes; (Gaver, Dunne, & Pacenti, 1999). For my research I looked to the areas of somatics, dance, and performance for methodological inspiration.

3.1. Exploratory Design Research

My research was exploratory in nature and the design was informed by Daniel Fallman's notion of the interaction design research triangle. Fallman's triangle is comprised of three related but distinct design activity areas: *design practice*, *design exploration*, and *design studies* (Fallman, 2008). He posits that these three areas constitute the full spectrum of activity in design research. *Design practice* is constituted by those activities traditionally performed by interaction designers in industry to bring a product or service to market. *Exploratory design* research activities are used to explore possibilities outside the current paradigm. From this perspective, "design becomes a statement of what is possible, what would be desirable or ideal, or just to show alternatives and examples" (Fallman, 2008, p. 7). *Design studies* encompass those activities that would generally be conducted within academia. These activities include design discourse, analytical work, and ultimately making one's own contributions to design theory.

Figure 5: Fallman's Interaction Design Research Triangle



My research activity is positioned in two of Fallman's research activity areas: *design studies* and *design exploration.* This document serves as evidence of my activity in the area of *design studies*. This is further exemplified by my multidisciplinary perspective and integration of somatic theory and practice, as well as by the involvement of skilled movers. Fallman explains that elements such as these characterize the design studies activity area:

> This also is where influences from other disciplines are most visible, for instance working together with social scientists and experimental psychologists, and by directly referencing and adopting other disciplines' techniques, practices, and theories. (Fallman, 2008, p. 9)

The second design research activity area in which my work is positioned is *design exploration.* This is evident in my interest in exploring novel uses for movement that are outside the current interaction paradigm. Since this research is exploratory and inductive and was developed as a "what if" scenario, a qualitative methodology was deemed most appropriate for the study; this approach facilitated the most inclusive exploration of the design space.

3.2. The Constructivist Paradigm

My research is situated within a constructivist paradigm. The constructivist approach was selected for its ability to address intangible mental constructions, such as the concept of bodily experience, that are both socially and experientially based. Knowledge in general is viewed as being both transactional and subjective and is illustrated in the reflexive and responsive nature of the relationship between the investigator and the phenomenon of study (Denzin & Lincoln, 2005; Guba & Lincoln, 1989). Researchers working within this paradigm use primarily qualitative methods in their research studies as it aligns with their epistemological and ontological perspective.

The constructivist paradigm's focus on individual thoughts, emotions, and preferences is aligned third wave HCI's emphasis on emotion, culture, and experience (Bødker, 2006). Under the third wave HCI paradigm, there was a shift away from systems intended for use in the workplace, with an emphasis on individual interaction, towards socially oriented applications for use in the public sphere or in the privacy of one's home. This shift requires new research methods and approaches to usability that prioritize a user's personal experience of interaction rather than efficiency or productivity (Bødker, 2006; McCarthy & Wright, 2004). This move corresponds with the shift towards considering movement as felt experience, as discussed in Section 2.4.5.

Constructivist methodologies are primarily used in group settings to acquire and distill individual constructions into consensual ones. (Yvonna S. Lincoln, 2002). Throughout this research project, participants were encouraged to share and discuss their subjective experiences with other participants. This allowed for ideas to be influenced by other participants' experiences and their input throughout the process. Relying on consensual thinking might at first appear to be at odds with traditional HCI methods which often prioritize empirical data. However, the need to arrive at concrete design solutions that are intended for use by large segments of the population ultimately requires large-scale consensual agreement based in part on subjective attributes. This phenomenon is at play when a particular product becomes popular and achieves market dominance. Regardless of the methods that were used to develop the product, ultimately it is the public's acceptance of the functionality and design that make a product successful.

Acknowledging the importance of consensual thinking during the research process allows for the consideration of groupthink during development rather than solely during deployment.

Constructivism has been criticized for being too aligned with language due to the focus on dialectical exchange. Researchers have also noted the lack of focus on the body as a source of experience within constructivist investigations. Rather than view these as limitations, however, I view them as opportunities. In his article “The Constructed Body,” B.S. Turner identified the absence of the body in constructivism and advocated its inclusion, challenging the notion that constructivism need be language centric (Turner, 2008). While verbal discussions were included in the research workshops for my study emphasis was still on techniques from dance, performance, and Somatics to directly access bodily experience. Through the introduction of these techniques, I transformed the relationship between myself, the participants, and the phenomenon of study, ensuring that somatic experience was prioritized.

3.3. **Methods**

My study incorporated elements of participatory design, somatic practice, and performative inquiry, and the analysis was conducted using a modified form of grounded theory. These methods were applied within a movement-based workshop involving the application of somatic practice in the context of movement exploration for technology design. The use of multiple methods in HCI is not atypical, but adds additional challenges to the research design. The methods used in my research follow the practice of expanding, adapting, and integrating existing methods in order to investigate a specific component of interaction. They share a focus on the active use of the body as a primary component of investigation and often have a basis in design methodologies rather than more traditional scientifically oriented HCI methods. Although each of these methods is unique, leading them to differ in their implementation and focus, they share a common methodological perspective and can generally be grouped under the moniker *design movement approaches*, a term coined by Hummels et al. (Hummels et al., 2007).

3.3.1. **Participatory design (PD).**

My research incorporated a PD-style workshop where skilled movers engaged in activities that allowed them contribute to the design process. Because participants in PD workshops are not necessarily able to explicitly articulate their knowledge and have no expertise in design, the activities must assist them in both capacities. I developed activities to elicit participants' tacit knowledge, a form of knowledge that has been gained through active work experience and that is difficult to articulate due to its implied and intuitive nature (Polanyi, 1958; Spinuzzi, 2005). This focus on tacit knowledge makes PD a useful method for working with movement experience. The challenge of accessing movement knowledge through direct dialogue or interviews can be difficult, especially in the case of somatic experience, which can be difficult to articulate. However, through the use of somatically oriented activities designed to elicit bodily experience, participants can be guided to focus attention and awareness on those elements that the researchers are investigating.

Using PD workshops to investigate movement-based interaction is a common approach in HCI. Jared Donovan and Margot Brereton used PD to explore the use of gestures to support work in dental offices (Brereton, Bidwell, Donovan, Campbell, & Buur, 2003; Donovan & Brereton, 2004); Toni Robertson, Tim Mansfield, and Lian Loke explored the use of PD methods to design movement schema for an immersive museum exhibit called *Bystander* (Robertson, Mansfield, & Loke, 2006), and in an explicit investigation of movement experience using a method called *making strange* (L. Loke & Robertson, 2007; Lian Loke, 2009); and Schiphorst and Andersen used PD-style workshops to explore *experience modeling* (T. Schiphorst & Andersen, 2004).

3.3.2. **Performative inquiry (PI).**

> *Movement and dance are not just ways to illustrate ideas but a way of grappling more deeply with the complexity of ways students can critically think, sift, perceive, and eventually come to fresh understanding of whatever subject they are studying. Dance is an invitation to think with our entire beings.*
>
> *Celeste Snowber* (Snowber, 2012, pp. 56–57)

My study incorporated an art-based method called *performative inquiry* (PI) that is used as a technique for engaging students in learning through the use of embodied, hands-on activities followed by periods of guided reflection. These activities are often based-on dance or theater activities, and games. PI is used to enhance learning through the incorporation of multiple modes of experience, allowing for the reintegration of the body as a site for learning and a repository of experience (Fels & Belliveau, 2008). PI's focus on experience makes it a beneficial alternative to traditional HCI methods such as hierarchical task analysis, knowledge-based analysis, task description hierarchy, and entity relationship (Fiore, 2004; McCarthy & Wright, 2004). Methods from art-based disciplines have been used by designers for decades but have found increased validation within the third wave HCI paradigm. Often categorized as *practice-based* methods, they have a basis in *reflective practice* as articulated by Donald Schon (Schon, 1995). These methods are primarily used during the formative stages of design, as many are intended to open the design space and facilitate brainstorming and idea generation making them appropriate for my exploratory study of kinesthetic tagging.

Although PI has not been officially used within HCI, many methods that have been used, particularly by designers, include elements of performativity (Burns, Dishman, Verplank, & Lassiter, 1994; Oulasvirta, Kurvinen, & Kankainen, 2003; T. Schiphorst & Andersen, 2004; Wakkary et al., 2007). One of the reasons for this exclusion may be the emphasis in PI on learning outcomes rather than data collection; however, as this research illustrates, PI can be used to assist experts in the articulation of tacit knowledge by providing opportunities for learning and reflection. In such cases, it is not the reflective practice of the designer that is highlighted (as in most HCI design research) but the reflective practice of the expert participant. This reversal is ideal for integration with a PD workshop, in which the emphasis is on garnering insights from the participants.

PD has significant prior use in the context of investigating movement. One particularly poignant example is the work of Celeste Snowber who articulates her experiences as an educator incorporating dance into her curricula (Snowber, 2012). She describes how dance enabled her students to more fully integrate all aspects of their intelligence from the emotional to the kinesthetic to the conceptual. Her work focuses explicitly on somatic awareness as a component of embodied knowledge. She articulates

the importance of this type of knowledge in the concept of *body data* borrowed from Cynthia Winton-Henry and Phil Porter (Winton-Henry & Porter, 1997):

> The body has constant data that speaks to us, whether it is the flurry in the stomach, the stretch of an elbow, or the abrupt contraction. Body data is the information that occurs in the present moment, the immediate present time, the ways we experience information through our bodies. (Snowber, 2012, p. 57)

Other researchers using PI as a method to interrogate movement are Ronald J. Pelias who used PI to explicate the variety of embodied ways of knowing that are facilitated through movement, and Donald Blumenfeld-Jones who used dance in context of PI as a form of supplemental knowledge to facilitate the exploration of meaning (Blumenfeld-Jones, 2008).

3.3.3. Somatic practices.

The performative component of the workshops was facilitated through the use of somatic practices. I selected LMA for its ability to function as both a theoretical lens through which to investigate movement experience, and as a collection of movement-based practices that facilitate a heightened awareness of kinesthetic experience. As a *theoretical lens*, LMA provided a framework for classifying movement on both physical and experiential characteristics. The Effort Factors were used to direct the focus of investigation on the expressive nature of movement, and facilitated the consideration of various qualities of movement in isolation. Somatic *practices* were incorporated into my research investigation as an empirical method for enhancing body awareness and kinesthetic assessment, and to facilitate the recall of embodied experience for my workshop participants (Thomas Hanna, 1995).

Laban Movement Analysis in HCI research.

While LMA is a commonly referenced somatic framework within HCI, its usage is frequently presented without reference to its somatic roots or their accompanying methods. For example, various researchers use LMA primarily for its notational capabilities, incorporating Labanotation as a research instrument to aid in the transcribing of users' movement patterns. This includes Astrid Larssen, et al who focused on using the

notation system as a tool for designing input into interactive systems (A. T. Larssen, Loke, Robertson, & Edwards, 2004) and Mads Vedel Jensen who used Labanotation as a means of transcribing movement data during ethnographic field work. (Jensen, 2005). Tom Djajadiningrat expanded on Jensen's research by exploring ways to characterize movement in terms of its expressive and emotional qualities rather than solely on its functional contributions to interactions (Djajadiningrat, Matthews, & Stienstra, 2007).

Another common approach to utilizing LMA is to focus on the theoretical components in isolation from somatic practice. In these cases, researchers utilize elements from LMA as lenses through which to understand interaction, incorporating concepts such as the *Effort-shape* factors. Michael Bacigalupi integrated LMA using Dewey's aesthetic theory to investigate the role of aesthetics in constructing an interactive experience (Bacigalupi, 1998). W.N.W. Hashim et al used LMA themes in the development of the *Graceful Interaction* concept, a framework for designing desktop interfaces for more effective, enjoyable, easy use (Hashim, Noor, & Adnan, 2010). Ana Paiva et al used LMA concepts to inform the development of the movement in their exploration of a *sympathetic interface*, a particular type of affective controller that responds to user's emotional gestures and touch (Paiva et al., 2002). (Paiva et al., 2002). And Petra Sundström, and Kristina Höök use LMA concepts to inform the design of their project *FriendSense,* a movement-based system that enables friends to share the physical sensation of emotional closeness (Sundström & Höök, 2010).

While the use of LMA concepts, a somatically derived approach, has provided insight for researchers investigating movement, the lack of reference to their origins in Somatics is problematic since it neglects the process oriented and action-centered basis of knowledge in the discipline and creates an epistemological conflict. This misalignment does not precluded the utilization of LMA concepts, however it severely limits their usefulness by removing them from the context within which they were developed creating a paradigmatic mismatch. The research examples presented above do not take full advantage of the benefits of LMA because they have separated the theory from the methods used to produce it. The application of the frameworks and underlying theoretical perspective is predicated on the facilitation of personal body-awareness as exemplified in Schiphorst's notion of *somatic connoisseurship* (Thecla Schiphorst, 2011). Other

researchers who have utilized LMA as a somatic practice in HCI research include Lian Loke, Astrid Larssen, Toni Robertson, and Thecla Schiphorst (A. T Larssen et al., 2007; L. Loke & Robertson, 2007; Moen, 2007; T. Schiphorst & Andersen, 2004; Thecla Schiphorst, 2011).

3.4. Research Questions

The research questions that guided the study were separated into two categories to reflect the distinct areas on Fallman's interaction design research triangle (Fallman, 2008). Those in the *design study* area addressed the embodied experience research questions; those in the *design exploration* area addresses the system design considerations.

3.4.1. Embodied experience research questions.

The research questions driving the investigation of embodied experience were:

RQ1: In what ways can the LMA Effort Factors assist in investigating people's embodied experiences during the imagery enactment process?

1A: How do people determine which qualities of movement to use when enacting an image?

1B: In what ways do qualities of movement reflect a person's embodied experience during the image enactment process?

1C: In what ways do image features affect the quality of a person's movements in the image enactment process?

1D: What factors influence a person's process of enacting images through movement?

The top-level embodied experience research question (RQ1) addressed the use of LMA as a tool for uncovering the embodied experience of the user during the image enactment process. This top-level question was sub-divided into four additional questions (1A – 1D) to address specific elements in this process. The embodied experience research questions did not relate specifically to the photo-tagging application but instead focused on the larger role of movement as an experiential referent and carrier of embodied forms of knowledge. The findings from this component of the research will contribute to

developing a greater understanding of the mechanisms underlying the creation of and access to embodied knowledge. By gaining a better understanding of how movement directly reference specific types of knowledge and experience, and the processes that contribute to this phenomenon, we can achieve greater insight into movement's role in structuring, retaining, and accessing various forms of embodied experience.

The embodied experience questions specifically focused on how participants enact their relationships with photographic content in the context of expressive movement creation. This included identifying the processes people use to formulate movements that embody visual content and (1A) and an investigation of how the qualities of these movements provide insight into their embodied experiences.(1B) . It also included an examination of the role of different image properties in the process of the process of mapping from imagery to movement (1C). These properties included both the formal qualities of the images (e.g., composition, color, texture, size, etc.) as well as the contextual features (subject matter, objects depicted, emotional response, etc.). This investigation allowed for a better understanding of which image features are the most salient for enacting movement and enabled comparisons with the role of identical features used in other tagging research.

3.4.2. **Design research questions.**

The research questions driving the design component of the research related to the use of LMA in the design process, as both a somatic practice and a theoretical lens (2A and 2B), and its ability to assist in the identification of design considerations for a kinesthetic tagging application. These considerations will inform the development of the indexing strategy, sensing technology, and use scenarios for this system (2C). These questions all pertain to the overarching goal of exploring the use of LMA to integrate functional and experiential movement in an interactive system (RQ2).

RQ2: How can LMA – as both a theoretical lens and somatic practice – be utilized as a tool to support the design of movement-based interactive systems??

2A: How can LMA as a somatic practice serve as a tool for designing a movement-based image tagging system?

2B: How can LMA as a theoretical lens be used to support the design of a movement-based image tagging system?

2C: What are the key design considerations for a movement-based image tagging system utilizing LMA Effort qualities?

3.5. Workshop Development through Pilot studies

A series of five pilot studies was conducted over a period of six months prior to running the LMA Workshop study. These pilot studies explored various approaches to designing somatically oriented workshop activities to support technology design. The first three pilot studies explored ways to incorporate somatic practices into the study of movement experience in general, and did not focus on the use of LMA in particular. These initial pilot tests were integral in supporting the development of the LMA-oriented workshop that I used for my research study by informing the structure of the warmup activities, the overall tone of the workshops, the types and difficulty of the activities, and the appropriate role of discussion. They were also central to refining the research questions and objectives. (The detail of these pilot tests are provided in Appendix A).

The fourth and fifth pilot studies were used to directly inform the design of the final LMA-workshop study and explored the use of the LMA Effort factors as a method of structuring the workshop to explore kinesthetic-tagging. These pilot studies included both participants who were skilled movers and people with no specialized training in movement. From the first three workshops, I came to realize that participants were confused by the term “movement experience” and needed systemic support to guide them. In addition, I recognized that movement awareness was too complex of a construct to investigate without reducing the scope of the study. I also realized that a scaffolding was needed to assist the participants in structuring and articulating their experiences. LMA provided an already existing framework for accomplishing this. These developments cleared up a lot of the confusion that was present in the previous workshops regarding the definition of *awareness* and its respective components. The focus on tagging also allowed for the narrowing of the scope of the research to a more manageable size and provided a clear design focus. My data collection was also more focused on tagging, so these workshops functioned as a test to see the data collection possibilities that existed.

The pilot workshops were documented using two video cameras as well as photographs when possible. Notes were taken during discussions, and any artifacts and notes created by the participants were collected at the completion of the workshops.

3.5.1. Impact on research design.

Although the pilot study data were not analyzed for inclusion with the results from the research described in this dissertation, they were integral to the design of the final full-scale workshop. This section illustrates the various ways that the pilot studies influenced the structure and activities used in the full-scale workshop.

Participation.

My initial supposition was that my participation in the workshop alongside the participants would provide me with a better understanding of their experience. This was true to some extent; however, its main benefit was that it helped me experience and articulate a more cohesive notion of felt experience. Despite the benefits of participation, it became clear through the pilot workshops that moderating and participating were not compatible. As moderator, I was needed to answer questions, monitor activities, and make observations about the participants' involvement. They often extended the activities in unexpected and interesting ways that required my attention in order to document. In addition, my participation could create unease for the participant working with me, as working with the researcher directly could cause him or her to feel that he or she was under enhanced scrutiny. For the research workshop, I limited myself solely to the roles of moderator and videographer.

Importance of warm-up.

For each of the pilot studies, a different set of exercises was used during workshop warm-ups. The activities varied from participant-led "generic" dance-class–style warm-ups to very specific calculated activities designed to improve somatic awareness. From this, three conclusions were made: 1) the warm-up is necessary to quickly get the participants in touch with their bodies and awareness and acts as a transition exercise through which the participants shift into a movement-oriented way of thinking and being. 2) The exercises conducted during the warm-up focus the participants' awareness on certain aspects of

their experience. Therefore, it is essential that appropriate exercises be used in order to ensure that the participants' awareness is focused on the LMA Effort being investigated. 3) Skilled movers are better at completing the warm-up exercises in a way that best satisfies the first two criteria. For instance, they have the prior experience to know how to lead the warm-ups and to use the most appropriate language, tone of voice, and activities to ensure a transition into bodily thinking and awareness. Experienced LMA practitioners also know how to use the warm-ups to ensure that the participants are focused on the respective qualities of movement for a particular LMA Effort.

These considerations led to Cheryl Prophet being engaged to lead the LMA warm-ups for the workshop. Her inclusion was seen as optimal because she teaches an LMA class and could condense some of the exercises used during this class to serve as part of the warm-up, ensuring that the participants would be familiar with each of the individual Efforts.

Characteristics of photographic imagery.

Following the completion of the workshop, the participants were asked about the use of the photographs and asked whether they felt those photographs were appropriate for use in LMA workshops. Some of the participants felt that the photographs were in general all too high quality and overly polished. They would have preferred to have some selections that were more like traditional snapshots. Some also felt that the subject matter was difficult to use in the intended manner in the workshops. Both of these concerns were taken into account for the selection of the photographs that were used in the final research study (Appendix B).

Expert Consultation

Another factor that influenced the selection of imagery was an expert consultation with Cheryl Prophet, a certified LMA practitioner and Senior Dance Lecturer at Simon Fraser University. I met with Prophet following the completion of the pilot studies to discuss the activities used in the workshops and to review the images I had selected for the tagging exercises. Her feedback provided added assurance that the images would not confound the results of the study either through unintentional bias or by creating excessive difficulty for the participants.

During our discussion Prophet noted that the imagery I selected might be difficult for the participants to enact due to the lack of a clear Effort correlation. This comment was taken into account and resulted in the replacement of several images. The decision to replace these images was also based on the feedback from the pilot workshop participants, who had suggested using more snapshots in addition to professional photographs and had pointed out some imagery that was particularly unsuitable for the workshop activities. However, due to the nature of the research, I was also interested in seeing how participants handled diverse subject matter, so I did not want to provide only imagery that could easily be classified within the LMA Effort framework. For this reason, most of the imagery was left as it was. Prophet also provided professional feedback relating to the use of LMA within the study, aiding in the structure or the workshop.

Prophet's suggestions included using imagery more evocative of specific LMA Effort qualities, noting that this approach would align with how mental imagery is used in LMA–based instructional workshops to evoke the sense of a quality of movement (e.g., the free-flowing river as illustrative of Free Flow). It was decided that some of the images would be evocative of the LMA Efforts, but not all of them, as one of the research questions dealt with the investigation of which features were used by participants to interpret visual content. Having some imagery that was less straightforward to interpret was deemed an important factor in this regard.

In order to explicitly investigate the differences between imagery selected specifically for its ease of use in LMA–based exercises and general visual content, an additional activity was added to the full-scale workshop. This activity used images that were intentionally selected for their affinity with one of the LMA Effort qualities. These images became part of the quick enactment exercise during which participants were asked to quickly enact imagery displayed on a wall for 10 seconds. This allowed for the quick collection of data pertaining to numerous images in a short period of time.

Duration of workshop.

The pilot workshops were scheduled for two hours, but all took at least three hours to complete. This was problematic because the pilot workshops did not cover all of the material that would be covered in the full-scale research study. Because of this, the full

study was estimated to require eight hours to complete (two hours for each of the four LMA Efforts). The movement-based nature of the activities in the workshop would make a single workshop of this length exhausting for the participants, so a two-day workshop was planned, with two Efforts explored on each day.

Activities.

The pilot workshops were integral to the selection of activities to use for the full-scale study. The final pilot test in particular acted as a test of the activities that were used in the full-scale workshop study, including the warm-up, the sorting task, the enactment of imagery from opposite sides of the Effort continuum, and the distillation activity. However, in order to use time effectively, rather than demonstrate their sequences to the entire group, participants would work in pairs and record each other's movements on Flip cams. This would provide documentation of their movements and private discussions for later analysis while saving time for the larger group discussions.

3.6. Research Design

This Section presents the various elements contributing to the design of the final research workshop. It addresses the participant selection, the setting, data collection procedures, and my role as researcher during the workshop.

3.6.1. Participants.

The participants in the study were skilled movers who regularly used expressive movement as part of their artistic practice. They were recruited from within a university-level contemporary arts program as well as from the larger community of professional actors and dancers in the Vancouver area. The participants had varying levels of experience: some had completed degrees in one of the relevant fields, some were in the process of earning a degree, and others were without degrees but had numerous years of professional practice.

Table 7: Participant Demographics

Participant #	Age	Gender	Area of expertise	Movement Practice (years)	Professional Movement training (years)	Professional Movement Experience (years)	Prior LMA experience
1	24	F	Theater	10	6.0	2.0	Yes
2	27	F	Dance	15	3.0	6.0	No
3	27	F	Physical Theater	8	2.5	3.0	Some
4	21	F	Theater	4	3.0	1.0	Some
5	19	F	Dance	15	2.0	0.0	Some
6	31	F	Somatics and dance	6.5	3.5	1.5	No
7	30	F	Theater	10	3.0	0.0	Yes
8	37	F	Theater and dance	17	11.0	17.0	Yes
9	25	M	Animation/Game Design/Film	NA	NA	NA	No

Sample size.

The workshop was attended by nine (9) people—eight (8) recruited participants and one (1) alternate who joined the second day when one of the original participants was unable to attend. The use of eight participants reflected findings in the literature demonstrating that for qualitative investigations, six (6) participants are satisfactory for identifying high-level overarching themes, and data saturation occurs at twelve (12) participants (Guest, Bunce, & Johnson, 2006). Related research found that for usability testing, six (6) participants were sufficient for identifying 80% of usability issues and twelve (12) for uncovering 90% of issues (J. Nielsen & Landauer, 1993). And from her anecdotally derived findings, Janice Morse suggests that six (6) participants is sufficient for phenomenological inquiries (Morse, 1994).

Demographics and background.

The nine (9) participants were comprised of eight (8) women and one (1) man. Two (2) of the participants had expertise in dance, four (4) had expertise in theater, one (1) had an expertise in Somatics (Alexander techniques) and dance, one (1) had expertise in dance and theater, and one (1) had a background in game design, animation and film.

The eight (8) primary participants ranged in age from 19–37 years, with a mean and mode of 27 years. Collectively, they represent 85.5 years of practice, 30.5 years of professional experience, and 31.5 years of training in their respective movement fields. The actors' specialties included physical theater, improvisation, impulse work, vocal performance, physical clown theater, devised theater, and collective creation. The dancers had specialties in modern dance, contact improvisation, performance art, contemporary, jazz, hip hop, tap, salsa, and West African dance.

In terms of prior knowledge of LMA, three (3) participants had taken courses that included LMA as a major component, three (3) participants had some exposure to LMA through classes and prior work, and three (3) had no prior experience using the LMA framework.

Recruitment.

The participants were recruited using posters and emails. They were self-selected based on their interest in movement and were compensated for their time. One of the limitations of the study was the unavoidable use of a high percentage of female participants. The initial set of eight participants was all women, with the one male participant being recruited on the second day from passersby.

3.6.2. Setting and Environment

The workshop took place over two days. Each day was structured into a four-hour block. Holding the workshop over two days allowed for recuperation time for the participants due to the high level of exertion required for movement-based activities. Each day was divided into 2 two-hour sessions. Within each session, one LMA Effort factor was explored, allowing for all four Effort factors to be completed over the two days.

The workshops took place in a dance studio in order to provide adequate space for each participant to move without inhibition. This also provided a safe and comfortable environment for the movement exercises as well as a familiar context for the LMA guided warm-ups directed by Cheryl Prophet.

3.6.3. Data Collection Procedures

The primary data collected from the workshop was in the form of video and audio. Two video cameras were set up perpendicular to each other in order to capture both front and side views of the participants. Video data were captured during discussions, as well as during the quick enactment exercises, and via Flip cams during the participant-recorded movement-sharing exercises. The outcomes of the sorting activities were documented using a DSLR still camera for later pattern and feature analysis and comparison.

Discussions followed each activity in order to gather subjective data. Discussions allowed for the articulation of rich descriptions of individual experiences and group dialogue and reflection. Because the research questions addressed processual issues, discussions enabled participants to convey their experiences in a narrative format.

A researcher's journal documenting reflections and analysis of the workshops and their outcomes was maintained throughout the data collection period. Excerpts from this journal are included in Appendix C. The use of research memos is considered an essential component of grounded theory and provides a method for the researcher to identify important and interesting developments for later exploration (Saldana, 2012).

3.6.4. Role of the Researcher

The role of the researcher in a qualitative study, especially one including participatory activities and discussion, allows for the researcher's biases, beliefs, and assumptions to potentially impact the outcomes. For this reason, and to ensure the validity of the findings, Creswell and Miller suggest that the researcher clearly articulate his role in the research from the outset (Creswell & Miller, 2000).

Camera operator.

In this study I functioned as the documentarian—running the video cameras and taking still photographs—and as the discussion leader. Video cameras were used throughout the entire duration of the workshop. Video cameras were set up prior to the arrival of the participants. During the workshop, they were accessed only to swap out

tapes between activities or to make slight adjustments in camera angle in order to ensure that there was full coverage of the room and the participants.

The still camera was used to capture observed moments of the movement creation exercises and to document the arrangement of the images following the sorting activity.

Discussion leader.

As discussion leader, I moderated the discussions following the quick enactment exercises and movement-creation/sorting exercises. Discussions were held in the dance studio with all the participants, including Thecla Schiphorst, Cheryl Prophet, and myself in a circle. I began the discussion with an open-ended question such as "What were your experiences during this activity?" and allowed each participant to comment as we moved around the circle. The discussions operated in a conversational manner, with participants responding to one another's comments; occasionally I followed up with questions related to a topic that I felt could use further elucidation or with questions directly related to my research objectives (e.g., questions that addressed the image features that guided their interpretations or how they approached the movement-creation process).

3.7. Workshop Activities

The workshop was completed over two days, with four hours dedicated each day. Table 8 provides an overview of the activities completed over the entire workshop. A more detailed description of each activity is included in the remainder of this section.

Table 8: Workshop Activities

A1. LMA Effort guided warm-up	Cheryl Prophet guides the participants through a series of activities through which participants develop an understanding of the individual Efforts and how they are experienced in the body.
A2. 15 Second Quick Enactment Activity	Participants are shown eight (8) images projected on a wall for 15 seconds each. They are asked to express each image through movement.
A3. Discussion of Quick Enactment Exercise	Group discussion of participants' experiences moving to the images.

A4. Photo sorting	Participants organize 32 photos by placing them on the floor in a continuum emphasizing an Effort's two poles (e.g., Flow: from Free to Bound).
A5. Expressing photos through movement (partner exercise)	a) Participants select a photo from one end of the continuum and express it using movement emphasizing the current Effort's qualities. b) Participants share their movement sequence with a partner and videotape each other with a Flip cam. c) Participants discuss their experiences moving and their partner's experience observing. These are also recorded using a Flip cam. d) Participants select a photo from the other end of the continuum and repeat Tasks A to C.
A6. Discussion of sorting and moving exercises	Group discussion of participants' experiences developing and sharing their movements.

3.7.1. **Activity 1: LMA guided warm-up.**

The two-day workshop was divided into four two-hour blocks, each devoted to a particular LMA Effort Factor. At the start of each block, participants completed an LMA guided warm-up on a particular Effort factor, after which they engaged in a series of activities exploring the application of the respective movement qualities to kinesthetic tagging. The same activities were completed for each Effort factor in the following order: Flow, Weight, Space, and Time. On the first day, the Flow and Weight Effort factors were explored. On the second day, the Space and Time Effort factors were explored. Although some of our participants had minimal experience with LMA, this was not required to take part in the research. Including these activities ensured that everyone recalled the details of the system and had the same understanding of each Effort despite any prior background or experience.

Description of guided warm-up activities.

Each Effort exploration began with the 45-minute guided warm-up, during which participants actively explored moving with the specific qualities of movement associated with the Effort factor. The Flow factor, for example, can be either Free or Bound, and during these explorations, participants were guided through a series of somatic exercises during which they learned to experience the sensation of the two opposing poles. The

activities focused primarily on getting the participants to sense and somatically experience the qualities of movement within themselves rather than observe the qualities in someone else's movement. Since each LMA Effort factor is defined as having two opposing poles, Cheryl spent half of each lesson focused on one pole and the other half on its opposite. In this way, the participants were made aware of the overall scope of qualities encompassed by a particular Effort factor. For some Effort factors, props were used. As part of the Space Effort exploration, for example, various objects such as shoes, purses, backpacks, and chairs were used as markers to focus the participants' attention within the studio. These objects were also used to construct an impromptu sculpture, and chairs were used for a game of musical chairs. A modified version of football was also used in a game that explored aspects of the Space Effort.

The instructor, Cheryl Prophet, frequently used imagery as a way of conveying the desired quality of movement. For example, water metaphors were used to describe the quality of the Free Flow Effort factor. Cheryl reported that using imagery to invoke Effort qualities is a standard pedagogical model used in teaching LMA principles to beginners and experts alike. Certified Movement Analyst (CMA) training exploits this acknowledged connection between visual modes of thinking and embodied knowledge, as do other forms of somatic training. This research study extends and makes this connection explicit and attempts to formalize and extend the relationship between movement and image. This method was shown to be effective for dancers in David Kirsh's research on creative cognition in choreography (D. Kirsh, 2011).

Rationale for inclusion.

The LMA-based warm-up served two functions in my research: first, it was the primary mechanism through which knowledge of the LMA system was conveyed to the participants. This was essential to answering all the research questions which required a basic understanding of LMA. These activities also functioned to warm-up the participants' bodies and prime them for the research activities to follow. The importance of priming participants prior to engaging them in movement-based research is critical; it engages somatic awareness and enacts a shift from a focus on the types of knowledge that are generally emphasized in our schools and daily lives—visual-spatial, linguistic, and logical-mathematical—to a focus on more bodily and kinesthetic forms of knowledge (Özdermir,

Güneysu, & Tekkaya, 2006). Other researchers have demonstrated the effectiveness of warm-up activities in helping participants connect with their kinesthetic awareness, including researchers Thecla Schiphorst and Kristina Andersen, who incorporated warm-ups into their workshops exploring experience modeling (T. Schiphorst & Andersen, 2004).

As dancers and actors, the participants in this study have been trained in developing their bodily-kinesthetic intelligence and therefore generally have more expertise in accessing this knowledge than would a more general audience. Howard Gardner has argued that humans possess eight forms of intelligence that are weakly correlated (Gardner, 1985, 1999, 2006), so when focusing on one in particular, it is important to ensure its activation prior to data collection. Unfortunately, too often with movement-based research in HCI, this factor is not taken into account.

Relevance to research questions.

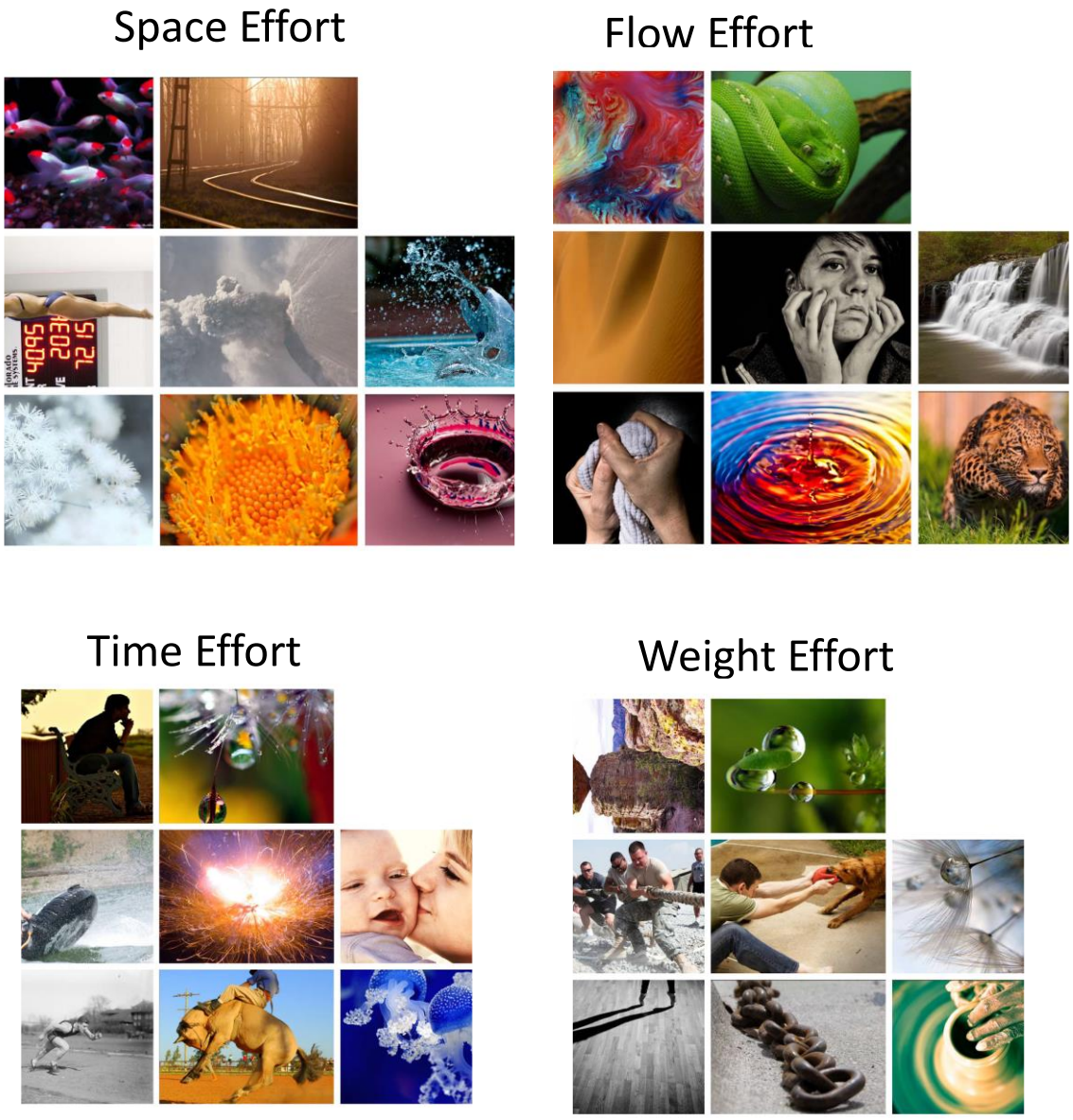
Including the LMA guided warm-up as a component of the research workshop was connected to answering my primary embodied experience research question (RQ1) investigating the ways that the LMA Effort factors can be used to assist the investigation of people's movement experience during the kinesthetic tagging process. By providing these introductions to the Efforts at the start of each block, participants were provided with an opportunity to explore specific aspects of their somatic awareness in a focused and directed manner. This primed them for the activities that followed and facilitated their exploration of their experiences in relation to the specific Effort factor being investigated.

The guided warm-ups were also necessary to address design question 2A investigating the application of LMA as a somatic practice in the design of a movement-based tagging system. As discussed in Section 3.3.3, LMA is most often utilized solely as a theoretical framework in HCI design research. My explicit intention here was to incorporate experience-based somatic practices in the research design in order to explore the effect on participants' ability to provide design relevant information.

3.7.2. **Activity 2: 15 Second Quick Enactment Activity.**

The quick enactment exercises were developed as a way to quickly gather data pertaining to participants' use of movement to express visual content. For this activity the participants were asked to quickly enact movements for a variety of images. The images consisted of 32 photographs (eight per Effort) that were projected onto the wall of the studio display. Four of the images were selected to express the condensing pole of the Effort factor (e.g., Bound Flow), while the other four expressed the expanding pole (e.g., Free Flow). The images were projected randomly so that the participants were not aware of which ones were meant to be associated with which pole. Each image was projected for 15 seconds, after which the next photo was displayed automatically. The activity was completed by the participants all at once with them in two rows facing the projections.

Figure 6: Images used in the Quick Enactment Exercises[1]



Rationale for inclusion.

The rationale for this exercise was the common pedagogical strategy of using imagery in order to access movement qualities, a strategy that is often incorporated in the

[1] Image authorship information available in Appendix B

explication of the LMA Effort factors. For example, students may be asked to imagine a certain type of image to assist them in connecting specific aspects of somatic experience with the conceptual terms that comprise the LMA framework. For example, conjuring an image of a river might be used to help students experience the qualities of Free Flow. This link between image and somatic experience appears to be direct and coherent in the context of movement creation. Within the LMA community, there are numerous repositories and "best teaching practices" that identify images that can be used to embody the qualities of each Effort factor. These repositories can be used for teaching as well as for other purposes (Bradley, 2008). For example, the website LMA Effort Bank (www.lmaeffortbank.com) is a community-supported resource that enables anyone to upload images relevant to the LMA Effort factors, States, and Drives (Konie, 2012). These images can be tagged by the submitter to associate them with a particular Effort quality.

The images used for the quick enactment exercises were curated through discussions with my research collaborator and Certified Movement Analyst (CMA), Cheryl Prophet. This discussion ensured that the selected images were relevant to the quick enactment activity and appropriate as depictions of the various Efforts. The quick enactment activity was designed to enable the workshop participants to practice expressing imagery through movement and was therefore not intended to be overly challenging. Rather, these images were selected for their easy association with a particular Effort quality. It also allowed for the collection of a large amount of data in a short period of time which was important given the time constraints of the workshop. These images and the author attribution are shown in Appendix D.

Relevance to research questions.

The specific research questions addressed in this activity are embodied cognition question 1A, 1B, and 1C. These relate to the ways in which people determine which qualities of movement to use when enacting images (1A), the ways that those qualities reflect their embodied experience (1B), and the ways in which specific image features affected their choice of movements (1C). Although these questions were not directly addressed with the participants during this activity, they related their experiences in the discussion that immediately followed (Activity 3).

3.7.3. Activity 3: discussion of the quick enactment exercises.

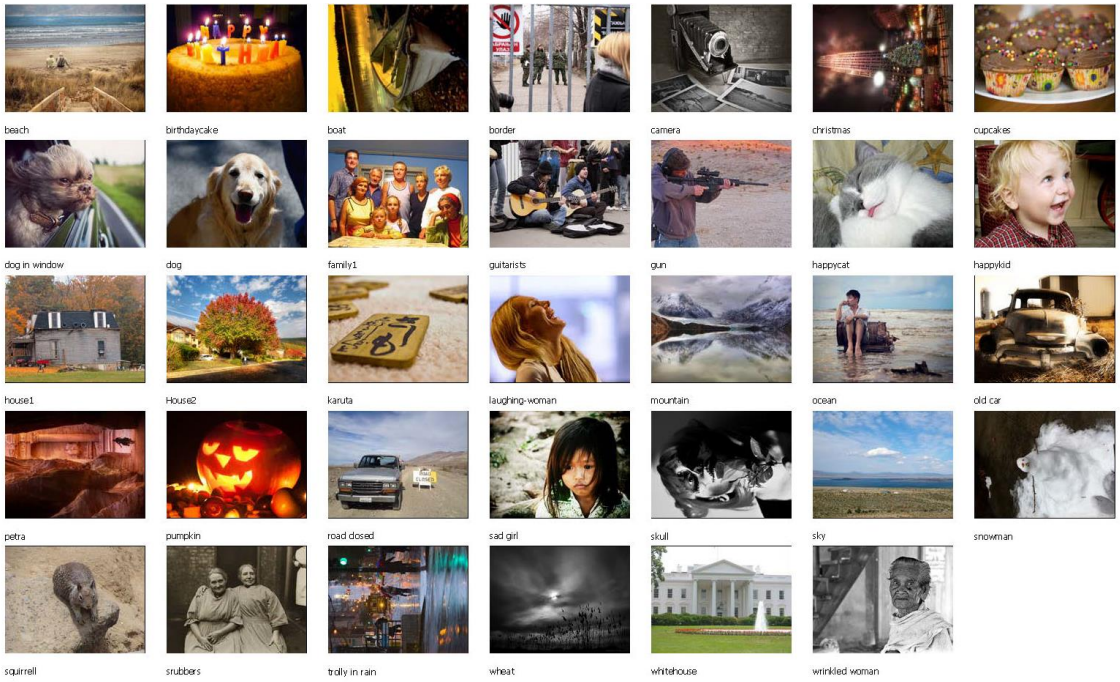
Directly following the quick enactment exercises, an open-ended group interview was conducted. The group of participants gathered in a circle while sitting on the floor to discuss their experience of completing the activity. The discussions functioned as a way of probing the participant's experiences during the quick enactment exercises. These discussions were open ended and therefore encompassed a variety of topics, including those dealing with movement selection, use of image features to influence movement generation, and any difficulties the participants encountered while doing the activity These conversations were transcribed and analyzed for themes pertaining to the research questions 1A, 1B, and 1C as discussed in the previous section.

3.7.4. Activity 4: photo sorting.

Description of the photo sorting activity

During this activity, participants were instructed to sort the 34 photos on a continuum so that the images progressed from those associated strongly with one pole of the Effort (e.g., Strong Weight) to those strongly associated with the opposite pole (e.g., Light Weight). The participants were asked to lay the images out on the floor of the studio to make this organization clear and to label the ends of the diagrams using sticky notes with the names of the appropriate Effort qualities. These diagrams took a variety of forms—some linear, some radial, others combinations of both.

Figure 7: Images Used During Sorting Exercises



At the start of the photo-sorting activity, participants were given identical sets of 34 photos. These photos were selected to provide a wide variety of image content, including variations in form, content, and emotion. The photos were selected from Creative Commons–licensed photos available on Flickr. (See Appendix B for author attribution information). Using Flickr as a source for the photographic content ensured that the images came from multiple sources and depicted a variety of subject matter. In addition, photos on Flickr are tagged by users of the site, providing a method for identifying key features of the photos. Figure 8 shows the 300 most frequent tags from the photos used in the study. A tag cloud uses an algorithm that visualizes the frequency of occurrence of words by scaling the size of the word in the tag cloud. Larger words occur more frequently than smaller ones.[2]

[2] The tag cloud does not reflect the fact that some photos are tagged with more words than others, resulting in a disproportional representation in the cloud. However, the diagram still provides a general overview of the diverse range of tags associated with the images.

Figure 8: Tag Cloud of the Image Descriptors

Rationale for inclusion.

The photo-sorting activity was included since it was the only activity that required the participants to consider all of the photos in relation to each other, rather than just focusing on one. Unlike the other activities it also did not require the participants to utilize movement. This was partially due to the nature of the task which would have been overly time consuming to complete if performance of each image was necessary, but also to explore facets of the process that were not related directly to the act of moving. This allowed for them to reflect on their process of interpretation and on how the various features and content in each photograph informed their process. This activity was intentionally ordered following the quick enactment exercises in order to ensure that the participants did have the experience of enacting images prior to completing this task.

Relevance to research questions.

This related to embodied experience question 1A and 1C pertaining to the ways in which people determine which qualities of movement to use when enacting images and the role of image features in that process, respectively. The results of the sorting exercise

provided data pertaining to the role of image content and features in the interpretation of Effort polarity and required the participants to consider their strategies and processes for interpreting Effort from a still image. It also facilitated the comparison of results between participants, potentially shedding light on the commonalities and differences in Effort interpretations.

The activity was also included to address design questions 2B and 2C relating to the LMA Effort factors use as a framework supporting the design of a kinesthetic tagging system. The results helped inform the design considerations of the computational classification system by illustrating the ways in which the participants ordered and organized their photos. All of the layouts were documented as part of the data collection process.

Figure 9: Continuum Diagrams

3.7.5. **Activity 5: enacting photos through movement.**

During Activity 5, participants selected one photo from each side of their continuum diagrams, one with strong Expanding qualities, and one with strong Condensing qualities in the context of the Effort factor being investigated. Participants were directed to select images for which they felt a personal affinity. Starting with the image selected for its Expanding qualities (e.g., Indirect Space), the participants developed short full-body movement sequences enacting the image in the context of the Effort under investigation. No instruction was given as to what aspect of the image to use to inform their movements. Once each participant had developed a sequence, they paired up to demonstrate their movements. Each group of two participants was given a Flip handheld video camera with which one partner recorded the movement phrases of the other. Participants were instructed to elicit feedback from their partners regarding the most prominent features of the movement and also to get feedback about the overall experience of the sequence. Their partner would then attempt to ascertain which photo was being performed by looking at their partner's arrangement on the floor. Following this, the person performing the movement would explain the rationale for her movements and how she devised the sequence. This entire process was repeated with the other participant. Once both participants completed the activity for their images from the Expanding side of the spectrum, they would repeat the exercise with a photo from Indulging side (e.g., Indirect Space).

Rationale for Inclusion.

Activity 5 was included as a way of exploring the participants' use of movement to enact imagery emphasizing opposing Effort qualities. This provided insight into the types of movements used for Expanding vs. Indulging qualities, and facilitated the participants' reflection on their own processes. It also enabled discussion in a more personal one-on-one situation where both participants were given time to consider movement from a first- and third-person perspective. One of the additional benefits of this was that it allowed for the collection of a large amount of data in a short period of time. Through the use of the Flip cameras, we were able to capture enactments and discussions that would have taken a huge amount of time if conducted as a group.

Relevance to research questions.

Activity 5 addressed all of the embodied experience questions. Through the process of enactment and discussion the participants had the opportunity to reflect on the various aspects of their experience and explore through dialogue with another person. This activity also addressed design research questions 2A and 2C dealing with the use of LMA as a somatic practice in the design of an image tagging system, and uncovering the design considerations for such a system, respectively. The movement sequences developed through the process of enacting images from opposite Effort polarities helped inform my understanding of how a computational system would differentiate Effort qualities; and the discussions contributed by providing insight into the various participant's processes used in the development of these sequences.

3.7.6. Activity 6: discussion of sorting and moving exercises.

Following the completion of the movement exercises, the participants gathered in a circle to discuss their experience of developing movement sequences to express photographs. These discussions lasted from 15–20 minutes and provided an opportunity for the participants to talk about the sorting activity and the movement activity. The participants offered insight into their strategies for movement and image choice, their rationale for sorting, and any complications they had while completing the tasks. Discussions were left completely open and covered a variety of topics that were dependent upon the particular Effort being explored. Participants were encouraged to provide overviews of their experiences with the particular Effort factor being investigated, as these discussions were the final wrap-up before moving on to another movement quality. All of these activities were completed in full for each of the four LMA Efforts that were investigated. Due to the open-ended nature of the discussions all of the research questions were addressed during this activity.

3.8. Grounded theory Approach

The coded of the discussion transcriptions was completed using a modified grounded theory approach (Strauss & Corbin, 1998). During this process relevant codes

and themes were identified and categorized in order to provide a deep understanding of the participants' experiences from their point of view. The coding was completed using MAXQDA data analysis software (www.maxqda.com). Although the LMA framework was used as the basis for the workshop, the data coding was completed without reference to this framework or any other initial categories or themes. Rather, the themes and categories emerged directly from the data through the process of coding. Grounded theory was chosen because it provides an entry point into exploring a phenomenon about which little is known (Strauss & Corbin, 1998).

A grounded theory approach is often recommended for exploratory research that has limited prior research upon which to base a theoretical framework. Because my extensive literature review indicated that little or no research had explored movement tagging for photographic images, I chose a modified grounded theory approach to allow for an analysis based on the experiences of the participants without the need to reference additional sources that describe methods of gathering movement-tagging data. In addition, this approach allows for an analysis to occur on multiple levels, from process through outcome, and assisted in identifying experiences on both individual and group levels.

3.8.1. First cycle coding: initial coding.

The coding was done in two phases: initial coding and second cycle coding. Initial coding is an exploratory process through which important data are selected, separated, and sorted in order to create an analytical account (Charmaz, 2006). The term *initial coding* is synonymous with *open coding*, a term more commonly associated with grounded theory and used by Corbin and Strauss to describe the process of splitting qualitative data into discrete parts, scrutinizing them, and identifying similarities and differences (Strauss & Corbin, 1998). In *The Coding Manual for Qualitative Research*, Johnny Saldana notes that initial coding is generally appropriate for all qualitative studies and that it provides an exploratory tool for approaching data. He stresses that the codes created during the initial coding cycle are provisional and that as the coding process goes on, categories will be merged and segments reordered as the researcher begins to make sense of the

phenomena under investigation (Saldana, 2012). As the data are coded, analytical memos are also written to track emerging themes and to document connections between codes.

Application in research.

Prior to beginning any coding, I read through the transcripts to refresh my memory of the primary topics and themes that were present in the discussions. I then went through the transcripts in chronological order and began to apply codes. The only pre-established codes were the participants' names and the LMA Effort factors and their respective polarities; all the other codes were generated during the coding process itself. Some categorization was done during the process, as it became clear that there were similarities between many of them. This was also done to facilitate the coding process and to keep the code tree comprehensible despite the large number of codes applied.

After the initial coding stage was completed, I had applied 303 codes in 48 categories 765 times Table 9 displays these 48 categories (Appendix E).

Table 9: Initial Coding Categories

Initial Coding Categories	
"Not wanting to let go"	Less Interpretation
Abstraction	Movement as a Form of Investigation
Acting/Actors	Movements
Activity Type	Observing vs. Performing
Affinities Between Gestures (where they align)	Participant Contradicts Earlier Statements
Agreement With Another Participant's Idea	Participants
Alternate way of thinking	Performing for an Audience
Athletes	Personal/Emotional/Cultural History
Awareness Level	Post-Movement Reflection
Benefit of Warm-up	Process of Creating Movement for Images
Chaos	Process of Distilling Images
City	Process of Interpreting Images
Conceptual Difficulties	Process of Interpreting Movement
Dancing	Process of Sorting Images
Differences Between Efforts	Reactions

Differences From Day One to Day Two	Relationship to Gravity
Difficulties	Response Time
Difficulty Trusting Intuition	Rules
Duration of Movement	Strategies for Interpreting the Images
Efforts	Things That Stopped the Movement
Experience of Difficulty	Visual Artist
Experiential Elements	Voice
Image Features	Walking
Influences on Interpretation	Working with Others

3.8.2. Second cycle coding: focused coding.

Focused coding is a modified form of grounded theory's axial coding that alleviates the need for categories to have dimensions and properties attributed to them (Saldana, 2012). The formal approach to axial coding has been criticized by numerous researchers for stifling analytical progress (Charmaz, 2006) and for lacking a fully developed logic of categorization and process (Dey, 1999). Focused coding expedites the process of consolidation and grouping by looking for the most frequently occurring codes and the most salient categories based on the researchers' analytic sensibilities (Saldana, 2012). It is ideal for identifying major categories and themes within the data.

Application in research.

The focused coding cycle was repeated several times during the analysis process. During these coding cycles I scrutinized the codes and reorganized them into more coherent categories that lined up with the research objectives. Following each reorganization, I returned to the transcripts and recoded the contents with the new codes. Each cycle resulted in the restructuring of the code tree, with some categories merging and some new categories being created. *Table 10* illustrates the first focused coding cycle: The table on the left shows the code categories from the initial code phase. The codes highlighted in blue remained after completing this focused coding phase. The code categories highlighted in gray were merged or renamed. The table on the right shows the resulting code category structure. Those categories with a plus sign next to them were added during this cycle. Following this, I again reviewed the transcripts to ensure that the

new codes were applied properly. This resulted in 288 codes in 25 categories applied 777 times.

After completing the first focused coding cycle, I conducted another round of focused coding. The process was identical to that of the first cycle and resulted in 544 codes in 27 categories applied 1464 times (Table 11). Again, the rightmost column lists the categories within the revised code structure.

Table 10: Consolidations and Deletions of Categories Resulting from the Initial Focused Coding Cycle

~~"Not wanting to let go"~~	
~~Abstraction~~	
~~Acting/Actors~~	
Activity Type	Activity Type
~~Affinities between gestures (where they align)~~	
~~Agreement with another participants idea~~	
~~Alternate way of thinking~~	
~~Athletes~~	
Awareness Level	Awareness Level
~~Benefit of Warmup~~	
~~Chaos~~	
~~City~~	
~~Conceptual Difficulties~~	
~~Dancing~~	
~~differences between Efforts~~	
Differences from day one to day two	Differences from day one to day two
Difficulties	Difficulties
~~Difficulty trusting intuition~~	
Duration of Movement	Duration of Movement
Efforts	Efforts
Experience of Difficulty	Experience of Difficulty
Experiential Elements	Experiential Elements
Image Features	Image Features
Influences on interpretation	Influences on interpretation
~~Less interpretation~~	
~~Movement as a form of Investigation~~	
Movements	Movements
~~Observing vs. Performing~~	
~~Participant Contradicts Earlier Statements~~	
Participants	Participants
~~performing for an audience~~	
~~Personal/emotional/culturral history~~	
~~Post movement reflection~~	
Process of creating movement for images	Process of creating movement for images
Process of Distilling Images	Process of Distilling Images
Process of interpreting images	Process of interpreting images
Process of interpreting movmenent	Process of interpreting movement
Process of Sorting Images	Process of Sorting Images
Reactions	Reactions
Relationship to Gravity	Relationship to Gravity
~~Response Time~~	
~~Rules~~	
Strategies for interpreting the images	Strategies for interpreting the images
~~Things that stopped the movement~~	
~~Visual Artist~~	
~~Voice~~	
~~Walking~~	
~~Working with Others~~	Working with Others
	+ Prior knowledge/background
	+ Real World Actions
	+ Real World Objects

Table 11: Consolidations and Deletions of Categories resulting from the Second Focused Coding Cycle

Activity Type	+ Activity
~~Awareness Level~~	+ Activity Comparison
~~Connections between different Effort Qualities~~	Activity Type
Differences from day one to day two	+ Attributes of Photos/Features
Difficulties	+ Benefit of Warmup
~~Duration of Movement~~	+ Body parts involved in movement
Efforts	+ Characteristics of movements
~~Experience of Difficulty~~	+ Concrete Image Features
Experiential Elements	Differences from day one to day two
~~Image Features~~	Difficulties
~~Influences on interpretation~~	+ Effort Qualities Comparison
~~Movements~~	Efforts
Participants	Experiential Elements
Prior knowledge/background	+ Factors Influencing Interpretation and Movement Creation
~~Process of creating movement for images~~	+ Inferred Image Features
Process of Distilling Images	+ Interpreting Effort Polarity
~~Process of interpreting images~~	+ Movement as Inquiry
Process of interpreting movement	Participants
Process of Sorting Images	+ Personal Experienced Level of Difficulty
~~Reactions~~	Prior knowledge/background
~~Real World Actions~~	+ Process of Creating Initial Movement
~~Real World Objects~~	+ Process of Distilling Movement
~~Relationship to Gravity~~	Process of interpreting movement
Strategies for interpreting the images	Process of Sorting Images
~~Working with Others~~	+ References to Elements not Present in Photo
	+ Strategies for creating movement for images
	Strategies Used for interpreting the images

3.8.3. Third cycle coding: selective coding.

Selective coding follows the focused coding process and is the stage at which the researcher identifies a primary category to use in the integration of all the coded data. This category should address the phenomenon under investigation and provide a foundation for the next stage in which an explanatory theory is suggested (Charmaz, 2006; Saldana, 2012)**.**

Application in research.

During the selective coding process, the code categories were filtered to isolate those that were most directly related to the process of image enactment through movement. The first step prioritized those categories that directly addressed active processes or codes relating to image enactment and tagging. The other categories were removed from the remainder of the selective coding process. Table 12 illustrates the results after the first round of selective coding. The categories highlighted in green were retained for further analysis, those in grey were ruled out as highly relevant categories and thus discarded.

During the next selective coding cycle, those categories that directly related to the process of image enactment through movement were retained, and the rest were discarded. The results of this cycle are shown in Table 13. Again, those categories highlighted in green remained and were used for further analysis, while those in gray were discarded.

The third cycle identified those categories and codes that directly related to the process of movement creation, tagging, and image enactment—only those that were verbs or actions or descriptions of process were retained. Table 14 illustrates the results after completing the third selective coding cycle.

The final remaining codes are shown in Table 15. They are *Interpreting Effort Polarity*, *Process of Creating Initial Movement*, *Process of Interpreting Movement*, *Strategies for Creating Movement for Images*, and *Strategies Used for Interpreting the Images*.

Table 12: Results After the First Round of Selective Coding

~~Activity~~
Activity Comparison
~~Activity Type~~
~~Attributes of Photos/Features~~
Benefit of Warmup
Body parts involved in movement
Characteristics of movements
~~Concrete Image Features~~
Differences from day one to day two
Difficulties
Effort Qualities Comparison
Experiential Elements
Factors Influencing Interpretation and Movement Creation
Inferred Image Features
Interpreting Effort Polarity
Movement as Inquiry
~~Participants~~
Personal Experienced Level of Difficulty
Prior knowledge/background
Process of Creating Initial Movement
Process of Distilling Movement
Process of interpreting movement
Process of Sorting Images
References to Elements not Present in Photo
Strategies for creating movement for images
Strategies Used for interpreting the images

Table 13: Results Following the Second Round of Selective Coding

~~Activity Comparison~~
~~Benefit of Warmup~~
Body parts involved in movement
Characteristics of movements
~~Differences from day one to day two~~
~~Difficulties~~
~~Effort Qualities Comparison~~
Experiential Elements
Factors Influencing Interpretation and Movement Creation
Inferred Image Features
Interpreting Effort Polarity
Movement as Inquiry
~~Personal Experienced Level of Difficulty~~
Prior knowledge/background
Process of Creating Initial Movement
~~Process of Distilling Movement~~
Process of interpreting movement
~~Process of Sorting Images~~
~~References to Elements not Present in Photo~~
Strategies for creating movement for images
Strategies Used for interpreting the images

Table 14: Results After the Third Cycle of Selective Coding

~~Body parts involved in movement~~
~~Characteristics of movements~~
~~Experiential Elements~~
~~Factors Influencing Interpretation and Movement Creation~~
~~Inferred Image Features~~
Interpreting Effort Polarity
~~Movement as Inquiry~~
~~Prior knowledge/background~~
Process of Creating Initial Movement
Process of interpreting movement
Strategies for creating movement for images
Strategies Used for interpreting the images

Table 15: Remaining Categories After the Selective Coding Process was Complete

Interpreting Effort Polarity
Process of Creating Initial Movement
Process of interpreting movement
Strategies for creating movement for images
Strategies Used for interpreting the images

3.9. Trustworthiness

In quantitative research, results are tested for validity in order to ensure that they accurately measure the phenomenon under investigation. In qualitative research, there is no straightforward method for assessing validity, and the use of the term *validity* is often rejected to illustrate this incompatibility (Y. S Lincoln & Guba, 1985). However, qualitative researchers still must demonstrate that their findings are a credible interpretation of the data. Rather than address validity directly, qualitative researchers focus on demonstrating the existence of criteria such as trustworthiness and authenticity, which take into account elements of confirmability, dependability, credibility, transferability, and fairness (Creswell & Miller, 2000; Y. S Lincoln & Guba, 1985).

Numerous methods for establishing trustworthiness have been accepted as alternatives to the statistical methods used in quantitative research (Creswell & Miller, 2000). Several of these methods were employed in this research in order to ensure the credibility of the findings from this research study. These methods include researcher reflexivity, expert validation, and thick descriptions (Creswell & Miller, 2000).

3.9.1. Researcher reflexivity.

Research reflexivity refers to the self-disclosure of the researcher's biases, assumptions, and beliefs early in the research description in order to allow the reader to better interpret their effect on the research process and to bracket those beliefs as they progress through to the findings (Creswell & Miller, 2000). This process is addressed earlier in Section 3.6.4, where I discussed my role in the workshops. I address a few additional factors in this section as well.

Although in this section I will be explicitly stating some of the biases and beliefs that have influenced this research study, it is my belief that they are already implicitly expressed throughout this document in the literature presented and the argument made. My articulation of the process of developing the pilot studies also functions as a method of making my research biases and assumptions transparent. For example, my position regarding the role of movement in people's lives is illustrated by the emphasis on somatic experience and felt movement in Chapter 2. It should also be clear that I believe that computational interaction has for too long de-emphasized the body and bodily experience and that this phenomenon has had a profound impact on the cognitive functioning, emotional health, and overall quality of life for users. And although we are seeing a shift towards the inclusion of gestural and full-body movement as a component of interaction, the way in which this transformation occurs is not predetermined and will affect the types of systems and interaction styles that we use for years to come. Thus it is of the upmost importance that we carefully consider how movement interaction is implemented rather than grab at low-hanging fruit by using gestures solely on the basis of their ability to be sensed by existing hardware.

To further expand on some of the themes mentioned above, I feel it is important for me to explicitly state that the use of the LMA framework as a central component of this study is a reflection of a set of personal beliefs about movement. The use of LMA attests to a belief that movement and computational interaction involving movement are more than merely communicative. LMA connects movement with a person's inner state—thoughts, emotions, and attention (Davies, 2001; Laban & Lawrence, 1947). For example, LMA has been used by Warren Lamb as a method of assessing individuals' stress levels and the capacity of senior executives for leadership roles within an organization (Lamb, 1978; Lovell, 1993). However, the LMA framework and the underlying assumptions it entails are not universally accepted and reflect a particular epistemological and ontological paradigm.

Another bias that has explicitly affected the direction of this research is the belief that movement experience, which includes somatic awareness and all its connections to human cognitive and emotional processes, needs to be considered in the development of computational systems in general. Although user experience has become a central

concern to computer interaction (Law, Roto, Hassenzahl, Vermeeren, & Kort, 2009; McCarthy & Wright, 2004), movement experience has had little influence on this discussion until recently and has yet to become of any significant commercial interest.

And finally, the use of a qualitative approach to studying movement reflects my belief in the importance of subjectivity in research and of the benefit of investigating the nuances of individual experience. Rather than remove outliers from the research findings, a qualitative approach allows every voice to express its unique perspective, ensuring that all points of view are not only heard, but understood.

3.9.2. **Audit trail/expert validation.**

An audit trail is a method for ensuring that the coding of qualitative data is done in a consistent and confirmable manner. The audit process involves researchers sharing their analytical processes in detail with a panel of experts (Rodgers & Cowles, 1993). The audit trail makes the researchers' logic and interpretation transparent and helps ensure the trustworthiness of their findings. Following the coding process, four CMA experts conducted an audit trail in which I presented my entire process of coding and analysis. The results of this audit are presented in Section 4.2.3.

3.9.3. **Thick, rich descriptions.**

The use of thick, rich descriptions is one of the defining characteristics of qualitative research. These are defined in contrast to thin descriptions, which report only factual accounts. Thick descriptions provide detailed and dense accounts of settings and participants in order to transport readers into the scene as though they were experiencing it themselves. Through this process of detailed explication, readers are better able to establish the credibility of the narrative interpretation (Creswell & Miller, 2000; Denzin, 2001).

For this research, the findings include excerpts of the discussions, using direct quotations of participants' statements. These statements allow the reader to assess the nuances of the experiences being articulated and to evaluate the credibility of the narrative being woven and the interpretation presented. In addition, all the audio and video

recordings can be made available for further exploration of the ways in which participants performed the various movement exercises.

Chapter 4. Theory Construction

After having identified those categories that were most relevant to my research questions and objectives, I began the process of reviewing the segments of the transcript to which the codes in these categories had been applied. As I reviewed these quotations and considered my recollection of the workshop discussions, I began to see that the process that the participants underwent throughout the workshop had multiple stages that appeared to be fairly standard. These stages are depicted in Table 16 below.

Table 16: Stages of Image Enactment Within the Workshop

Stage of Enactment	Description of Stage	
Stage 1	Establish Connection with Image	
Stage 2	Assess appropriate Effort Polarity	
Stage 3	Create movements to Enact Image	Reflect while Moving
Stage 4	Perform Movement	
Stage 5	Post Movement Reflection	

4.1. Stages of enactment.

Stage 1, Establishing a Connection with the Image, involved the participants' first responses to the images. These responses appeared to vary depending on the day and the Effort factor under investigation. During this stage, participants found ways to make the images meaningful or identify interesting elements within the photographs.

Stage 2, Assess Appropriate Effort Polarity, involved considering what characteristics of the image to use for enactment in the context of the Effort factor being investigated. This involved simultaneously considering the various features present within

the photograph and using them to assess both the Effort polarity (e.g., Bound Flow vs. Free Flow) and the relative amount of that factor present.

Although stages one and two are temporally distinct, they did not occur discretely. Often participants' connections to images were influenced by their assessment of the appropriate Effort polarity making the processes underlying these two steps tightly integrated.

Stages 3 and 4 both had two activities occurring simultaneously. I will discuss the primary activities first and address the secondary shared activity immediately after.

During Stage 3, Creating Movement to Enact Image, the participants considered ways to express the image through movement, prioritizing the Effort factor under investigation. During this process, many of the participants explored a variety of movements before settling on a specific sequence.

In Stage 4, Perform Movement*,* the participants performed their movements for each other. This stage was built into the workshop, as the participants were asked to share their movements and discuss them from the perspectives of both the observer and the performer.

Both of these previously discussed stages also included a secondary shared activity, Reflecting While Moving, which occurred simultaneously with the primary activity. The reflection that occurred during this stage was often self-reflexive and sometimes expressed in a very critical voice that the participants often described as second-guessing their initial choices.

During Stage 5, Post-Movement Reflection, participants consciously reflected on the choices that they made during the enactment process. This stage was a by-product of the workshop study structure because I included discussions after both the quick enactment activities and the photograph/movement-sharing activity.

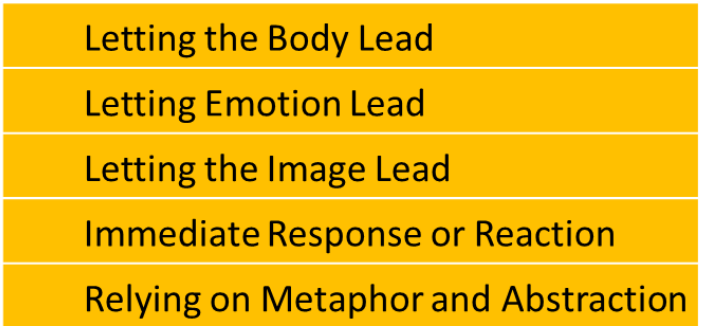
4.2. Initial process model.

After establishing these stages, I was interested in investigating their relationship with the embodied experience of the participants (question 1A). To explore this further I decided to return to the transcripts and examine the codes that were most relevant to each step. I began by focusing on the first two stages, as they were most directly connected to the process of interpreting the images within the LMA Effort factor framework. These stages were Establish a Connection with the Image and Assess Appropriate Effort Polarity.

4.2.1. Strategies used for interpreting the image.

The selective code category that seemed most relevant to the process of connecting to the images was Strategies Used for Interpreting the Images. The codes in this category directly address the ways in which participants individually interpreted images within the context of the Effort factor under investigation in order to assess Effort polarity and create movement. The open codes contained within this category further subdivide the strategies into frequently occurring groups. These groups are Letting the Body Lead, Letting Emotion Lead, Letting the Image Lead, Immediate Response or Reaction, and Relying on Metaphor or Abstraction (Figure 10).

Figure 10: Strategies Used for Interpreting the Images



Letting the Body Lead.

The specific strategies based on the open codes in the data contained in the category *Letting the Body Lead* are:

- Internalizing the Experience
- Internalization of Efforts
- Focus on Breath/Breathing
- Bodily Awareness

The following section presents specific examples from the discussions to better relate the exact manner in which these strategies were used by the participants. For instance, one of the passages coded Internalizing the Experience was related by Participant 7:

> I felt the same way with a lot of the images that I hadn't personally experienced, I would take a second and take the image into my body. We do it a lot with mask work or red nose where you take on the shape and let it sink into your body, and I found that that really helped me with that one picture that looked like a log at the beach, but it was really close and there were really sharp points, and I found those edges and I felt a lot of those edges.

An example of when a participant Internalized the Experience was when Participant 5 described the difference between working with Flow and working with Weight:

> I think that if someone was viewing my movement, it was probably less clear what I was trying to tell the audience when I was working with Weight than when I was working with Flow. And I think that I internalized Weight a lot more and I knew what I was thinking and it felt really Strong or it felt really Light. But as a viewer it would be a lot more challenging to understand.

While discussing some of the difficulties involved in interpreting the images without falling into stereotypical responses, Participant 7 describes how she Focused on Breath/Breathing:

> I was challenged by the stereotypes as well, but something that helped me to break through that was thinking about the breath and looking at the image and I was like what does my—how does my breath respond to that image—like does it make it go faster slower and then just going with that and just having the image be just part of that experience.

Participant 3 relates her experience of using Bodily Awareness as a strategy for interpreting an image of a dog poking its head out of a pickup truck window:

> As you mentioned earlier, Free and Bound, there's no negative or positive connotations for it. So I really did just try to think about muscle tension for me. So that little dog in the window, as much as he's like, “Free, FREEDOM WOO-HOO,” I felt like there was such muscle tension because I know when I hang my head out of the window for a long time I get really cold. Even though it feels really good, there's a lot of tension there. So I was just really focusing on muscle tension.

Letting Emotion Lead.

The specific strategies contained within the category Letting Emotion Lead include:

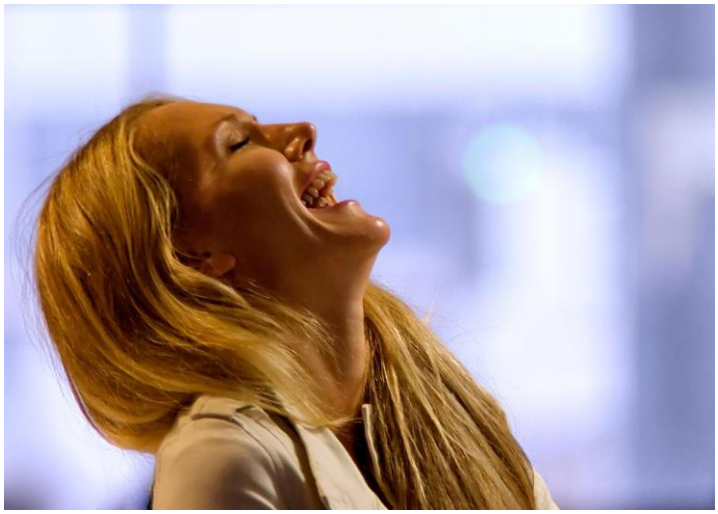
- Personal Connection With the Image
- Emotional Interpretation

Participant 2 describes an example of using Personal Connection With the Image as a strategy to help in the enactment process. As she relates her experience:

> I could connect to the people because I have done those actions or I could imagine what they were feeling and that's where I made a lot of conclusions from.

Participant 5 provides an example of using Emotional Interpretation as a strategy for interpretation and enactment:

> I picked the picture with the woman laughing, and it was very much the sense of euphoria which informed my movement.



Letting the Image Lead.

The next category of strategies describes moments during which the participants focused primarily on the image or properties of the image to guide their interpretations. This category includes the following specific strategies:

- Compositional Approach

- Analytical Interpretation
- Imagined Interaction
- Creating a Narrative
- Immersion Within the Image
- Becoming the Image/Part of the Image
- Embodying the Image
- Focusing on Energy in the Image

Participant 9 provides an example of using the Compositional Approach strategy when he describes his sorting process:

> If there was one main part of the image that was the main focus then I put it more as Direct. Whereas if it was—if there were two conflicting things they kind of move each other out, there was no one winning out over the other so it's kind of more Indirect.

Participant 4 describes the use of Analytical Interpretation when addressing the difference between interpreting a photo of the ocean and one of the desert:

> I feel like on water, I act like on water, but the sand I feel nothing for so I was a lot more just there and observing. So I feel like I was more Bound when I was treating it like an object. But when I was something feeling it, I was more aware of that freeness.

Participant 8 presents an example of the strategy Imagined Interaction when she describes how she applied her background in clowning to the interpretation activity:

> When I clown what we do—because I do clowning as well—is you take an object—the Pochinko work—and you find however many hundred ways in which you can interact or in a sense you become that object. So for me this is like a Pochinko.

The next strategy, Creating a Narrative, is very clearly articulated by Participant 2 during the Time Effort explorations while talking about the inherent narrative potential of the images:

> Something that came up for me when categorizing the images this time was thinking about potential…I would have more association with the image of being like, OK that's the image that's before me but what is it

> suggesting, but what's the potential of that? What's going to happen next? or what could happen next?

Participant 5 describes an example of Immersion Within the Image:

> I found myself in the environment in a lot of pictures, and I thought there were some that were more environmental to me and that was the mood and the feeling and that was how I would be in that environment.

When exploring the Time Effort, Participant 4 relates her use of the strategy Becoming the Image/Part of the Image:

> Whenever I see an image and if it speaks to me it's usually because I want to be a part of it or I don't want to be part of it. And with this one I wanted to be part of a lot of them or at least I could just feel myself experiencing the time that was in the image and that's where my mind went.

Participant 7 describes her experience of Embodying the Image during the Weight Effort investigation:

> So for instance the rock picture of the balancing stone in a cliff, initially I felt like balancing and poised-ness, it was a Light feeling.

Participant 4 describes how she Focused on Energy in the Image when investigating the Space Effort:

> I tried to define if it was Indirect or Direct—if the energy was directed somewhere or if the energy was just filling the world and the space whichever way it wanted to.

Immediate Response or Reaction.

The category of Immediate Response or Reaction contained the following strategies used by the participants:

- As if Seeing Them for the First Time
- Adjacent Thoughts (Before or After Seeing Image)
- Instant Reaction
- Acting on Impulse

Participant 7 describes her use of the strategy As if Seeing Them for the First Time:

> I approached them like I'd seen them for the first time and I was letting them wash over me.

The next strategy, Adjacent Thoughts, includes moments during which the participants were influenced by thoughts they had immediately before or after seeing the image, which induced a specific response for them. Participant 7 described her use of the strategy:

> So I had to just let it hit me whether it was—going off of Participant 2—how it affected my breath or what I was thinking was the moment before or the moment after.

Participant 7 describes her Instant Reaction to the photo of lightning striking:

> It was the lightning. And I saw that as dabbing the air. I thought of light as *light*. But not only that, just the flash in the sky, and the dabbing the sky came to me right away.

Participant 7 recalls a moment when she Acted on Impulse during the interpretation process:

> It was easy for me to go off my impulse and whatever the image made me feel I just let it out without thinking or trying to judge it or analyze it.

Relying on Metaphor or Abstraction.

The final set of strategies used for interpreting the images involved Relying on Metaphor and Abstraction. This category included the following specific strategies:

- Referencing the Elements
- Metaphorical Interpretation

Participant 1 demonstrates how Referencing the Elements in a symbolic manner allowed her to interpret some of the images that were less obvious:

> The birthday cake, for some reason, seemed very stationary, even though fire dances, but I thought that maybe fire for some reason was a lot more Bound than wind or water or . . . earth. Earth could be more Bound, but the desert, that's moved by the wind. Right. But, I don't know if anyone else feels that fire is Bound. It's like it could be free, but stays rooted.

Participant 7 relates a Metaphorical Interpretation when describing her strategy for enacting an image of metal chains. She explains:

> I thought about somebody being in chains, and like dying or being freed from that, so there was a sense of rising that came from that.

4.2.2. **Conceptual Framework Development**

Following the identification of the primary categories that defined the strategies participants used when interpreting images during the enactment process, I returned to the transcripts and started looking at where strategies overlapped. It became clear that the strategies were not mutually exclusive. For example, during the Flow Effort investigation, Participant 7 describes her experience of interpretation:

> I found that my upper body was really Bound, but my legs were swinging—because my image was the rider on the bucking bronco—and his legs are relaxed, but he's still holding himself on an animal and his arms grabbing the reins, and waving his arm I felt like there was so much strength and tension in my sternum and my neck—that it was very interesting that I found both present in my body.

This quotes clearly describes a bodily experience (Letting the Body Lead) as well as an experience of imagining herself as the rider of the horse (Becoming the Subject of the Image). This intersection of strategies was not isolated to this example; it occurred frequently throughout the data. During another enactment, Participant 4 also describes the use of two strategies simultaneously. In this instance she describes Immersion Within the Image and Judging the Image. She relates:

> Whenever I see an image and if it speaks to me it's usually because I want to be a part of it or I don't want to be part of it. And with this [Effort] I wanted to be part of a lot of them or at least I could just feel myself experiencing the time that was in the image and that's where my mind went.

Another example of the use of multiple strategies can be seen in the interpretation of the birthday cake photo during the Flow Effort explorations:

> That's interesting because I instantly thought of breath when I looked at the birthday cake, and breathing, and blowing out the candles, because it's your birthday, and the flames don't stay on there for very long, it's like you light them and then blow them out.

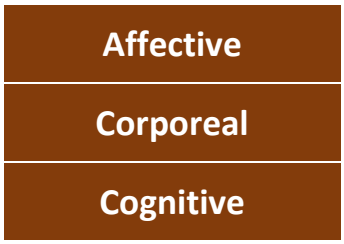
Here we can see the simultaneous use two strategies: Immersion within the Image and Letting the Body Lead.

I was troubled by this, as it seemed to imply that there was a deeper level at which interpretation was taking place for the participants. I returned to the strategies and attempted to identify characteristics that they had in common that might explain these overlaps. As I was doing this, I also considered the stages that the participants went through in the process of enactment. I noticed that I had been investigating the codes connected to two stages: both the process of Establishing a Connection With the Image and Assessing the Appropriate Effort Polarity. Because the strategies I had identified were applicable to both stages, I decided to explore temporal ways in which the strategies could be revised.

As I reconsidered the strategies, I realized that some strategies were more related to Stage 1: Establish a Connection with the Image, and some were more related to Stage 2: Assess the Appropriate Effort Polarity. For instance, in our previous example, Letting the Body Lead seemed to describe a physiological reaction that Participant 7 had immediately to the image, whereas Becoming the Subject of the Image was a later event that invoked her cognitive processes to assist in understanding the experience and analyzing it in the context of Flow Effort.

As I re-evaluated the list of strategies using this new lens, a new model began to emerge that used a two-dimensional, temporal relational model; accounted for all the cases; and maintained the separation of Stage 1 and Stage 2. In this new model, Stage 1 involved connecting with the image using one of three possible modes: Cognitive, Corporeal, or Affective. I refer to these as the *modes of connection*. The assessment of the Effort polarity that took place in Stage 2 was reduced to seven primary categories: Reaction, Analysis, Memory, Narrative, Immersion, Abstraction, and Transformation. I refer to these as the *mechanisms of interpretation*.

Figure 11: Modes of Connection



The modes of connection.

The modes of connection, Cognitive, Corporeal, and Affective function as labels that describe the primary aspect of experience of which a participant was aware of during the initial stage of meaning-making through enactment. From an embodied perspective, such a division is inconceivable as the three modes are integrated components of a unified process and any discussion of one would implicate the others (Clark, 1998; Antonio R. Damasio, 1995). However, from a human experience perspective, our awareness shifts constantly as we interact with the world, allowing for the prioritization of specific sensory and cognitive elements at any given time. The modes of connection reflect the three most commonly addressed elements of awareness by the participants in the workshop. Although the underlying interactions between these aspects of awareness are complex, the modes facilitate a simplified pragmatic separation that allows for the clear articulation of the phenomenon observed.

Affective.

When participants connected to the images in the photographs using an Affective mode of connection, they described having an initial response that was associated with a feeling, emotionally laden memory, or emotive reaction.

Participant 7 describes her experience of using an Affective mode of connection during the Flow Effort exploration. She explains, “It was easy for me to go off my impulse, and whatever the image made me feel, I just let it out without thinking or trying to judge it or analyze it.”

Participant 5 relates her experience of Affective connection during the Time Effort exploration. She notes, “I could connect to the people because I have done those actions or I could imagine what they were feeling and that's where I made a lot of conclusions from.”

Participant 4 also describes her Affective connection during the Time Effort exploration:

> I think for me it kind of became, if I was in that situation what would I be experiencing and what kind of time I would be in—like the one with the mother and child—it just felt like it would be a long sustained moment, something I wouldn't want to let go of.

Corporeal.

When participants described connecting to the images using the Corporeal mode of connection, they recalled having an initial physiological reaction to the content of the photographs. For example, these reactions were sometimes visceral, kinesthetic, or vascular in nature.

Participant 8 describes her Corporeal connection during the Flow exploration:

> I felt like I was feeling the texture of the pictures in my movement. It allowed me to kind of get deeper with my movement actually doing that.

Participant 7 also describes how her muscles responded immediately to one of the images:

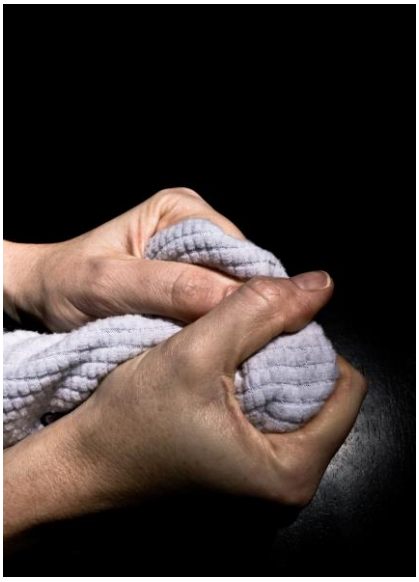
> My image was the rider on the bucking bronco—and his legs are relaxed, but he's still holding himself on an animal and his arms grabbing the reins, and waving his arm I felt like there was so much strength and tension in my sternum and my neck.

Cognitive.

When participants connected to the content of the photographs using a Cognitive mode of connection, they described analytic, distanced, or rational responses as their initial experiences.

An example of connecting using a Cognitive mode of connection was given by Participant 5:

> The first image, the hand wringing the dishcloth, to me that's not a very expressive movement in itself, so *I made the choice not to do that*, to me that was more of an environment of relaxation of calm, and routine, but I know I made the choice with the snake to become the snake. Or with the cheetah, to become the cheetah. [emphasis added]



Her account articulates the process of making a contemplated decision as the first step in her enactment of the image of the wrung dishcloth. She also recounts a similar decision-making process for the cheetah and snake.

Participant 5 describes a similar Cognitive connection when exploring the Weight Effort during the sorting exercise:

> That's how I felt when I was first sorting it by myself. And I felt like that was a real challenge for me. I saw less interpretation in them and saw more right and wrong answers.

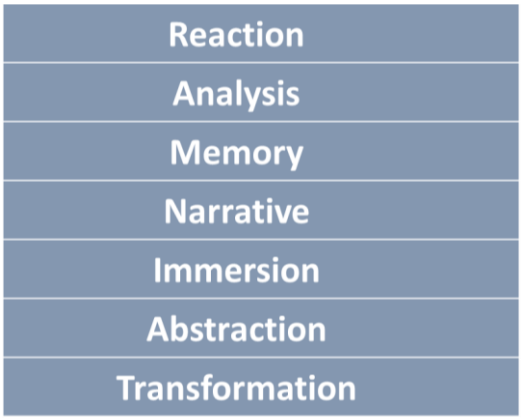
Again, she describes completing a rational assessment of the imagery as her first step in the process of enactment.

Mechanisms of interpretation.

The second dimension in the model temporally follows the process of connecting to the photographs using one of the modes of access. This dimension describes the primary method through which a participant interpreted the polarity and intensity of the Effort under investigation. The process of interpreting the Effort in each of the images builds upon the mode of connection but also requires a strategy that allows for the translation from a visual mode of representation to a bodily one.

Seven mechanisms of interpretation were identified based on the transcript data. They are Reaction, Analysis, Memory, Narrative, Immersion, Abstraction, and Transformation (Figure 12). They are elaborated individually below.

Figure 12: Mechanisms of Interpretation



Reaction.

When Reaction was the mechanism of interpretation, the participant determined the polarity of the Effort under investigation by responding to an immediate or almost immediate response to the images. The mode of connection used by the participant

determined the nature of the response. For example, when discussing the challenge of identifying the polarity of images during the Time exercise, Participant 7 said:

> I felt for me that really was very present and I had to make my choices based on my first impulse because if I sat with a photo too long—like I was speaking to Participant 5 about—that I would start to think too hard about all the presence of both and so I had to just let it hit me whether it was—going off of Participant 2—how it affected my breath.

Participant 7's focus on her immediate response to the image through her breath indicates a Corporeal mode of connection and Reaction as the mechanism of interpretation.

In another instance, Participant 7 relates her experience of using an Affective mode of connection with Reaction as the mechanism of interpretation:

> One of the pictures that said "road closed," I instantly thought of open road even though the sign said "road closed," and I look behind it and it's just this vast desert. Yeah! And I found that so freeing. That I could feel whatever I wanted and it was interesting.

During the Space Effort exploration, Participant 5 described an experience in which she used an Affective mode of connection with Reaction as the mechanism of interpretation. She also described having a feeling of freedom accompanied by a positive emotional response:

> I felt like all my impulses were informed by a—I don't even know what—just a sense of impulse and I really enjoyed that freedom. I don't why I made

> a lot of the choices I did but I never really felt stuck in any image, which was really nice.

Analysis.

Analysis was used as the mechanism of interpretation in cases in which the assessment of the Effort polarity was arrived at through conscious decision making, logical deduction, or similar means.

Participant 1 describes her experience during the Flow Effort exploration when she had a Cognitive mode of connection with Analysis as the mechanism of interpretation:

> I just wanted to extend that to the elements. Because when I thought about the jack-o-lantern and I was like, “it’s encased,” but the birthday cake, for some reason, seemed very stationary, even though fire dances; but I thought that maybe fire for some reason was a lot more Bound than wind or water or . . . earth. Earth could be more Bound, but the desert, that's moved by the wind. Right. But, I don't know if anyone else feels that fire is Bound. It's like it could be Free, but stays rooted.



Participant 1’s complex thought process illustrates the analytical nature of her experience of interpreting the Effort polarity.

Memory.

Memory was used as a mechanism of interpretation when participants described recalling personal experiences from their own lives in order to interpret images.

During the quick enactment exercises that explored the Time Effort factor, Participant 5 described using an Affective mode of connection with Memory as the mechanism of interaction. She described her process of interpreting the images by relating

them to her own experiences, explaining: “I could connect to the people because I have done those actions, or I could imagine what they were feeling, and that's where I made a lot of conclusions from.”

Similarly, during the Flow exercises, Participant 2 described how her own experiences assisted her in the sorting process. In this example, she relied on a Corporeal mode of connection with Memory as the mechanism of interaction. She explains:

> I found that I was immediately able to divide them into the ones that I had personally experienced, so if there was a landscape that I was like “I know how that feels,” then I can put it here or I can put it there, but the ones that I was like, “I don't really know what that's like,” or “I don't really know what that means to me,” it was interesting the process of looking at it and, uh, trying to get a sense of what it might be, and that was more difficult. And so the easier ones were the ones that I felt relationally more connected to, if that makes sense. So it was like drawing on the past.

Here, Participant 2 notes that she was able to connect not just to people, but also to environments that she had previously experienced. She also explicitly notes that she was drawing on her own past experiences.

Narrative.

When participants used Narrative as a mechanism of interpretation, they created stories about the images they were viewing and used the contents of the story to assess how they would enact them through movement. In this example, Participant 5 connected Affectively to the photograph, using Narrative as the mechanism of interpretation. She demonstrated people’s amazing capacity to construct narratives from images. She explained:

> So for my Sudden Time I chose the family photo—of the family all standing there completely still—which I noticed other people had categorized as Sustained and to me that photo was very Sudden because I imagined all the chaos that it took to get eight people all standing there, all facing one direction, and there was kids and I could imagine them running around and everyone's yelling like, “Gran take the photo,” like, “No one is here,” and Participant 7 was even saying in the photo you can see the some of the expressions, like, “I can't make dinner after this why is it taking so long?”

Participant 5 constructs a detailed narrative to provide a perspective from which to interpret the image. Her account includes specific characters with unique personalities as well as imagined dialogue.

Participant 4 describes a less detailed experience of constructing a narrative based on the characters in an image and using that as a way of assessing the Effort polarity. Like Participant 5, she also relied on an Affective mode of connection. She explains:

> I think for me it kind of became if I was in that situation [what] would I be experiencing and what kind of time I would be in? Like the one with the mother and child—it just felt like it would be a long Sustained moment, something I wouldn't want to let go—and then there were other ones, especially I think it was sport, I just feel like the time would have been flying past—so that`s kind of what I was trying to express with my body.

Participant 4's narratives are more experiential than Participant 5's and help inform her about the quality of Time in each image.

Immersion.

Participants who used Immersion as a mechanism of connection transitioned from having an observational point of view to imagining themselves entering into the world depicted in a photograph. In this example, Participant 5 used Affective as the mode of connection and Immersion as the mechanism of interaction. She describes experiencing various environmental images as if she were in them herself:

> I found myself in the environment in a lot of pictures, and I thought there were some that were more environmental to me and that was the mood and the feeling and that was how I would be in that environment.

Participant 4 similarly described how she immersed herself in the photographs by taking on the role of one of the subjects. Like Participant 5, she also used an Affective mode of connection. She recalls:

> I think I kind of either typically became the subject of the image or something else that was part of the environment that the image was because that was the way I got into the photo was my connection with the person or the object or the action that I saw.

Abstraction.

Participants who used Abstraction as a mechanism of interpretation used various approaches to interpreting the contents of images by considering them in very symbolic or metaphorical ways. For example, Participant 4 describes focusing on the energy in a photograph during the Space investigation. She used a Cognitive mode of connection with Abstraction as the mechanism of interpretation:

> I think I was trying to pick up the energy in the picture and either where that person was directing that energy or if it was a landscape where that energy was going and that was how I tried to define if it was Indirect or Direct—if the energy was directed somewhere or if the energy was just filling the world and the space whichever way it wanted to.

Participant 4's emphasis on the abstract concept of energy allowed her to consider the photographs from a spatial perspective, assisting her in the interpretation of the Effort polarity.

Other participants described using abstraction as a way to connect emotionally with an image. Participant 7 explained:

> But with other things it was more like the painting. . . . I was responding to what the brushstrokes made me feel emotionally.

Here, Participant 7 describes using abstraction as a way to connect to her emotions to interpret and respond to an image.

Transformation.

When participants relied on Transformation as the mechanism of interpretation, they describe becoming the subject or one of the objects in an image. The participant's interpretation of the Effort polarity was assessed based on this foreign perspective. Participant 7 describes having a transformative experience during the Flow explorations. In her case, she used a Corporeal mode of connection with Transformation as the mechanism of interpretation. She recalls, "There were certain things like the snake where I felt I was the snake."

Participant 5 also described her experience of transforming into the subject of a photograph during the Time explorations. She explains,

> I imagined I was the dewdrop—I think we commented yesterday some of us were—you either were the item or you were in the environment kind of

responding, and with all these images I was the person or I was the dewdrop.

Participant 5 clearly differentiates her transformative experience in reaction to the dewdrop photograph from the observational perspective that she assumed towards other photographs.

4.2.3. Assessing the Trustworthiness of the Analysis

Prior to conducting further analysis of the data, the framework developed through analysis of the workshop transcripts was presented to four certified LMA experts to conduct an audit trail (Creswell & Miller, 2000). The audit trail consisted of a presentation of the coding process that detailed the various decisions and inferences that were made as well as the process of category development and theory generation. During the audit, one of the experts commented on the large number of transcript segments that had been coded with the Cognitive tag, noting that some appeared to reference difficulties resulting from over-analysis while others related directly to the use of a Cognitive mode of connection during the enactment process. These segments were later reviewed in a separate session, and it was discovered that the Cognitive code contained historical references from early coding activity that had been retained within this category. To clarify the assessment process, we also discussed the criteria for assigning all of the modes of

connection. Following this, I returned to the segments coded with Cognitive, Corporeal, or Affective and recoded them to ensure that they met the agreed-upon criteria. This resulted primarily in a reduction of Cognitive codes for segments that addressed difficulties that participants experienced but that were not directly connected to the enactment process. (These segments were re-coded for inclusion in other types of analysis.) There were also segments that had the Corporeal code added to them. The final coded segments were isolated and discussed in another meeting with the one LMA expert, at which time there was agreement on a majority of the codes and the remainder of the analysis was conducted. This analysis examined various other codes to identify factors that were relevant to my specific researcher questions. These are discussed in detail in the next chapter.

4.2.4. **Delimitations**

The study was intentionally delimited to focus only on the four LMA Effort factors. Although most movement consists of varying levels of all the Efforts, they were addressed separately in order to study their contribution to embodied experience individually.

Another factor that delimited my study was the use of participants who were all skilled movement practitioners. This was done to utilize people who would be most capable of experiencing, reflecting on, and discussing their somatic experiences. However, they are not representative of the average users of technology, and as such the results would less applicable to the general population. This was not a concern since my study was qualitative and exploratory in nature.

Finally, my study was delimited in scope. As already mentioned, the results of the research did not include the implementation of a working application of kinesthetic tagging, rather I generated hypotheses and design considerations to guide future development.

4.2.5. **Limitations.**

My research had several limitations that need to be addressed. First, due to the nature of qualitative studies there is always the possibility for personal bias to affect the

findings. Although steps were taken to ensure that this was not occurring, such as the use of expert validation, it is impossible to fully eliminate all bias.

Another limitation was the use of self-reporting by the participants. Although the workshop discussions were held immediately after the activities, participants were still required to recall, process, and articulate their experiences after the fact. It has been shown that under such conditions research participants are unreliable witnesses. Measures were taken to alleviate this phenomenon as much as possible, including the use of Flip Cameras to allow participants to record their thoughts during the movement activities.

My small sample size and make-up were also limiting factors. The use of only nine participants made my results less generalizable, however as noted earlier, this was not a concern due to the exploratory nature of the study. The use of all female participants and their limited age ranges also affected the generalizability of the findings.

Finally, the time constraints that were imposed on the workshop affected the ability of the participants to fully integrate the nuances of the LMA Effort framework, and limited the time for exploration and discussion.

Chapter 5. Analysis

The framework presented in the previous chapter facilitated the further analysis of the transcripts to investigate numerous factors relating to kinesthetic tagging. In this chapter I present these data and extrapolate them to discuss their relevance to understanding the relationship between movement and embodied experience. I also discuss the relevance of the findings to the design of movement-based interactive systems. These analyses were completed using the analytical functions built into MAXQDA to identify the frequency of specific code use, and the intersection of various codes within a specific segment of the transcript.

Due to the exploratory and qualitative nature of this study and the small sample size, the goal of these analyses were not to generalize the findings to a larger population. Rather, the objective was to identify pertinent themes and from these to generate hypotheses regarding the factors that inform the process of enacting images through movement. The use of qualitative studies for this purpose is described by Carl F. Auerbach and Louise B. Silverstein in *Qualitative Data: An Introduction to Coding and Analysis* (Carl F. Auerbach & Louise B. Silverstein, 2003). The hypotheses generated through this research will be used to direct future qualitative studies and, eventually, technology design research using quantitative methods.

5.1. Embodied Experience Research Questions

This section addresses factors relating to the role of embodied experience in the enactment process. It covers the strategies used by participants during the process of interpretation, the positive and negative factors that influenced the enactment process, the connection between image features and Effort polarities, and the difficulties that participants experienced while performing the workshop exercises.

5.1.1. Strategies used for interpretation.

1A: How do people determine which qualities of movement to use when enacting an image?

This question was addressed primarily by looking at the strategies used by the participants to interpret the Effort polarity in an image.

Enactment Strategies

Throughout the workshop, participants described numerous strategies that were used during their process of enacting images. There were five primary categories into which these strategies fell:

- Immediate Response/Reaction
- Letting Emotion Lead
- Letting the Body Lead
- Letting the Image Lead
- Relying on Metaphor and Abstraction

These high-level categories were identified based on the specific strategies participants described during the workshop discussions. Table 17 presents all the strategies used by participants. The Strategy Category provides a general description of a group of similar strategies. The Strategy Type provides a summary of the key strategies in each category. And the Individual Strategy describes a particular use by a participant within the workshop. These categories formed the foundation for the development of the framework presented in the previous chapter.

Table 17: Strategies Used by Participants to Interpret Effort Dimensions in Images

Strategy Category	Strategy Type	Individual Strategy
Relying on Metaphor and Abstraction		
	Referencing the Elements	
	Metaphor/Abstraction	
Immediate Response/Reaction		
	As if Seeing Them for the First Time	
		Letting the Image "Wash Over" Me
	Adjacent Thoughts (before or after seeing image)	
	Instant Reaction	
	Acting on Impulse	
Letting the Body Lead		

	Internalizing the Experience	
	Internalization of Efforts	
	Focus on Breath/Breathing	
	Bodily Awareness	
		Bodily or Sensory Reaction
Letting Emotion Lead		
	Personal Connection With the Image	
		Connecting With the Action in an Image
		Connecting With Subject of Image
		Connecting With People in Images
		Connecting to Animals in Images
		Connecting to Prior Experience
		Associations With Image
		Connecting to a Personal Experience
		Empathy With Subject of Image
	Emotional Interpretation	
		Effort Classification Based on Liking or Disliking Image
		Connecting Emotion With Effort
		Responding Emotionally to the Brushstrokes
		Reacting to Images
		Judging the Image
Letting the Image Lead		
	Compositional Approach	
		Counting the Number of Objects
	Analytical Interpretation	
		Commenting on the Image
		Literal Interpretation
		Analytical/Distanced Interpretation
		Observing the Image
	Imagined Interaction	
		Reflecting on how Image Subject Transformed the Space
		Imagining Ways to Interact With Object
	Creating a Narrative	
		Image Potential (considering what could happen next)
		Cause and Effect
		Imagining a Scenario
	Immersion Within the Image	
		Entering the Image

		Being Watched by Someone on the Outside
		Insertion Into the Image
		Following a Path/Moving Instinctively
	Becoming the Image/Part of the Image	
		Being the Image
		Imagining Becoming the Object
		Becoming the Image
		Becoming the Subject of an Image
		Becoming the Surroundings in an Image
	Embodying the Image	
	Focus on Energy in the Image	
		Directed Energy
		Energy Filling the World

Relation to user experience.

The strategies presented in Table 17 represent the primary methods that people used to connect to and interpret images during the enactment process. These strategies provide insight into the process of mapping from the visual domain onto the kinesthetic/body domain and give insight into the factors underlying the experience of the user. These strategies can be also be considered in the context of McCarthy and Wright's four threads of experience: *Sensual*, *Emotional*, *Compositional* and *Spatio-Temporal* (McCarthy & Wright, 2004). The sensual thread corresponds to those elements of experience that comprise the physicality of interaction and involve the senses and the body. *Sensual* experiences would incorporate strategies such as those in the category *Letting the Body Lead.* These include:

- Internalizing the Experience
- Internalization of Efforts
- Focus on Breath/Breathing
- Bodily Awareness

Emotional experiences would incorporate strategies such as those in the category *Letting Emotion Lead.* These include:

- Personal Connection with the Image

- Emotional Interpretation
- Connecting With Subject of Image
- Connecting With People in Images
- Connecting to Animals in Images
- Connecting to Prior Experience
- Connecting to a Personal Experience
- Empathy with Subject of Image

Compositional experiences are those that affect the narrative structure of the interaction and would utilize strategies such as those defined in the category *Letting the Image Lead.* These include:

- Compositional Approach
- Imagined Interaction
- Creating a Narrative
- Embodying the Image

Spatio-Temporal experiences are defined as those that affect a user's sense of pacing and boundaries. Users would exploit strategies such as:

- Reflecting on how Image Subject Transformed the Space
- Immersion within the Image
- Becoming the Image/Part of the Image

These alignments provide insight into the processes underlying the experiential threads posited by McCarthy and Wright and can be used as tools for designing interactions that incorporate specific strategies to influence the various threads of experience.

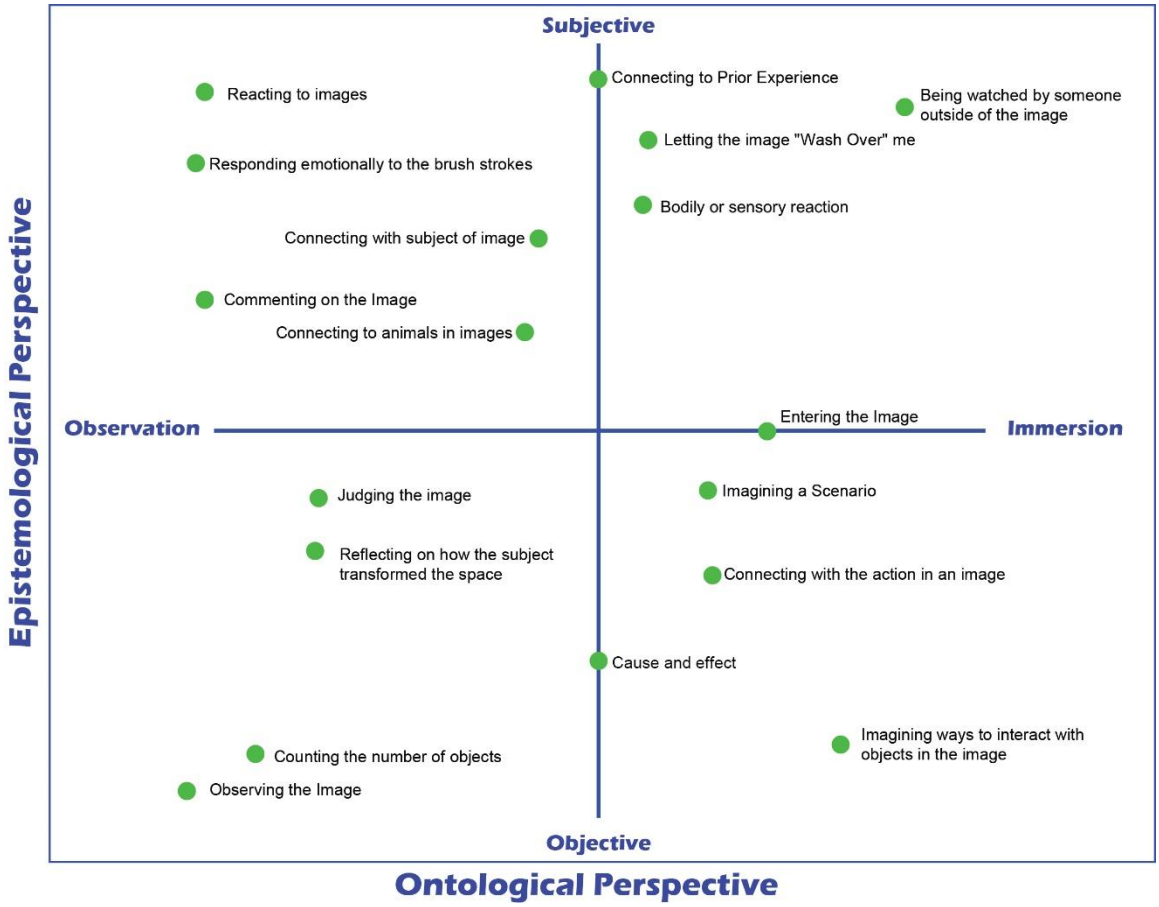
Epistemological and ontological perspective.

I continued my analysis by mapping the strategies using a two-dimensional grid with the X-axis representing a participant's *primary ontological perspective* when interpreting the image (from *3rd person* to *1st person*), and the Y-axis representing the participant's *epistemological perspective* (from *subjective* to *objective*). Figure 13 shows

several of the strategy codes that were used during the analysis of the transcripts plotted in this manner.

This approach to exploring the relationships between strategies highlights the

Figure 13: Classification of Strategies Based on Ontological and Epistemological Perspective



Although this approach to classification is useful for summarizing the various strategies used by the participants and assisted in the conceptualization of the more complex framework, it is a very high-level view that does not take into account the temporal aspects that inform the process of interpreting and enacting imagery. The modes of connection and mechanisms of interpretation are needed for a more complete understanding of the process.

Classification strategies.

Image feature–Effort correlations.

1C: In what ways do image features affect the quality of a person's movements in the image enactment process?

In order to better understand the connection between the features present in an image and the way in which the image was interpreted and enacted by the participants, the image features mentioned in the workshop transcripts were coded and labeled either *concrete* or *inferred*. Concrete image features were features that were visually present in the image (e.g., car, person, blue, large, etc.). Inferred image features were features that were not explicitly depicted in the image and were extrapolated by the participants (e.g., frightening, happy, laughter, wind, etc.). These data were analyzed using MAXQDA's Code Relations Browser to identify when participants mentioned them in the context of an Effort factor. Table 19 and Table 21 show the outcomes of this analysis for both concrete and inferred image features, respectively. The strongest alignments are summarized in Table 18: *Concrete Features* and Table 20: *Inferred Features*.

To better understand how kinesthetic tagging compares with other tagging system I considered these image features in relation to Eakins and Graham's framework (Figure 4) for feature classification. Their framework utilizes three levels: primitive features (syntactic), logical features (semantic), and human constructs. In this framework, primitive features (Level 1) include features such as the color, shape, texture, and spatial location of objects. Level 2 includes derived features comprised of identifiable objects. Level 3 is comprised of features with abstract attributes such as emotions, actions, and human constructs (Eakins et al., 1999).

There were no examples of Level 1 features associated with specific Effort factors. Level 2 features aligned with the concrete image features (Table 18) that had been identified, and the abstract attribute features (Table 20) aligned with the inferred image features.

Table 18: Correlations between Effort Factors and Concrete Image Features

Effort	Primary Features	Secondary Features
Flow	Natural Objects	Natural Landscapes Action Man-Made Objects
Weight	Natural Objects	Action People Man-Made Objects Natural Landscapes
Time	People	Sports Action
Space	Urban Landscapes	

Table 19: Frequency of Occurrence of Concrete Image Features with Effort Factors

Feature Type	Concrete Image Features	Flow	Weight	Time	Space
Derived	Animals	5	4	2	1
Derived	People	5	6	19	4
Derived	Sports	0	0	11	0
Derived	Police/Military	0	3	0	3
Derived	Natural Landscapes	13	6	4	3
Derived	Urban Landscapes	1	0	0	7
Derived	Natural Objects	32	16	1	4
Derived	Man-Made Objects	10	6	0	1
Derived	Action	12	7	9	2
Derived	Faces/Expressions	0	0	4	2

Table 20: Correlations Between Effort Factors and Inferred Image Features Based on Eakins and Graham's Framework

Effort	Emotions	Human Constructs
Flow	Emotion Darkness/Negativity Angst Tension Calm/Relaxation	Breath Freedom Time Cold
Weight	Tension	Light (Weight) Freedom Movement Gravity Strength Power/Powerful Death
Time	Emotion	Time Stillness Chaos Disorganization Thoughts (of subjects in photos)
Space	Calm/Relaxation	Transformation Movement Strength Constant Awareness Light (Weight) Compressed Space

Table 21: Frequency of Occurrence of Inferred Image Features with Effort Factors

Feature Type	Feature	Flow	Weight	Time	Space
Abstract: Action	Transformation	0	0	0	1
Abstract: Action	Movement	1	5	0	1
Abstract: Construct	Compressed Space	0	0	0	1
Abstract: Construct	Constant Awareness	0	0	0	1
Abstract: Construct	Thoughts (of subjects)	0	0	2	0
Abstract: Construct	Stillness	0	0	1	0
Abstract: Construct	Light	0	3	0	1
Abstract: Construct	Death	0	2	0	0
Abstract: Construct	Air	1	0	0	0
Abstract: Construct	Encased	0	0	0	0
Abstract: Construct	Cold	1	0	0	0
Abstract: Construct	Freedom	1	2	0	0
Abstract: Construct	Wind	2	0	0	0
Abstract: Construct	Time	2	0	8	0
Abstract: Construct	Breath	1	0	0	0
Abstract: Construct	Gravity	0	3	0	0
Abstract: Construct	Strength	0	1	0	1
Abstract: Construct	Power/Powerful	0	1	0	0
Abstract: Construct	Disorganization	0	0	2	0
Abstract: Construct	Chaos	0	0	4	0
Abstract: Construct	Consuming vs. Expansive	1	0	0	0
Abstract: Emotion	Darkness/ Negativity	1	0	0	0
Abstract: Emotion	Angst	1	0	0	0
Abstract: Emotion	Calm/ Relaxation	1	0	0	1
Abstract: Emotion	Emotion	4	0	1	0
Abstract: Emotion	Tension	1	2	0	0

The findings show that Flow Effort was most often used to represent natural objects and emotions. This alignment is expected because natural objects often have smooth organic

features that are easily conveyed through movements emphasizing Free Flow. The emotional features also are expected because Free Flow is often experienced as joyful or liberating, while Bound Flow induces tension and constriction.

Weight Effort was used in a similar manner for concrete features but did not have the same level of association with emotional states. In terms of natural objects, Weight Effort was often used by participants to enact images depicting flowers or balancing rocks, which were seen as having strong correlations with Light Weight. In terms of abstract attributes, Weight Effort was associated with the effects of gravity as well as the concept of power or strength. The connection of Weight with metaphors for degrees of power or strength supports Lakoff and Johnson's concept of embodied schemata, which posits that humans develop the concepts of *more* and *less* from their experience of gravity and the association with *up* and *down* (George Lakoff & Johnson, 1980). This provides further evidence to support the work on using image schema for the design of tangible and movement-based interaction that has been done in HCI (Alissa N. Antle, Corness, & Droumeva, 2009; Bakker, Antle, & van den Hoven, 2011; Macaranas et al., 2012), and demonstrates how LMA Effort factors can be utilized to further inform movement selection.

Figure 14: Mother and Baby Image from Workshop Quick Enactment Exercise

Time Effort was most often associated with concrete imagery of people. Again, this is expected, as time is primarily measured in terms of human action, whether as objective time (e.g., time to complete a task or make a decision) or subjective time (e.g., periods of connection with others as depicted in Figure 14 In terms of abstract attributes, Time was aligned with constructs such as stillness, chaos, and thinking, which are all dependent on the passage of time.

Space Effort was often used to represent urban landscapes, with their contradictory characteristics of both constriction and expansion. In terms of abstract attributes, Space was identified with the emotional state of calmness and the constructs of transformation, movement, and weight. The association of Space Effort with movement is clear because in LMA, Space is associated with attention and Direct Space often expedites movement in the direction someone is looking. It is less clear from the data why Space was associated with transformation and weight; however, based on observations made during the workshop and my own personal experience, movement through Space

often provides a catalyst for transformation. For example, imagine yourself squatting on the floor, your arms wrapped around your legs, your body contracted into a ball. As you move from this position towards a distant point in space, it becomes necessary to unfurl and rise up, transforming into a being with Light Weight. The very act of movement provides opportunities for these transformations of our bodies and shifts in our experience of Weight.

Visual sorting strategies.

Another interesting observation was that participants showed strong individual preferences for particular arrangements of their photos when organizing them based on Effort polarity. This may have application in the design of the interface for a kinesthetic tagging application. Some of the prominent layouts from the workshop included radial (Figure 15), linear (Figure 16), cluster (Figure 17) and radial cluster (Figure 18).

Figure 15: Radial Layout

Figure 16: Linear Layout

Figure 17: Cluster Layout

Figure 18: Radial Cluster Layout

Relevance to HCI

The association of the LMA Effort factors with specific image features suggests that particular aspects of somatic awareness (which are experienced as qualities of movement) can be used to support Content-Based Image Retrieval (CBIR) techniques as described in Section 2.5.3. Text-based approaches to image-retrieval are confounded by the misalignment of perceptual and conceptual classifications resulting in the semantic gap (Smeulders et al., 2000). This research suggests that kinesthetic tags in the form of LMA Effort factors are capable of providing supplemental meaning to aid in the overcoming of the semantic gap. For example, if a computer algorithm identified a strong LMA Weight Effort in an image, it may be possible to infer conceptual associations with movement, light, death, freedom, gravity, and tension. Additional research will be required to develop, collect, and validate the appropriate kinesthetic metadata and conceptual associations for specific image types.

5.1.2. Factors influencing the enactment process.

1D: What factors influence a person's process of enacting images through movement?

The factors influencing the enactment of imagery were extrapolated from the coded transcript using the previously generated category *Factors Influencing Interpretation and Movement Creation.* Again, this was facilitated using MAXQDA's Code Query functions. The identified factors were then divided into two groups: *factors influencing interpretation* and *difficulties encountered*.

Factors influencing interpretation.

The factors influencing interpretation were divided into positive and negative factors. Table 22 and Table 23 present the relevant codes identified from the workshop discussions.

Table 22: Positive Factors Influencing Interpretation

1	Committing to your intention
2	Easy classification due to duality of Effort polarities
3	Being present in the process
4	Absence of judgment or analysis
5	Strong awareness of difference between Effort polarities
6	Straightforward interpretation
7	Feeling free to make a decision
8	Open to interpretation
9	Automatically accessing prior knowledge/tools
10	Relying on other performance tools
11	Clear awareness of difference between Effort polarities

Table 23: Negative Factors Influencing Interpretation

1	Fear of commitment to an interpretation
2	Habitual tendencies
3	Repetition of the familiar
4	Fear of trying something you don't like
5	Being tired
6	Sitting too long with photos

7	Desire to impress/be a good student
8	Familiarity with the images (over duration of workshop)
9	Preconceived notions

Challenges.

In addition to the positive and negative factors that influenced the enactment process, there were also a number of specific difficulties identified by the participants. These fell into several categories:

- Confusion With Instructions
- Difficulty With Weight Effort
- Contradictions
- Awareness of Personal Limitations/Preferences
- Difficulty With the Medium
- Conceptual Difficulties
- Sensory/Perceptual Difficulties
- Self-Judgment/Difficulty Trusting Intuition

Table 24 lists the specific difficulties identified during the workshop discussions.

Table 24: Difficulties Encountered During Enactment Process

Difficulty Category	Specific References
Confusion With Instructions	
Contradictions	
	Effort in Photo Transforms During Movement Creation
	Co-Existence of Effort Polarities in Movement
	Contradictory Image Interpretations
	Contradictory Effort Elements
	Inconsistent Application of Rules During Sorting
	Co-existence of Effort Polarities in Image
	Participant Contradicts Earlier Statements
	Contradictions Between What Is Seen and What Is Felt
	Unaware of Personal Processes
Difficulty With the Medium	
	Difficulty With Purely Visual Aspects of Medium
	Getting Stuck Experiencing the Photo
	Dealing With Time in Still Images
	Difficulty Overcoming Realism of the Images
	Not Liking the Imagery
	Difficulty With the Photographic Medium
Conceptual Difficulties	
	Difficulty Understanding Efforts
	Difficulty With LMA Concepts or Terminology

	Difficulty Overcoming Vernacular Use of Terminology
	Difficulty With Weight Effort
Difficulty Interpreting Images	
	Inability to Identify Source of Response to Image
	Resistance to Interpretation
	Multiple Interpretations of Effort Quality in Image
	Difficulty Interpreting Effort Polarity
	Contradictory Interpretation
Difficulty Sorting	
	Not Enough Time To Sort
	Limited Awareness of Options
Sensory/Perceptual Difficulties	
	Awareness of Limits of Perception
Self-Judgment/Difficulty Trusting Intuition	
	Unsure of Choices
	Concern About Doing it Wrong
	Feeling Inauthentic
	Sense of Limited Options for Interpretation
	Feeling Boxed In
	Difficulty Seeing From Within
	Sense of Having no Control Over how Brain Interprets Images
	Comparison With Others' Interpretations
	Desire To Be Creative
	Expectations
	Feeling of Right and Wrong Interpretation
	Self-Judgment/Doing it Wrong
	Stereotypical or Obvious Response/Interpretation
	Delayed Response/Reaction
	Analytical Voice/Inner Dialogue (Overthinking)

Some of the difficulties described by participants were specifically related to the workshop structure and activities and are not relevant to a greater understanding of the underlying process of enacting imagery through movement. This includes the category *Difficulty with Instructions.* The remaining relevant categories are discussed below.

Contradictions.

Participants described numerous difficulties that they encountered during the workshop because of various contradictions. These difficulties were broken down into the following types:

1. Effort in Photo Transforms During Movement Creation
2. Co-Existence of Effort Polarities in Movement

3. Contradictory Image Interpretations
4. Contradictory Effort Elements
5. Inconsistent Application of Rules During Sorting
6. Co-Existence of Effort Polarities in Image
7. Participant Contradicts Earlier Statements
8. Contradictions Between What Is Seen and What Is Felt

The first type of difficulty*, Effort in Photo Transforms During Movement Creation*, participants experienced contradictory interpretations of the Effort factors in an image due assessments made using different aspects of their intelligence. Generally these contradictions occurred during the sorting exercises when a participant would assess the image without performing movement, and therefore without activating their kinesthetic intelligence. These initial assessments would often conflict with the interpretation experienced during the process of creating and performing movement sequences. This particular difficulty illustrates the challenge of investigating movement without directly engaging the body. Participant 1 describes an instance during the Flow exercises in which she experienced this type of difficulty. She explains, “I experienced that as well. The picture of the ocean slamming against the cliff. And I thought the ocean is very free and when I got up to do it and hitting like that, that was the stop, the Bound.” Participant 1’s difficulty came from interpreting the image using two different forms of intelligence. Her kinesthetic intelligence responded strongly to the Bound energy of the water colliding with the cliff even though her analytical intelligence had interpreted the image as Free Flow.

This category also included the experience of creating movement that incorporated movements from both Effort polarities (e.g., Bound and Free Flow). This specific difficulty, the Co-Existence of Effort Polarities in Movement*,* occurred after participants interpreted an image and assessed the appropriate Effort polarity only to find that their instincts for movement included elements of both polarities. Participant 7 described her experience of this difficulty:

> I found it really showed up a lot for me that I would be Bound in my legs and Free—like, my lower body half would be really Bound—because I would be walking or I need to have tension in my muscles to move. But then I would find freedom in my arms, and even with my Bound image I found that my upper body was really Bound, but my legs were swinging—because my image was the rider on the bucking bronco—and his legs are

> relaxed, but he's still holding himself on an animal and his arms grabbing the reins, and waving his arm I felt like there was so much strength and tension in my sternum and my neck. That it was very interesting that I found both present in my body.

This difficulty highlights the flexible nature of interpretation as well as the difficulty of producing movement that encompasses only a single Effort pole. This poses potential problems for using movement for tagging, as it would require a an algorithm for Effort detection to take into account not just the presence of an Effort pole but also the comparative use of both poles and possibly other more complex analytical tools.

Difficulty with the medium.

The next difficulty category, Difficulty with the Medium, addressed problems that the participants experienced that were specifically related to the use of the photographic medium in the workshop. This category is significant because it sheds some light on the overall problems of enacting imagery. The category included the following types of difficulties:

1. Difficulty With Purely Visual Aspects of Medium
2. Getting Stuck Experiencing the Photo
3. Dealing With Time in Still Images
4. Difficulty Overcoming Realism of the Images
5. Not Liking the Imagery
6. Difficulty With the Photographic Medium

Participant 5 expressed her problems with the photographic medium during the Time Effort exploration. She explained:

> Participant 7 and I were talking and we were saying what a challenging medium photography is to discuss Time because it seems like photography is orientated all around time and the capturing of one moment and distilling it in a way so that it is captive—there's like time-lapse photography—it's just such an element of photography—we agreed that it was challenging for us to get past the medium and look at the situation.

Her comments reflect the strong association of the Time Effort with images of actions being performed or photos of people. These subjects naturally align with the Time Effort because they emphasize the moment over time and the subjective sense of time (e.g., a

person crying over a loss, a mother and daughter playing together, etc.). Participant 2 expressed a similar sentiment about interpreting Time Effort:

> The idea of like thinking about what was happening before or after came up a lot for me and for the ones that were specifically humans or animals moving through space and so I had to be, like, "No, just my first impulse, just go with that," because for one or two of the first movement-based ones I was really stuck on, like—okay well this is just—this is in between two moments how do I know what that moment is if it's something made it happen then something is going to happen after and maybe what happened before was Sustained, and what happens after is Sudden—so that was—I had to let that go.

Another difficulty that arose was related to the realism of the photographs. Participant 5 explained:

> Maybe it's just harder to find a movement within. . . . We had so many different interpretations of that one log with the movement of the water, the actual object, and then the photographer—but here if you see a little flower you know that flower is light so it's a lot harder to find the different variations. There's not a lot to go from. I guess you could think of the roots of the flower, but that wasn't shown.

Participant 5's difficulty with feeling that she had too many options might have been caused by a misunderstanding of the instructions, which caused her to interpret the images literally. Regardless, her initial instinct was to assess the photos as realistically as possible. Had the images been more abstract, she likely would have not felt the same constraints.

Conceptual Difficulties.

The next category, Conceptual Difficulties, highlighted some of the issues the participants had as relative newcomers to LMA theory. This covered challenges relating to the Efforts themselves and larger LMA concepts including the terms used within the framework. The specific types of difficulties included were:

1. Difficulty Understanding Efforts
2. Difficulty With LMA Concepts or Terminology
3. Difficulty Overcoming Vernacular Use of Terminology
4. Difficulty With Weight Effort

One common difficulty was overcoming the use of *Strong* and *Light* Weight instead of the more traditional *Heavy* and *Light*. For example, Participant 4 described her process for assessing the Effort polarity of the image of the dog sticking its head out of the pickup truck:

> Just to go back to sorting the images, it was hard. . . . Like, the dog with the air blowing, that's not the Weight of the dog, or the Weight of the car, but the Weight of the experience that the dog is going through. And then just trying to think through like more Weight, through experiencing it rather than just the object, kind of made my. . . was a little bit of overload for my brain. Made some interesting choices that I probably wouldn't have done if I hadn't been thinking that way.

Here, Participant 4 demonstrates that she is still exploring the idea of Light and Strong Weight Effort but has not become comfortable with the concepts yet.

Other participants had more trouble understanding the subtle difference between Strong Weight as a concept in LMA versus the more common use of the term *heavy weight*. This confusion made it more difficult for participants to interpret the images, because they felt there was a single correct interpretation. For example, as Participant 5 explained:

> I think it's because we actually have a defined idea of weight. Where, like, rock is heavy, chain is heavy, and so we don't necessarily talk about things in our regular lives as bound or free as much. So I think that's why it's [*Flow*] more open for abstraction.

This misunderstanding resulted in the participants interpreting photos as heavy due to the weight of the objects in the images instead of basing their assessments on the experience of exertion exemplified in the photo.

Previous work done investigating movement in HCI also identified the difficulty of training researchers, designers, and participants in aspects of LMA (Larssen, Robertson, Loke, & Edwards, 2007; Lian Loke et al., 2005). These researchers, however, focused primarily on the use of Labanotation, an extensive scripting system, and not on the articulation of the Effort factors through experiential activities. Considering the limited exposure my participants had to the LMA Effort factors, the conceptual difficulties encountered were minimal, suggesting that additional training could overcome this challenge.

Difficulty Interpreting Images.

This category included any difficulties related to the interpretation of the Effort present in the photos. It included the following types of specific difficulties:

1. Inability to Identify Source of Response to Image
2. Resistance to Interpretation
3. Multiple Interpretations of Effort Quality in Image
4. Difficulty Interpreting Effort Polarity
5. Contradictory Interpretation

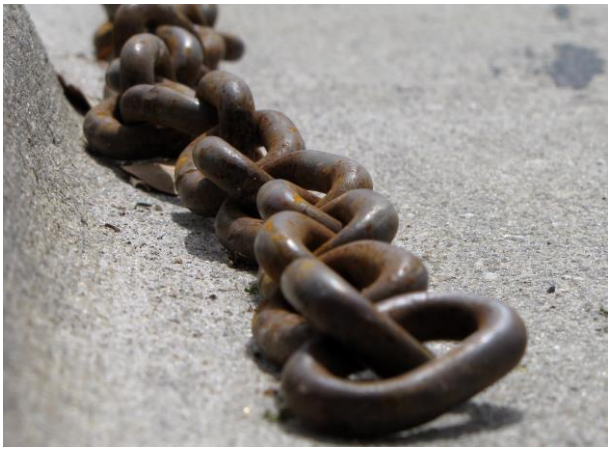
The most common difficulties in this category were Difficulty Interpreting Effort Polarity, Contradictory Interpretations, and Multiple Interpretations of Effort Quality in Image.

Participant 2 described her experience of trying to assess an image during the Flow Effort investigation:

> My image for Free Flow was one that actually encompassed what I saw as the power of Bound. So it seemed like it had more freedom and more direction if it was balanced by the Bound energy. I also found the experience of trying to separate the two was very challenging at points because some images, like I found, had definitely had both.

Another participant explained how she had two very different interpretations of the same image during the Weight Effort explorations. Participant 7 explained:

> I found myself doing that sometimes, going against my initial association. . . . For example, with the chains, I . . . first thought, “Ok, the metal is heavy and they are big links.” But then I thought about somebody being in chains and, like, dying or being freed from that, so there was a sense of rising that came from that which I found interesting.



Difficulty Sorting.

The next difficulty category included any problems that the participants encountered while performing the sorting exercise. This exercise involved arranging all of the photographs in a continuum from the *expanding* to the *condensing* (e.g., Free to Bound Flow). It included two types of difficulties:

1. Not Enough Time to Sort
2. Limited Awareness of Options

Participant 4 described how she handled placing images into her continuum when they didn’t clearly represent one of the extreme poles. She explained, “I don't know, maybe it was partly a cop out, ’cause if I could see too much of both I would just shove it in the middle and arrange [it] that way.”

In another discussion, Andrew noted that he found it easier to sort some Efforts than others. He explains:

> I found organizing them by Space a lot easier than by Time. Because I'm a visual artist, so, and I also am in animation school right now. So when I have to sort it by Time it's like I have to go through the process on what the material in the picture is doing. Whereas in Space, I just have to be is there one focus in the picture—sort it more that way.

Participant 5 also commented on how working with a partner helped her with the sorting process:

> But it was eye-opening to talk with someone else and see their completely different ideas about the images. . . . Which was interesting because when we were working with Flow I could see all the sides by myself. And with Weight, it was far more challenging, and I needed that chance to talk to someone else or see someone else's movement.

Participant 5's comment illustrates the commonly shared sentiment that often, the participants needed someone else to affirm their decisions in order to feel comfortable with them.

Sensory/Perceptual Difficulties.

The category Sensory/Perceptual Difficulties dealt with difficulties pertaining to the participants' awareness of their own limits of perception. For example, when discussing the role of attention in differentiating between Direct and Indirect Space, Participant 6 explained:

> I found that really tricky, really—being able to interpret a sort of focused attention versus a more expanded attention in different ways related to the different senses or feelings that the images were evoking. Am I relating directly to the image I'm seeing? Am I relating to my own body? Like, I wasn't really sure what was going on. It was hard.

This comment really summed up a lot of the challenges related to the interpretation of images using LMA. Participant 6's awareness of the multiple sensory stimuli that she was experiencing made her assessment of the polarity very difficult. Choosing an appropriate strategy for interpretation is very important but not always easy to do given the multitude of options.

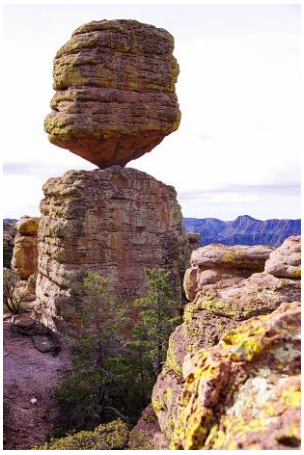
Self-judgment/Difficulty Trusting Intuition.

The difficulty category Self-Judgment/Difficulty Trusting Intuition was the most prevalent difficulty expressed during the discussions. This is not unexpected, as the participants had limited or no previous involvement with LMA and were learning the framework and its application as we went through the various exercises. The numerous types of difficulties within this category were:

1. Sense of Limited Options for Interpretation
2. Feeling Boxed In
3. Difficulty Seeing From Within
4. Sense of Having no Control Over how Brain Interprets Images
5. Comparison With Others' Interpretations
6. Desire To Be Creative
7. Expectations
8. Feeling of Right and Wrong Interpretation
9. Self-Judgment/Doing it Wrong
10. Stereotypical or Obvious Response/Interpretation
11. Delayed Response/Reaction
12. Analytical Voice/Inner Dialogue (Overthinking)

One of the most commonly shared difficulties was the feeling of one's "analytical voice" encroaching on what felt like more impulsive and natural responses to the images. Participant 6 explained:

> And then there was the initial impulse, like what I felt from the image, and then afterward would come the analytical voice. So, for instance, the rock picture of the balancing stone in a cliff, initially I felt like balancing and poised-ness, it was a Light feeling. And then in comes my mind, but there like solid stone with Weight, so it had both.



At other times, the participants would have the opposite experience. In these moments, they would doubt their initial responses as being too obvious and "unartistic." Participant 5 explains:

> I agree with both of you that was very challenging in kind of a box way. I felt like I was often doing the obvious thing, and I think especially because a lot of us here are artists who try to have dynamics and surprise an audience, like, that is a common goal. You start doing the obvious thing and then you say, "Oh, like I should have done the more interesting, more creative, more dynamic thing." So I do think that is kind of an inner dialogue.

Relevance to HCI.

The challenges relating to the process of interpretation that were identified in this research highlight some of the same concerns identified by other HCI researchers investigating user experience. Jodi Forlizzi and Katja Battarbee identified three types of *user product interactions*: *fluent, cognitive* and *expressive* (Forlizzi & Battarbee, 2004). *The first two types, fluent and cognitive,* refer to automatic actions that are familiar to the user and require little thinking, and cognitive interactions that focus on deciphering the correct plan of action. A majority of the difficulties described in this section – such as when participants second--guessed their initial response, partook in self-judgment, or experienced conflicting sensory information -- may have been caused by the intersection of these two types of interactions resulting their fluent responses being confounded by their cognitive responses. This suggests a need to achieve a better understanding of the various factors that inform these types of interactions in order to utilize them more directly

in the design process. The identification of the modes of connection and the mechanisms of interpretation contributes to the further understanding of how qualities of movement relate to this process.

5.1.3. Effort factors and embodied experience

RQ1: In what ways can the LMA Effort Factors assist in investigating people's embodied experiences during the imagery enactment process?

The findings from this research suggest various ways in which the LMA Effort factors can help provide insight into peoples' embodied experiences during the imagery enactment process (RQ1). The framework presented in Chapter 4 articulates the processes of connecting to and interpreting imagery, two of the primary factors impacting the nature and structure of a person's embodied experience. As part of the deeper analysis, this framework was used to illustrate how the various LMA Efforts align with specific modes of cognitive processing—Corporeal, Cognitive, and Affective—and how these modes act in conjunction with specific interpretive mechanisms to support the translation from the visual to the kinetic modality.

The first step in this further analytic process was the re-coding of the transcripts with the Modes of Connection and the Mechanisms of Interpretation using MAXQDA. MAXQDA provides various analysis tools to facilitate the exploration of coded segments of the transcripts. Two of the primary tools utilized were the *Code Query tool* and the *Code Relations Browser*. The code Query tool was used to identify overlaps of various codes within the transcripts, for example, when a particular segment was coded with a particular Effort factor and a particular Mode of Connection. This tool returned the text segment resulting from the overlap. The Code Relations Browser was used to identify the frequency of intersections of the various codes. This tool returned a matrix showing the number of intersections for each pair of codes.

The first analysis I conducted was the identification of the intersection of the modes of connection with specific Efforts. Table 25 displays the result of this query, showing the frequency with which the participants used each mode of connection in conjunction with each Effort. The orange highlighted cells indicate which Effort was most commonly used

by the participants to interpret imagery for a specific Effort factor. I then completed an analysis of the intersection of the mechanisms of interpretation with each Effort factor. The results of this query are presented in Table 26. As this study is qualitative, these associations were used only as tools to guide exploration and to assist in the development of hypotheses and are not intended to show evidence of significant correlation.

Table 25: Most Commonly Used Modes of Connection for Each Effort

EFFORT FACTOR	COGNITIVE	BODY	EMOTION
% ALL FLOW	29%	46%	25%
% ALL WEIGHT	24%	74%	3%
% ALL TIME	17%	52%	30%
% ALL SPACE	19%	69%	13%

*Orange highlight indicates Effort factor with highest individual occurrence of a mode.

Table 26: Occurrence of Each Effort Factor with the Mechanisms of Interpretation

	FLOW	WEIGHT	TIME	SPACE
Abstraction	10%	3%	2%	8%
Reaction	8%	13%	20%	12%
Transformation	7%	0%	7%	14%
Analysis	15%	3%	10%	18%
Immersion	8%	5%	5%	17%
Narrative	5%	18%	18%	5%
Memory	8%	0%	2%	6%

*Orange highlight indicates Effort factor with highest individual occurrence of a mode.

Jungian cognitive functions.

During the presentation of my findings to the panel of LMA experts, it was brought to my attention that these alignments were similar to those used by Rudolf Laban in the development of his movement analysis system. Laban correlated each of the Efforts with a particular way of interacting with the world based on the Jungian cognitive functions (Davies, 2001). These functions were later extrapolated by Katharine Briggs and Isabel Briggs-Myers for their well-known personality inventory questionnaire. Jung identified four principle psychological functions through which people interact with the world: sensing, feeling, intuiting, and thinking (Jung, 1923). Table 27 shows the alignment between the original LMA concepts, the Jungian cognitive functions, and the findings from my research.

Table 27: LMA Effort and Jungian Function Alignment

Effort	Inner Participant (LMA)	Jungian Cognitive Function	Mode of Connection	Mechanism of Interpretation
Flow	Progression	Feeling	Affective and Cognitive	Analysis
Weight	Intention	Sensing	Corporeal and Cognitive	Narrative
Time	Decision	Intuition	Affective	Reaction and Narrative
Space	Attention	Thinking	Corporeal	Analysis and Immersion

Daryl Sharp summarizes Jung's cognitive functions as follows: "The function of thinking refers to the process of cognitive thought, sensation is perception by means of the physical sense organs, feeling is the function of subjective judgment or valuation, and intuition refers to perception by way of the unconscious (e.g., receptivity to unconscious contents)" (Sharp, 1987, p. 14). Jung referred to thinking and feeling as *judging* types and intuition and sensing as *perceiving* types.

Table 28: Jung's Cognitive Types

Cognitive Type	Description
Sensing	The use of our senses to gather concrete data.
Intuition	Making connections and finding meaning without the direct use of sensory data.
Thinking	Using logic and objectivity to evaluate information and make decisions.
Feeling	Considering the value of information based on what is important to me.

* From MBTI Type Today. (2014, September 9). Carl Jung & Psychological Types. Retrieved from http://mbtitoday.org/carl-jung-psychological-type.

Considering the Efforts individually, we see that in LMA, Flow is connected to Feeling. The findings from my study align Flow with both Affective and Cognitive (modes) and Analysis (mechanism), all of which would be used in the evaluation of data based on what is considered important to the individual. Feeling would take into account both emotionally driven impulses as well as decision-making faculties and analysis.

Weight, which is correlated by Laban with Jung's sensing function, also aligns well with the findings from this study. Sensing involves the use of human sensory faculties rather than theory or logical thought to process our experience of the world. The use of Corporeal and Cognitive as modes of connection would be central to this type of processing. The use of Narrative as a mechanism of interpretation also fits with this definition because Narrative provides a method for creating meaning that is processed experientially rather than logically.

In LMA, the Time Effort is correlated with Jung's intuition function. Jung describes intuition as the process of finding meaning without relying on sensory data. Using Affective as the mode of connection would again align this with the findings from this study, as emotion provides a means of creating meaning internally, without necessarily relying on external stimuli. The inclusion of Reaction and Narrative as the mechanisms of interpretation could make sense as well. Intuition can be seen as an intuitive reaction rather than a logical deduction. And again, as with Weight Effort, Narrative functions as a method for constructing personal meaning experientially rather than through logical processes.

In LMA, Space is aligned with thinking. The mechanisms of interpretation associated with Space are Analysis and Immersion, which support this perspective. Analysis is used to process the world logically and deductively, while Immersion facilitates a deep level of concentration. My analysis also found Space Effort to be aligned with Corporeal as a mode of connection, which was less expected and could be a result of the small sample size. Further investigation is warranted to confirm all of these connections.

The high level of correlation between Jung's functions and the modes of connection and mechanisms of interpretation is significant because it provides additional validation of my framework, which was developed without any prior knowledge of the Jungian cognitive functions or their connection to the LMA Efforts. This correspondence not only gives credence to my findings but also adds legitimacy to Laban's theoretical framework, as my study arrived at its outcomes independently and without prior knowledge.

The alignment of the Efforts with the modes of connection and mechanisms of interpretation is significant because it suggests that specific movement qualities (as described in the LMA Effort framework) are connected with specific types of cognitive processing. Even though in this study the correlations were identified by interpreting imagery through movement, assuming that the inverse relationship exists is not an unreasonable hypothesis, and it is one that can be tested. The alignment can also be used to inform the design of technology using movement. This discussion is presented in the section on implications for technology design.

5.2. Embodied Experience Hypotheses

The following hypotheses were generated from the research study findings and provide rich areas of further research and exploration.

1. The process of interpreting an image in order to enact it through movement is a two-phase process.

The process of enacting imagery through movement appears to be a two-step process. The first step involves a person establishing a meaningful connection to the image. The second step involves decoding the image in order to map it to movement. These two processes are not discrete, however, and often influence each other. For example, the way in which a user connects to an image directly affects the interpretation method.

2. Individuals prefer using a particular mode of connection when enacting similar types of visual subject matter.

The findings suggest that there is an association between the features present in an image and the manner in which an individual connects to it to find meaning. For example, images containing people were most often enacted using movements characterized by Time Effort qualities, whereas images of nature were generally enacted using Flow Effort factors. There are additional questions that need to be investigated in conjunction with this, such as whether or not these associations are consistent over time and what processes underlie the individual selection of meaningful features within an image.

3. Specific modes of connection align with certain mechanisms of interpretation more than others.

Using MAXQDA to identify the intersections between the modes of connection and the mechanisms of interpretation highlights the strongest alignments (Table 29). This includes the frequent use of emotion as a mode of connection with both transformation and immersion as mechanisms of interpretation. Corporeal as a mode of connection is often used with reaction, transformation, immersion, and narrative for interpretation. And when Cognitive is the mode of connection the most common mechanisms of interpretation

are analysis, abstraction, and narrative. Further investigation of these connections can help identify ways in which they can be utilized to support embodied interaction.

Table 29: Co-occurrence of Modes of Connection and Mechanisms of Interpretation

	Cognitive	Corporeal	Affective
Abstraction	3	0	3
Reaction	0	10	3
Transformation	1	11	6
Analysis	4	4	3
Immersion	0	9	6
Narrative	3	8	3
Memory	0	3	1

4. The use of a particular mode of connection will determine the expressive quality of the movements used to enact an image.

The research findings suggest that the use of a specific mode of connection impacts the quality of the movements used in the enactment process. Affective was aligned with Flow and Time Efforts; Cognitive was aligned with Flow and Weight Efforts; and body was aligned with Weight and Space Efforts.

5. Movements incorporating specific Effort qualities imply underlying cognitive processes that are alluded to by the modes of connection and mechanisms of interpretation.

When someone's movements are analyzed using LMA, the Effort qualities identified may act as signifiers of the person's current cognitive state. It might be possible to assess the mode of connection and mechanism of interpretation based on this information.

6. Transforming the quality of an individual's movements can transform his or her cognitive state (e.g., help induce a new mode of connection).

If a person's cognitive state informs the way that he or she connects with imagery and enacts it in movement, then the inverse relationship should exist as well.

5.3. Design Research Questions

This section discusses the results of the analysis in the context of the design research questions. The findings are presented primarily in the form of design considerations that address elements from each of the design research questions.

5.3.1. Design considerations for image tagging.

2A: How can LMA as a somatic practice serve as a tool for designing a movement-based image tagging system?

2B: How can LMA as a theoretical lens be used to support the design of a movement-based image tagging system?

2C: What are the key design considerations for a movement-based image tagging system utilizing LMA Effort qualities?

1. The image enactment process has multiple stages (2C).

The multiple stages involved in the enactment process may help inform the structure, design, and user interaction of future movement-tagging systems (Figure 19). These stages may also assist in further understanding the cognitive processes underlying the movement-tagging process.

Figure 19: Stages of Tagging Process

Stage of Enactment	Description of Stage	
Stage 1	Establish Connection with Image	
Stage 2	Assess appropriate Effort Polarity	
Stage 3	Create movements to Enact Image	Reflect while Moving
Stage 4	Perform Movement	
Stage 5	Post Movement Reflection	

2. The enactment process often results in conflicting Effort interpretations (2C).

One of the primary difficulties relating to the kinesthetic tagging process that was the interpretation of the Effort factor in an image in multiple ways. Two of the common causes of this were self-judgment, and conflicts resulting from the use of multiple forms of intelligence. The first factor was seen in the participants' tendency to question their initial responses to imagery and to very quickly begin to overthink and doubt their interpretation choices. The second occurred mostly due to interpretations made without actively incorporating movement. Any design of a movement-tagging system will need to take these factors into consideration in order to support a user's interpretations process.

3. People have different preferences for laying out images on an Effort continuum (2B and 2C).

The use of various layouts during the sorting exercises suggest that there is a connection between a user's mental model of the Effort spectrum and their interpretation process. A kinesthetic tagging application will need to consider this factor in the design of the user interface as it may impact a persons' cognitive load, creative response, and other usability factors.

4. People have personalized movement patterns (2B and 2C) .

People will have varying movement capacities and will perform within their limits. One person's Strong Weight may be much more intense than another's. Future research will need to consider how movement calibration can benefit and adapt to individual movement styles. The LMA Efforts provide a classification system that can assist in the process of identifying variations in the way people perform movements.

5. People's movement styles can transform over time (2C).

People are affected by various factors that can transform the ways they move. These can be short-term changes based on a specific social or environmental context or longitudinal changes emerging from aging, injury, or positive rehabilitation factors. A movement-tagging system could incorporate normalization of such temporal differences in personal movement style.

6. Laban Movement Analysis Effort factors have the potential to be used as a movement schema within a computational movement recognition model (2B).

Through this research, LMA Effort factors were shown to facilitate the articulation of somatic experience through categories associated with expressive qualities of movement. As a classification system it also appears to be capable of correlating aspects of qualitative movement with various cognitive processes and prior embodied experience. These characteristics enable the LMA Efforts to be used as the basis for a computational model that provides an internal recognition schema to interpret or translate the nuanced language of movement qualities into everyday descriptions of movement.

7. Laban Movement Analysis can be used as a mapping tool for higher level semantic structures (2A).

My analysis shows that LMA Effort factors function not only as descriptors but also map specific cognitive and emotive states, making it useful as a component of a recognition schema for movement interaction in social and personality typologies. This is evidenced by the notion of personal movement signatures, which are used in psychological taxonomies.

8. Most users will not have knowledge of LMA (2C).

Although consideration for the future design of movement tagging may use and even take advantage of LMA descriptors to analyze movements, we know that not all users will have knowledge of LMA. Fortunately, it is not necessary to expect users to have any knowledge of LMA to design a movement-tagging system. Such a system could use LMA for an internal recognition model but simply require that users move and describe images through movement.

5.3.2. Application to movement-based interactive systems.

RQ2: How can LMA – as both a theoretical lens and somatic practice – be utilized as a tool to support the design of movement-based interactive systems?

1. Improved gestural design.

The LMA Effort factors provide an additional dimension for designers to consider in the development of gestures. Currently, many gestural interfaces rely solely on the spatial characteristics of a gesture. For example, a swipe might be defined as a movement of a user's hand from left to right or right to left without significant change in elevation. Adding in LMA Effort qualities allows a designer to differentiate between swipes incorporating Sudden and Sustained Time, allowing for greater levels of disambiguated functionality. For example, a hand swipe demonstrating Sudden Time might be used to trigger an application to exit, while a Sustained Swipe might open a context menu. The addition of these additional qualitative dimensions of movement will also allow for gestures to align more with users' innate experiences and expectations and could enable greater personalization and dynamic system adaptation through the analysis of a user's movement preferences on multiple levels. The ability for a computer to adapt to a user's personal movement style would allow for more precise recognition of the intent of a gesture and alleviate numerous errors in detection.

Numerous HCI researchers have explored methods for developing expressive gestures for interaction based various aspects of user experience (Djajadiningrat et al., 2007; Hummels et al., 2007; Astrid Twenebowa Larssen et al., 2007; Lian Loke &

Robertson, 2008; Moen, 2005) My research supports and extends their work by providing further insight into the application of somatic experience and the application of LMA Effort factors in the design of gestures. One of my research contributions is demonstrating the benefits of integrating LMA theory and practice in the design of movement-based interaction. This differs from the traditional approach in HCI of applying LMA concepts without regard for their somatic origins which has caused considerable confusion regarding their rigor and relevance to movement interaction design.

2. Cognitive support through movement interaction.

A better understanding of the correlations between the modes of connection, mechanisms of interaction, and Effort Factors will help designers view movement not as an ancillary component of interaction, but as a unique modality capable of transforming the embodied experience of a user. On a basic level, this knowledge could be used to tailor the design of movement interaction within specific applications or products based on intended goals or purposes. For example, a personal photo management system might incorporate movements exemplifying Sudden Time and both Free and Bound Flow, which are all aligned with cognitive processes emphasizing emotion. An accounting application might incorporate the use of movements associated with analytical processing (which in this exploratory study were characterized by the Flow and Weight Efforts).

The identified role of Affective awareness as a mode of connection in the enactment of images suggests that a greater consideration of expressive movement can help support decision making by facilitating the activation of specific somatic states (A. R. Damasio et al., 1996). In this context LMA can function as both an exploratory design tool to further investigate these connections, and function as a practical movement schema to support the integration of movement quality detection into various applications. There is also the potential use of LMA to support more nuanced embodied metaphors that incorporate expressive qualities as well as spatial and relational ones (Alissa N. Antle, Corness, & Droumeva, 2009; Hurtienne & Israel, 2007; Macaranas et al., 2012) Current research investigating the use of embodied schema for interaction has primarily focused on a the spatial aspects of movement. However, the experience of movement as articulated through its performative qualities may also inform the development of these schema and help identify new interaction metaphors. The findings from my work, and in

particular the conceptual framework, can help support future research exploring the use of movement to support these types of embodied cognitive processes.

3. Support Reality-Based Interaction (RBI)

The somatic practices encompassed by LMA provide a way to explore additional facets of embodied knowledge that could be used to support extensions of Jacob et al.'s concept of RBI. Their current framework takes into account the categories of Naïve Physics, Body Awareness and Skills, Environmental Awareness and Skills, and Social Awareness and Skills (Jacob et al., 2008). The use of the Somatic practices encompassed within LMA have the potential to assist in the investigation and exploration of additional elements of the RBI framework, particularly within the category of Body Awareness and Skills, through the facilitation of augmented body awareness. My findings also provide a preliminary example of how LMA can function as a framework for incorporating these elements into design processes and design thinking by highlighting links between existing embodied knowledge and experience and movement qualities.

4. Adaptive computing.

The movement qualities described by the LMA Effort factors provide a glimpse into the cognitive processes and embodied experience of the user. This information has the potential to be used in assessing a user's state, taking into account various contextual factors such as emotion, fatigue, sensory awareness, and thinking strategies. The ability to ascertain aspects of users' experiences will enable computers to support human activities in a variety of locations, situations, and activities and with less need for explicit interaction. This has benefits for supporting new applications of technology in the ubiquitous computing paradigm (Weiser, 1991) where direct input modalities will be limited. A greater understanding of peoples' embodied states will also allow computers to better predict and adapt to users' needs and support them in dynamic situations. This has implications in areas such as affective computing where researchers attempt to design systems capable of ascertaining aspects of a user's emotional state in order to tailor the interaction (Picard, 1997).

5. Integrate experiential and functional movement.

The presentation of a conceptual kinesthetic tagging application illustrates one possible way that experiential movement could be integrated with functional movement in a utilitarian manner. The process of investigating the connection between visual content and movement highlights the myriad ways in which movement supports the articulation of embodied knowledge and reflects users' cognitive states. It also illustrates how the way in which a user relates to an artifact, a central theme in the area of user experience (McCarthy & Wright, 2004; Sengers et al., 2002), significantly affects her interactions on a kinesthetic, cognitive, and embodied level. Rather than considering movement only as a component of user experience, integrating functional and experimental movement demonstrates the synergistic interplay between the user and the system and their mutual effect on one another (Levisohn, 2007). Just as the system is transformed by the user, so too is the user transformed through interaction on an embodied level. This understanding is key to developing applications that integrate functional and experiential movement.

These five themes highlight the contributions of this research to the field of embodied interaction. They illustrate the substantial benefits that can be gained through the incorporation of expressive movement and somatic awareness into human-computer interaction and the role that LMA can play in the future of movement-based interaction.

Chapter 6. Conclusion and Future Work

The research presented in this dissertation addresses a gap in the field of movement-based computing by investigating novel approaches to the integration of kinesthetic experience into human–computer interaction. The research study was comprised of a participatory workshop incorporating performative inquiry and movement exploration with the goal of identifying design considerations for a movement-based tagging system. The research approach utilized a somatically oriented perspective, incorporating the LMA concept of Effort as both a theoretical lens and a somatic practice to facilitate the collection of qualitative movement data from participants in a structured manner.

The study investigated the strategies and cognitive processes involved in the mapping of content from a visual mode to a kinesthetic mode. Rather than focus on all aspects of movement, the study's scope was limited to the exploration of qualities of movement as defined by the four LMA Effort factors: Flow, Weight, Time, and Space.

This research makes a methodological contribution by adding to the literature on the use of somatic practices as research tools. The numerous pilot studies that were conducted in preparation for the workshop assisted in the development of activities to support the incorporation of somatic methods and theory in a design research study.

The outcomes of the study include a conceptual framework identifying the two-stage cognitive process underlying the assessment of the Effort quality depicted in an image. The first stage of the process involves connecting to the image using one of three modes of connection: Corporeal, Cognitive, and Affective. The second stage involves the interpretation of the image in terms of the LMA Efforts using one of seven mechanisms of interaction: Transformation, Immersion, Analysis, Abstraction, Memory, Reaction, and Narrative.

The conceptual framework facilitated further analyses that were used to identify additional factors involved in the enactment of imagery through movement. This included the connection between image features and the quality of movements used to express

them. This was presented in relation to one of the primary frameworks for image feature classification (Jaimes & Chang, 1999) to illustrate the connections between the modes of connection, LMA Efforts, and various categories of image features (e.g. inferred and concrete). Table 30 presents these relationships.

Table 30: Laban Movement Analysis Effort Alignment With Modes of Connection, Mechanisms of Interpretation, and Eakins et al. Image Features

Effort	Mode of Connection	Mechanisms of Interpretation	Concrete Image Features	Inferred Constructs	Inferred Emotions
Flow	Affective and Cognitive	Analysis	Natural Objects Natural Landscapes Action Man-Made Objects	Wind Air Breath Freedom Movement Time Cold	Emotion Darkness/ Negativity Angst Tension Calm/ Relaxation
Weight	Corporeal and Cognitive	Narrative	Natural Objects Action People Man-Made Objects Natural Landscapes	Light (Weight) Freedom Movement Gravity Strength Power/Powerful Death	Tension
Time	Affective	Reaction and Narrative	People Sports Action	Time Stillness Chaos Disorganization Thoughts (of subjects in photos)	Emotion
Space	Corporeal	Analysis and Immersion	Urban Landscapes	Transformation Movement Strength Constant Awareness Light (Weight) Compressed Space	Calm/ Relaxation

An additional outcome of the research presented in this thesis was the generation of several hypotheses relating to the role of embodied experience in the act of image enactment (Section 5.2). This included the articulation of a set of design considerations for a kinesthetic tagging application (Section 5.3.1). I also identify five areas of interaction that would benefit from the incorporation of somatic experience (Section 5.3.2).

6.1. Future Work

The framework developed through this research functions as an instrument for the further investigation of movement and its underlying cognitive structures. As this research was exploratory in nature, the framework and related findings are in a rudimentary form that will require additional studies to elaborate and validate. The next step will be completing an LMA–based analysis of the movement data from the workshop videos to add to the existing research materials. These data will allow for a more complete assessment of the relationship between specific movements and observed (rather than solely reported) Effort qualities within the conceptual framework.

Additional qualitative studies are also needed to expand the results from this research. The addition of more participants would provide more transferability of the findings, enable the verification and augmentation of the data, and allow for the further refinement and investigation of both the embodied cognition hypotheses and the design considerations. These studies would also include prototype development and exploration in additional workshops.

Quantitative studies will be necessary in order to dramatically increase the sample size and to validate specific components of the framework and Effort alignments. Once a robust system for detecting Effort qualities is made available, it will allow for large-scale data collection to validate the identified correlations between image features, Efforts, and movement.

This research agenda will provide valuable insight into the nature of human nonverbal communication, enable a greater understanding of the mechanisms underlying embodied cognition, inform the development of robust human-centered camera sensing

systems, and provide designers with the knowledge to develop gestures and full-body interactions that support human cognition and creativity. Ultimately, these findings will enhance and transform current methods of human–computer interaction through the inclusion and application of human tacit and embodied knowledge.

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Appendices

Appendix A. Pilot Studies

Research Questions

The following research questions guided the first three pilot workshops:

1. How can the experience of movement be conveyed between people?
2. What types of movements provide the most intense experience of movement to a participant?
3. What strategies can be used to augment somatic awareness and movement experience?
4. How do participants describe their somatic experiences?
5. What types of movements provide the strongest sense of kinesthetic empathy for observers of movement?

Pilot Study 1

The first pilot study focused on investigating the notion of shared movement experience. The findings from such a workshop would help inform the development of remote-communication systems (such as Skype or FaceTime) by allowing them to incorporate shared movement experience. The activities therefore guided the participants to work with one another to explore concepts such as kinesthetic empathy and attention.

The initial pilot study was conducted with three participants, two males and one female. My role as a participant observer furthered my experiential understanding of the felt experience of movement and helped me understand how better to frame it in my study. Two of the participants had dance experience, one through formal training and the other through participation in activities such as contact improvisation. They all had some background in LMA, although this study did not directly incorporate the LMA Efforts into the activities.

Throughout the workshop, participants were asked to write down a few words to describe their experiences. They were provided with 4” x 5” colored cards on which to make these notes. These notes were for them to use to recall their own experiences during the final workshop discussion, but they also served as data collected from the workshop.

Workshop activities.

1. Warm-up.

The activities used in the workshop were developed based on exercises used in somatic training, dance, and theater classes. The workshop began with me conducting a guided meditation focused on experiencing the body. This was intended to bring the participants into a space of augmented somatic awareness and focus. Similar techniques are used in movement classes and by movement researchers to enable participants to be more fully present and to support their ability to respond and improvise with one another (Oliveros, 2005; T. Schiphorst & Andersen, 2004). Following the warm-up, the participants were asked to write down 1–3 words on one of the cards that described their experience of stillness during the activity.

2. Weight exploration.

Figure A1: Participants Engaged in Weight Exploration Activity

The first activity was Weight exploration through the use of small objects. The participants were given a series of small hand weights to hold. They were guided through a series of movements intended to help them experience various durations of movement reaching in different directions, and they were then permitted time for individual exploration. They were next asked to repeat the exercise without the weights and to pay specific attention to the quality and location of any bodily sensations they experienced.

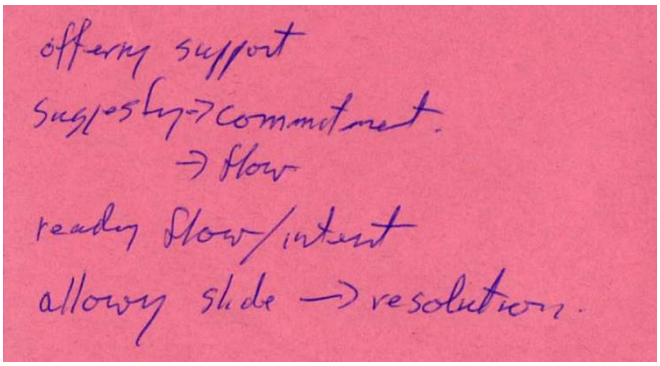
They then wrote down a few words describing their experience of Weight on one side of a note card, and on the other side they recorded where their awareness was most intense.

3. Balance exploration.

The second activity focused on the participants' awareness of balance. Working in pairs, they took turns closing their eyes and leaning backwards while being supported by their partners (Figure A2). This activity is based on contact improvisation, a movement-based activity in which partners explore trust and weight-giving while constantly maintaining contact. Again, following the exercise, participants were asked to write down 1–3 words describing their experiences on one side of a card and where in the body their awareness of balance was strongest on the other side of the card (Figure A3).

Figure A2: Participants Engaged in Balance Exploration Activity

Figure A3: Example of Completed Note Card for Activity 2



4. Shape exploration.

The third activity explored the use of the body and limbs to transform the shape of a participant. Again, the participants worked in pairs, this time with one person closing his or her eyes and allowing the other person to move him or her into various positions (Figure A4). Participants then pretended that there was a giant lump of clay in front of them that they could mold into whatever shape they desired. They were told to exaggerate their movements and to use their entire bodies to mold the clay, then to scale down their movements so that they were very small. They were asked to direct their attention to where they experienced somatic sensations and to think of how changes in scale affected this. Again, they were given note cards on which to write down a few words describing their bodily experience and where their sensations were localized.

Figure A4: Participants Engaged in Shape Exploration Exercise

5. Empathy exploration.

The fourth activity explored kinesthetic empathy. This activity involved working in pairs, with one participant emulating the movements of another while standing behind him or her. This activity was meant to provide the participants with a glimpse into the unique movement style of another person. They were then asked to swap positions. At the end of the activity, they again wrote down a few words describing their somatic experience and where in their bodies awareness was the strongest.

6. Discussion.

The workshop concluded with a circle discussion in which the participants shared their experiences and tried to identify commonalities in their awareness during the various activities. They were encouraged to use movement as much as possible to explore and convey their thoughts. They were asked to think in particular about moments during which they felt increased awareness and to speculate about what caused this.

Feedback from participants.

Immediately following the workshop, the three participants engaged in a feedback session. This was an open discussion during which the participants were asked to bring

up any concerns or difficulties that they had during the workshop and any suggestions to improve the activities. Their comments are summarized in Table A1 and described below.

Table A1: Matrix of Comments From Participants on Pilot Test 1

Warm-up	Need for appropriate warm-up to prime participants for activities to follow.			
Exercises	Use more sophisticated exercises in lieu of familiar activities to better focus on somatic experience.	Provide ample time to explore experiences.	Have participants identify ways to augment experience of weight, shape, and balance rather than provide rote exercises.	Make workshops more free form to allow experts to use their movement experience.
Dialogue	Allow more time for participants to talk about their experiences with each other outside of the discussion.	Carefully consider word choice so as not to bias participants.	Ask specific focused questions of participants.	

The participants felt that greater clarification of the intended use of the note cards was needed. Some of them thought that the cards were only for data collection purposes when in fact they were first and foremost intended to act as reminders of important aspects of the participants' experiences. While they were collected at the end of the workshop to be included as one component of the data, they mostly served as reminders of what the participants had discussed.

The use of meditation as a warm-up was felt to be inappropriate for this type of workshop. Participants felt that a more movement-oriented activity was needed to prepare participants for the activities. One participant suggested a self-guided warm-up such as is used in contact improvisation classes, in which the instructor provides a model that can

be used by attendees but individuals can tailor the warm-up to their own needs. This method, however, could be problematic with novice movers because they would not be capable of as much self-direction.

One participant had difficulty with the ambiguity of what I was investigating. It was suggested that I phrase my inquiries as questions such as “What is balance?” or “What is movement awareness?” It was also suggested that each workshop focus on just one concept at a time to allow the participants to fully explore their experiences of balance, weight, or awareness. They noted that they could have spent the entire workshop on just one of the exercises and that this would have permitted a deep interrogation of one particular aspect of movement experience. One participant commented that repetition of the activities during the workshop allowed them to focus on the subtle details of experience and that this could potentially be used to interrogate movement awareness.

The two participants with a substantial amount of movement experience noted that many of the exercises that were employed were common in beginning dance classes and would likely not be interesting to more advanced movers. They suggested finding alternate activities that would be more engaging and provide a novel experience of the body.

Another suggestion was to ask participants to identify methods of eliciting specific sensations or augmenting awareness of a particular body part using props. This would provide a way of replicating participants’ experiences and could be explored as a group.

The participants also suggested that they be permitted more time to talk while not in the formal discussion circle in order to share their experiences while completing the activities.

One participant suggested the careful use of words when describing activities so as not to bias people into a particular way of thinking. One example was the use of the word *agency*.

The final suggestion was to make the workshop more free form so that that the participants with significant movement background could use their expertise. One participant also suggested that the workshops could be more like theatrical rehearsals in

which I would function as director. The research problem could be thoroughly explained, as this would essentially be the “play” for which we would be rehearsing. This would allow for a more free-form workshop that would make use of the expert knowledge of the participants.

Personal observations.

My own observations were that the activities prompted a lot of discussions about personal connections and the challenge of copying someone else’s movements, which was not the desired content. This was thought to be due to the ambiguity of the questions asked of the participants (as they noted in the feedback session) and the types of activities employed. I also found it difficult to participate and observe the participants at the same time. I felt that it would have been more useful for the research for me to take notes and photographs of the participants’ movements and interactions.

Pilot Study 2

The second pilot study incorporated a number of suggestions provided by the participants in the first workshop. The workshop was restructured to emphasize more free exploration using props and the identification of movements that elicited augmented awareness of a specific part of the body. The introductory script was also modified to explain the research questions and objectives in greater detail in order to provide more context to the participants.

There were two participants in this study, one male and one female, both with professional dance and movement training. The female participant had taken part in the first workshop and was able to provide feedback comparing the pros and cons of the differing structures.

Workshop activities.

1. Warm-up.

The workshop began with a warm-up similar to those used in dance classes. During the warm-up, I led the participants through a series of movements that began on

the floor and slowly progressed through various stages to a full standing position. This was followed by a discussion of the components of movement awareness, which was meant to provide additional context regarding my research objectives and to make the goals of the workshop clearer.

Figure A5: Participants Engaged in Warm-Up Activity

The remaining activities in the workshop were a set of repeated exercises designed to explore methods of eliciting heightened awareness of a specific part of the body. Following each activity, each participant shared her exercise with another participant and then the group as a whole. (In this case, because there were only two participants, I acted as a member of the larger group to whom they conveyed their findings.)

2. Movement awareness activity development.

The first activity involved individual explorations of movement awareness using props. These props included yoga balls, balance boards, stretch bands, ankle weights, and tennis balls. Participants were asked to first consider all the aspects of bodily awareness that they could think of and to write them down on one of the supplied note cards. They were encouraged to use movement during this process when it would be beneficial. Once they had compiled a list of several components, they were asked to select one that they felt was important or interesting to them and, using props and movement, explore ways to emphasize that particular aspect of movement awareness. They were directed to identify a small set of movements, a pose, or a larger choreographed sequence that was particularly suited to eliciting awareness and that could be easily shared with the

other participants in the workshop. Once they had identified their exercises to share, they were asked to document them using words, short phrases, and pictures.

Figure A6: Participants Engaged in Movement Awareness Activity

3. Activity sharing with a partner.

Once the participants had completed documenting their exercises, they paired up and demonstrated their activities to their partners. During this process, the participants were asked to assist each other in modifying the exercises to make them as functional as possible and to refine their articulation of the particular experience of awareness they were attempting to elicit. Because they were learning each other's activities, they would also present these together to the larger group.

4. Group sharing and discussion.

The next activity involved presenting the awareness-eliciting exercises to each of the other groups. (In the case of this pilot workshop, they presented only to me.) All participants attempted the exercises as they were demonstrated. A discussion of the exercises, their effectiveness, ways to modify them to improve their efficacy, and the nature of the type of awareness was conducted, and I took notes, photos, and video in order to record all the exercises and discussions about them.

5. Repeat activity.

At the completion of the discussion of the exercises, the participants reviewed the notes they took at the start of the workshop regarding all the types of bodily awareness

that they could think of. These lists were shared among the group, and the participants were asked to pick another aspect of awareness to explore. The previous process of exploration, documentation, sharing, and group discussion was repeated.

In the full-scale workshop, this process would be repeated as long as time permitted; however, during the pilot study only two iterations were possible. At the conclusion of the workshop, a final discussion took place during which all the exercises were ranked based on how successful they were in eliciting their respective aspects of movement awareness.

Feedback from participants.

Table A2: Matrix of Comments From Participants on Pilot Test 2

Warm-up	The traditional dance-style warm-up was better.	Might want to include vocalizations in the warm-up to prepare for discussions	Begin with a discussion of participants' thoughts on movement awareness in general.		
Roles	Clarify roles more clearly and emphasize participant's expertise.	I should participate in the workshop to assist in conveying my intentions and to learn more about movement experience myself.			
Dialogue	Less academic dialogue and discussion.	Be more specific about "the components of movement experience."	Be careful not to overwhelm participants with difficult or ambiguous	Ask more "how" questions to help direct participants.	Careful choice of words like "technology," which can limit

			questions, as this will distract their focus during the activities.		participants' thinking.
Exercises	It might be okay to use basic exercises with expert movers provided they are given ample time to explore their experiences.	Workshops need to be longer to facilitate deep exploration.	Sharing activities was seen as a positive addition that aided the participants in exploring their somatic experiences.	Suggested focusing explorations on a particular modality such as weight or balance as in the previous workshop to narrow the scope for participants.	Use additional props.
General Comments	Might be beneficial to have both skilled and nonskilled movers together for more diversity.	Use LMA concepts to focus explorations.	Might benefit from having participants use imagery to convey somatic experiences.	A better focused workshop than the previous one.	Use a specific scenario to help explain the goal of the workshop.

One participant felt that in general, the workshop would be confusing to participants without a strong academic background due to the abstract nature of the questions. In particular, he articulated that I was likely asking them to think about experience in a way that might not be familiar to them and would require greater explanation. He suggested that it would be clearer to start off with a discussion of movement awareness in general rather than the components of movement awareness. He also added that even he was confused when thinking about the components of movement awareness and that this affected his ability to really focus during the exercises.

There was also some concern about the use of the word *technology*, which I periodically reference in my opening script. The participants felt that this word would

convey laptops to a lay audience and that I needed to better articulate the nature of the hypothetical technology that I was designing. I provided an alternate version of my script to them in which I ask, “If you could send a video of one of your dance routines to a friend, what kind of awareness would you include?” and they found this approach much more compelling and descriptive of my objectives.

The same participant also noted that I should clearly acknowledge the gap between the movement experts and myself in order to clarify my role in interpreting their knowledge for my work. He suggested that I repeat things back to participants in their own words during the discussions to acknowledge that I might not always understand their perspectives and might need additional elaboration.

Unlike the previous participants in Pilot Study 1, one participant felt that doing basic exercises with expert movers was not a problem, because the focus on movement awareness would provide them with a new focus during the exercises that would likely keep them engaged.

Both participants felt that my participation would have been beneficial in this pilot study, as it would have allowed me to better articulate my goals while learning more about movement at the same time. One participant even felt that having a mixed group of expert and nonexpert participants could allow for a more diverse range of responses and outcomes.

Both participants liked having a more traditional warm-up at the start of the workshop; however, one of the participants commented that the warm-up could have been more effective and suggested adding vocalization exercises in order to get them ready for the discussion components of the workshop.

Both participants also felt that the workshop needed to be longer to allow time to complete all the activities. However, the participant who had been involved in the first pilot study noted that despite this, she still felt her contribution was much more defined in this workshop that it had been in the previous one.

The participant who had been in the previous study felt that this workshop was better focused, making it easier to understand the goals. She did note that she found it difficult to separate sensation from perception because people need to choose to become aware in order to sense anything. She also suggested that in lieu of the explicit documentation process that I was asking participants to complete, it might be more effective to have them use imagery (e.g., “the wind is rushing up your back”) or focus more on the mechanics of movement.

Another suggestion was to combine the directed activities from the previous workshop (e.g., weight and balance explorations) with the development of exercises to elicit heightened awareness. This would allow me to have more control over the types of awareness I was interested in and allow the participants to focus on explorations of awareness.

Both participants enjoyed the sharing aspect of the workshop and felt that it helped them to better articulate their experiences.

One participant suggested asking more “how” questions, as this would help focus everyone on the process of eliciting awareness (e.g., “How are you relating to the ground and the environment?”). It was felt that this could help break down my goals into smaller pieces.

The use of additional props such as mini-tramps and chairs was also suggested as a way of providing more possibilities for exploring awareness. The possible use of temperature-altering props (e.g., heating pads, cold packs, and ice cubes) was also suggested as a means of adding another sensation to the explorations.

One of the participants also suggested using the four LMA components, Body, Shape, Effort, and Space, as a way to structure the workshop and guide the participants’ thinking about awareness.

Personal observations.

My own observations included recognizing the need for someone with a formal movement background to lead the warm-up. I also concurred with the suggestion that I explain my research through a narrative describing a possible scenario such as conveying a dance sequence over Skype. Although both participants would have liked me to participate in the workshop, I still felt it was too difficult to moderate and take part in the activities at the same time and that participation was not necessarily of major benefit to the outcome of the workshop. I also considered the use of LMA concepts a very interesting possibility, and eventually the Efforts became central to the final version of the full-scale study.

Pilot Workshop 3

The third pilot study was based more on LMA concepts, as suggested by the previous participants. The study incorporated aspects from the Bartenieff Fundamentals (a later addition to the LMA framework emphasizing the body) during the warm-up to highlight the evolutionary aspects of movement development. The study also continued to include activities focusing on the use of props to elicit awareness. The introduction script was also modified to include a more narrative explanation of the design goals, using the example of the limits of sharing a dance piece with friends using Skype.

The participants in this study included one female with no dance experience at all and one male who had previously participated and had a significant amount of nonprofessional movement experience.

Workshop activities.

1. Discussion of movement awareness.

The workshop began with a 15-minute discussion of movement awareness during which all the participants and I shared our perspectives on the phenomenon. This was followed by a description of my research that was set within the context of our discussion of awareness.

2. Imaginary evolution warm-up exercise.

The first movement activity was based on the Bartenieff Fundamentals and functioned as both a warm-up and an investigation of bodily experience. During the activity, I guided the participants through a series of imagined states, with them beginning on the floor as amoebas without structure or organs. From here participants evolved into flatworms capable of wiggling and body articulation and then came up on all fours to explore bending, twisting, turning, and curving as more developed organisms. This led into an exploration of the LMA concept of the *kinesphere*, a term used to describe the space around a body accessible through the extension of the limbs and twisting of the body. During this stage, the participants evolved from tubular organisms to organisms capable of reach and extension, adding rhythm and timing to their movements. Next they became mobile creatures, grounded with a strong sense of Weight. They then took flight and became light and free.

3. Documentation of experience.

Following the imaginary evolution exercise, participants spent 10 minutes documenting their experience of movement awareness, including their most intense sensations, any imagery they experienced that could help convey a sensation, and any specific components of movement experience that they noticed (e.g., weight, balance, etc.).

4. Communicating through movement.

For the next exercise, the participants paired up and sat facing each other. They then communicated their experiences during the previous exercise using only body movements. They were directed to start with small movements that used just the fingers, hands, and wrists, and then to slowly increase the use of their bodies to include the arms, upper torso, and eventually the entire body. They were asked to consider how they were communicating their experiences as well as how the limitations that were imposed on them affected their experiences. They were then given 10 minutes to document their experiences on the provided note cards. They were also asked to compile a list of the types of awareness that they had while completing the exercise.

5. Movement awareness exploration.

The next exercise repeated the independent exploration of one aspect of movement awareness using props. The participants were asked to select one component of awareness from the list that they previously compiled and to come up with a pose, movement, or sequence of movements that augmented their awareness. They were directed to make notes on a note card to enable them to recall the experience they had and the movements they developed to augment awareness. They were also asked to come up with an example of imagery that conveyed the experience of that particular aspect of movement awareness.

6. Group sharing, discussion, and moving.

Following the independent exercise, the participants came together as a group to share their work. First they compiled a list of all the aspects of awareness that they came up with to create a master list. They then demonstrated the movements/poses that they developed to augment awareness, with the rest of the group performing those sequences as well. Once all the participants had demonstrated their methods for augmenting movement awareness, a discussion of their experiences took place. This was followed by a revisiting of the list of the components of movement awareness in order to rank them based on the participants' sense of their perceived importance in using technology to communicate movement to a remote friend.

Feedback from participants.

Table A3: Matrix of Comments From Participants on Pilot Test 3

Warm-up	Suggested creating short movement sequences during warm-up to share with other participants if they are going to share their experiences.	Suggested focusing on internal awareness during warm-up.	Confusion over "evolutionary" characteristic of warm-up.	Benefitted from initial discussion of movement awareness.
Exercises	Difficulty with the sharing movement activity. Felt they had	Include more observation of	Start with big movement and	

	to stay in character. Felt the exercise became too conversational. Suggested having the mover close his/her eyes.	movement by participants.	move to small ones.	

Overall, the participants enjoyed the initial discussion of movement awareness and felt that this provided a good context for the remainder of the workshop. They noted some confusion over the imaginary evolution warm-up and felt that it should have focused more on interactions between the participants rather than individual experience. It was also suggested that the warm-up focus more on internal awareness of organs and bones in order to exemplify the goals of the workshop. One participant also suggested having them develop a short movement sequence to explore their awareness during the warm-up, which could then be shared with the other participants, rather than have them communicate their experiences without any preparation.

Another suggestion was to incorporate more watching of each other performing routines in order to investigate how movements are perceived by an observer.

The most problematic aspect of the workshop was the exercise in which they conveyed movement experience while facing each other. One participant noted that she felt like she was supposed to stay in character (e.g., embody the animal she portrayed). The participants also reported that the exercise became too conversational and interpretive. After some discussion, it was suggested that the exercise might work better if the gesturing partner kept his or her eyes closed. They also felt that starting with big movements and then shifting to small ones would be more effective. Overall, though, there was still confusion about what I had intended them to convey.

Personal observations.

Overall, I concurred with the comments from the two participants. The imaginary evolution warm-up did not appear to have the desired effect of focusing their awareness on internal sensations and added confusion by setting a specific tone for the remainder of the workshop.

The exercise during which the participants attempted to convey their movement experience while facing each other did not achieve the expected results. Overall, it seemed that I still needed to find a better way to articulate my expectations and clarify my own notion of movement awareness to the participants.

The suggestion to incorporate more time for observation in order to better understand how movement is experienced differently by the mover and a spectator was very interesting and did become a component of the full-scale study.

It also seemed that the discussion and conversation in the workshop served to limit the participants' independent thinking, restricting the variety of their insights. This could have occurred due to the disparity in movement experience between the two participants, which may have created a leader and a follower.

Pilot Studies 4 and 5

Research questions.

The following questions guided the final two pilot workshops:

1. How do the LMA Effort qualities of Space, Weight, Time, and Flow correlate with specific image features?
2. What strategies do participants use to map images to movement?
3. What characteristics of movement are used by observers to map to photographic content?
4. What roles do somatic awareness and movement experience play in the enactment of images?
5. What are the most basic characteristics of movement that can be used to enact a visual image and that are still meaningful to observers?

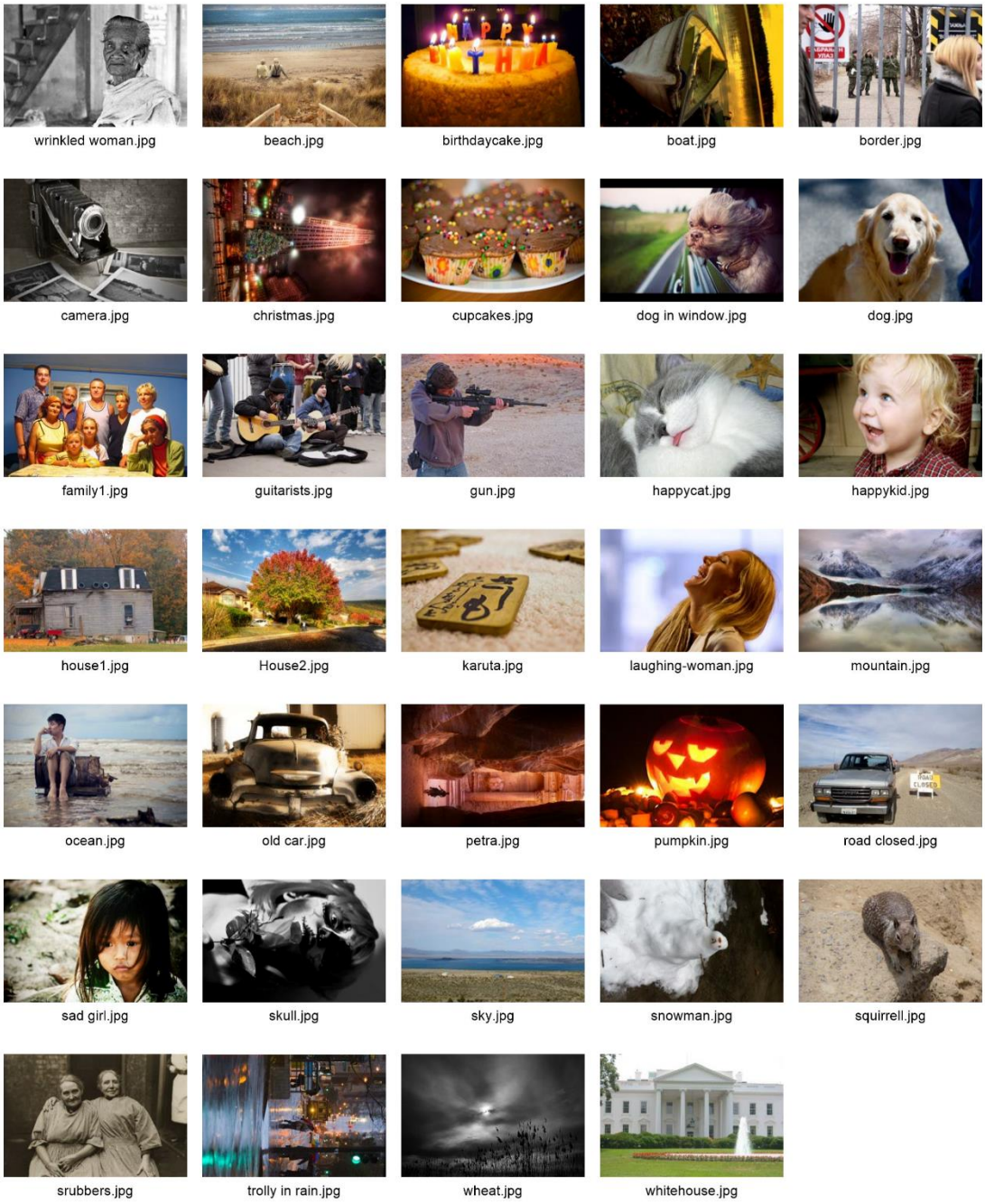
Workshop activities.

The workshop was conducted with two participants, one male and one female, both with professional movement training and both having completed one of the previous workshops.

1. Warm-up exercise.

Like the previous pilot workshops, this one began with an introductory script outlining the research objectives and the participants' role in the research. This was followed by a warm-up conducted by the female participant. Having a participant lead the warm-up was a way to ensure that the exercises were general in scope, wouldn't interfere with the goals of the workshop, and were appropriate for trained dancers.

Figure A7: Images Used During the Workshop



Following the warm-up, the participants were given identical stacks of photos to use during the workshop activities (Figure). The photographs were all obtained from the photo sharing website Flickr (www.flickr.com) and had appropriate *Creative Commons* licenses to permit their use in a research study. (For a full list of photo authors, please refer to Appendix B.) The photos were selected for their diverse subject matter, composition, and quality (e.g., snapshot vs. professional photo). The use of varying styles and types of photographs was important in order to provide as wide an array of image features as possible. As LMA is commonly taught using dynamic imagery, I specifically included images with subject matter that was inert to explore how participants dealt with visual content that had no clear association with an LMA Effort factor (e.g. Free Flow).

The participants were first instructed to sort the photos into meaningful categories based on subject matter, visual features, the emotional response they generated, or any other criteria that seemed personally relevant. The sorted images were then placed in front of the participants, with all photographs visible (Figure). This categorization process was done to investigate which image characteristics were important to a particular participant and how they were represented through movement.

Figure A8: Image Groups Formulated by One of the Participants

The participants were then asked to select one category of images and to develop a movement sequence that reflected the images' common characteristics and personal meaning (Figure). Participants were told to consider the types of movements they used as well as the quality of those movements and how they related to the image content.

Figure A9: Participants Developing Movement Sequences

Once the participants had completed their movement sequences, they performed them for the group. Everyone was asked to consider three questions:

- Which category appears to be represented by the movement sequence?
- Which movements carry the most meanings?
- Which movements are the least ambiguous?

The participants then returned to the images laid out in categories and were asked to apply labels identifying the thematic content of each group. These layouts were photographed for later analysis.

For the next activity, the participants were asked to select two images from the same category and to develop two separate movement sequences to embody and

differentiate their responses to the two images. Once they had completed choreographing these sequences, they performed them for the group at large. The group was first asked to identify the qualities of the movements and the meanings that they felt those movements embodied. The photos that had been used for the exercise were then revealed and the participants attempted to ascertain which sequence embodied which image. The performer then revealed which sequence went with which image and provided a label for each photo to describe the primary theme or feature that informed the movements. A discussion then took place to discuss the participants' thoughts on the effectiveness of the movements used.

The final activity involved selecting one of the two images that each participant had just performed for the group, and together with a partner, distilling the sequence down to the most basic possible movements while maintaining the original intention. Again, the movements were performed for the group as a whole without revealing which photo had been selected. The participants then attempted to identify the embodied photo by identifying the inherent qualities of the distilled movement sequence. The actual photo used was revealed by the performer, and a discussion of the distillation process took place.

Data collection.

One of the primary differences between this workshop and the previous ones was the collection of specific data for the purpose of exploring analysis options. This data was used for a mini-analysis primarily looking at the ways in which the participants organized the images into categories, as this would provide insight into how they approached assigning meaning to the images within the movement-based context of the workshop.

The data collected from the pilot workshop included the video record of the session, photographs of the image layouts, and a brief analysis of the self-created image groupings. These provided insight into how the participants assigned the images to various categories based on the features that were most meaningful to them. Notes were also taken on which categories were performed by the participants and the characteristics of the movements that were used. Table and Table show the results of this analysis for the two participants.

Table A4: Image Categories Used by Participant 1

Category label	Participant 1 (female) image Inclusion	Description of category by participant	Description of how image category was performed
Falling over	happycat.jpg pumpkin.jpg house1.jpg squirrell.jpg old car.jpg dog.jpg	Images of objects and animals in a state of falling	Off balance. Recovery. Closing in on oneself. Looking for something, but found something else altogether. Last moment-called out "yelp" Light and quick. Focused on mimicry of objects in images.
Eyes on the right (side)	laughing woman.jpg sad girl.jpg wrinkled woman.jpg dog in window.jpg happykid.jpg	These photos were not selected by the participant for further discussion.	
Central stability	sky.jpg border.jpg scrubbers.jpg guitarists.jpg beach.jpg family1.jpg		
Pllrrph, plop center explode	House2.jpg mountain.jpg whitehouse.jpg Birthdaycake.jpg cupcakes.jpg wheat.jpg		
Left balance	gun.jpg road closed.jpg ocean.jpg karuta.jpg skull.jpg camera.jpg		
Vertical lean	christmas.jpg boat.jpg petra.jpg snowman.jpg trolley in rain.jpg		

Table A5: Image Categories Used by Participant 2

Category label	Participant 2 (male) image Inclusion	Description of category by participant	Description of how image category was performed
Individual organisms/ self-awareness/ audience-ship/ "the moment"/ sublime	happykid.jpg dog.jpg skull.jpg happycat.jpg wrinkled woman.jpg sad girl.jpg dog in window.jpg laughing woman.jpg squirrell.jpg	Organisms in the moment of awareness of being photographed	Flick, twitch, squirm Up and down spine Dab with knee Fast and soft flicks
Military	border.jpg gun.jpg	These photos were not selected by the participant for further discussion.	
Groups of people having a good time	scrubbers guitarists.jpg family1		
The built environment	christmas.jpg		
Artificial things backgrounded by nature	house1.jpg whitehouse.jpg road closed.jpg boat.jpg		
Pretty landscapes	sky.jpg mountain.jpg wheat.jpg		
Things made by humans	camera.jpg old car.jpg Birthdaycake.jpg pumpkin.jpg cupcakes.jpg karuta,jpg		
Bizarre hybrids of nature and human activity	snowman.jpg		
People dwarfed by the environment	ocean.jpg petra.jpg House2.jpg beach.jpg trolley in rain.jpg		

Data analysis.

The tables above illustrate the variety of characteristics used by the participants to generate their categories. One of the interesting effects to note is the difference in the types of features that were meaningful to the respective participants. Participant 1 focused on compositional elements such as “falling over,” “central stability,” “left balance,” and “vertical lean.” What is interesting about these categories is that she differentiated between “falling over,” which implies a current state of motion and activity, and “vertical lean,” which was based purely on the formal compositional elements within the frame. She also created a category called “eyes on the right,” which again illustrates a desire to separate animate from inanimate objects and an awareness of things that possess life. These small details give a great deal of insight into how the participant created meaning for herself given the constraints of the workshop. However, it is also important to bear in mind that these categories were created within an artificial context and the participant may have labeled the categories based not on what she necessarily found meaningful in general but rather on what she found useful in the context of creating movement for the workshop activities.

Participant 2 had a much wider range of features used to generate categories. One interesting observation was the overarching theme of separating natural from artificial things. This was obvious in categories such as “the built environment” and “artificial things backgrounded by nature” but is more subtle and in many ways more interesting in the categories of “organisms with self-awareness” and “groups of people having a good time.” These types of categories not only reflect a division between animate and inanimate but also reflect a preoccupation with emotion and consciousness. Participant 2’s categories reflect a continuum from the purely artificial, to mixed living and artificial subjects, to self-aware organisms, and finally, to humans experiencing emotions. The one outlier category is “military,” but with some inference, this could be seen as again reflecting the outcome of human endeavors.

The data collected also included the characteristics of the movements used by the participants to perform one of the categories. Due to time constraints and the limited data

from the workshop, these movements did not present themselves for any form of significant analysis other than pure description.

Feedback from participants.

The participants both reported feeling less confused about the point of the workshop. This was due to the clarity of the research question and the specificity of the activities. This was a big improvement over the previous workshops. The participants did comment that the images all seemed to be of high quality, as if they were selected for their adherence to good compositional rules. They suggested that I might create more photographic diversity by adding some images that were clearly snapshots taken by amateur photographers.

Personal observations.

While this pilot study was certainly more focused than previous ones and resulted in the collection of usable data, based on feedback from the participants it was determined to be still too loose in structure. An analysis of the movements generated by the participants proved to be too difficult to complete without a point of reference or some means of comparison. This was remedied in the next pilot workshop by directly incorporating the LMA framework from the start. The LMA framework provides unique categories that can be used to describe the characteristics of movement, and for the workshop, it could provide a framework for aligning image features with movement qualities.

One concern that I had following the workshop was that the artificial context did not reflect the participants' full range of connections with the images. In particular, this was the case with Participant 1, who focused purely on compositional elements within the photographs. Although this could have been an authentic exploration of her relationship with the contents of the images, it seemed more a reflection of some kind of priming effect such as the result of a demand characteristic biasing her towards the identification of image characteristics that were easily transformed into movements (Nichols & Maner, 2008). The possibility of this effect occurring would need to be checked in subsequent pilot studies and in the full-scale study.

Pilot Study 5

The final pilot study built on the previous one and included the LMA Efforts as the focus of the movement activities. This workshop also had two participants, one expert mover and one novice mover. The expert mover had been a participant in the previous tagging pilot test. Two hours were allocated for the workshop.

Rather than use this workshop primarily to elicit feedback from participants, I instead designed the activities to test the applicability of using the LMA framework to guide the activities. The workshop activities were very similar to those of the previous workshop and used the same images. This workshop functioned primarily as practice for the final workshop and as such did not involve the same level of feedback from the participants or data analysis. Rather, a consultation with an LMA expert was conducted following the workshop to ensure that the activities were in line with current LMA practices.

Workshop activities.

The workshop began with an introduction of my research and an explanation of the focus on using movement as a method of tagging visual content. Rather than use a general movement warm-up, I guided the participants through a demonstration of the four LMA Effort qualities: Flow, Weight, Time, and Space. This was necessary because the remainder of the workshop would use knowledge of these Efforts and their polarities.

Although in a full-scale study, all of the LMA Effort qualities would be investigated, for this pilot study I chose to focus on the Space Effort. For the first activity, the two participants were given the same two photos, one with a strong evocation of Direct Space, the other of Indirect Space. The participants were asked to come up with movements emphasizing the Space Effort, which they would use to describe these photos kinesthetically. This activity was selected because it would allow me to ensure that the participants had a clear understanding of the LMA Space Effort while simultaneously allowing them to complete a fairly straightforward movement exercise.

Once the participants generated their movements, we came together as a group to share them. This was followed by a discussion addressing the following questions:

- What kinds of things are similar in the way are you seeing or kinesthetically sensing these performances?
- What things are different?
- Do you feel that someone else's movements strongly resonate with your experience of space in the images?

The next activity had two parts. The participants were given a full set of 35 photos and asked to first sort them into three piles: those that for them evoked a strong sense of Direct Space, those that invoked a strong sense of Indirect Space, and those that did not evoke Space at all. Once they had completed the grouping task, they were asked to sort the photos that evoked Direct and Indirect Space on a continuum depicting the relative amounts of the Effort present.

The participants were then asked to create short movement sequences enacting two of the photos, one evoking a strong sense of Direct Space and one Indirect Space. Once they had completed these sequences, they then shared them with the group as a whole. The group was asked to try to identify which photos were being enacted, and this facilitated a discussion of the movements' qualities as well. After everyone had completed demonstrating their movements, the group discussed what worked and what didn't and their experiences as both movers and observers.

Following the discussion, the participants were asked to distill their movement sequences down to the simplest set of movements possible that would still convey their original intentions. These were then shared with the group and discussed.

The final individual activity involved the participants returning to the photos that they had already performed and identifying the features or attributes that informed the photos' classification as depicting either Direct or Indirect Space. They were asked to label a note card with those attributes and place it next to the photo. These were photographed for later analysis.

We concluded with a final group discussion during which we addressed the following questions:

- What attributes of the images were associated with Space Efforts?

- Were there similarities between different participants?
- Do some attributes better lend themselves to being described by Space Efforts?
- How did limb or body use relate to the photographic content or features?
- What was the role of body awareness or movement experience in the activities?
- Any other insights?

Appendix B. Images Used In Sorting Study.

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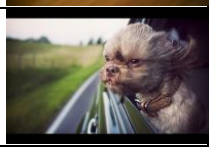
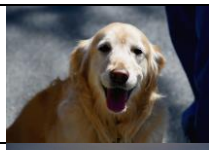
“Not A Care In The World” by Ian Wedlock is licensed under CC BY-ND 2.0 http://www.flickr.com/photos/ianwedlock/3923809669/	

“Happy Golden” by liz west is licensed under CC BY 2.0 http://www.flickr.com/photos/calliope/136335411/	
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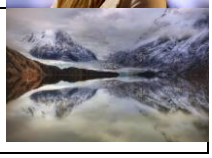
“The Glacially Still Morning Lake” by Trey Ratcliff is licensed under CC BY-NC-SA 2.0 http://www.flickr.com/photos/stuckincustoms/4247290972/in/photostream	

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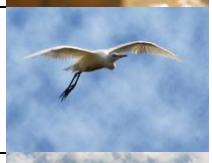
“White bird fly” by Flavio is licensed under CC BY 2.0 http://www.flickr.com/photos/37873897@N06/3814726822/	
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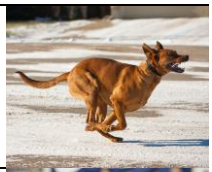
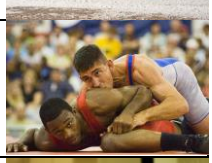
“SHe-Ra In Mid-Stride” by Jason Mooy is licensed under CC BY-NC 2.0 http://www.flickr.com/photos/jay_mooy/6723684191/	
“World Class Athlete Program - WCAP - Best Of - United States Army - FMWRC” by familymwr is licensed under CC BY 2.0 http://www.flickr.com/photos/familymwr/4930510749/	
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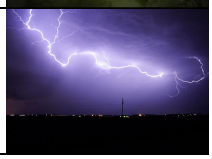
“Nature's Power” by Rachel Gardner is licensed under CC BY-NC-ND 2.0 http://www.flickr.com/photos/rachelrusinski/2586245854/	

Appendix C. Excerpts From Coding Journal.

May 31

I am going through my codes today to continue to revise and condense them into primary groupings. I noticed that some of what I had done last time was not jiving with me today and I adjusted the names of several categories. This included changing several items listed under “Strategies for Interpreting Images”. First, I changed the category “Insertion into the image” to “Image as Narrative” since I felt this more accurately reflected the essence of what participants were doing in these examples. This often included insertion into the image, but this was not always explicitly stated by the participants. Another change was changing “bodily awareness” to “Physiological Response” since this covered emotional responses, breathing focus, and more visceral responses as well. I also found that the item “judging the image” was difficult to place. I found that several of the segments that were labeled with this code did not seem to warrant it and I was unsure in some cases why it was applied. In others I found that the judgment was part of a larger process in which judging was only a small and often unnecessary component. And in one case it seemed I had tagged it to emphasize that the participant made statements that she did not judge the images. I was considering moving this particular code under the category “Analytical/Distanced responses” but felt that most of the cases where judgment was legitimately applied there was a strong emotional component. So it was not a cold and removed response. For now I am leaving it out of the coding scheme, but will consider adding it back if necessary. I am also removing the category “immediate Experience/reaction” since this was the only code listed under it.

I had also started to lump the categories under larger primary headings. The only one that I had created was “Image Properties”, but looking at my list of codes that seems unnecessary at this point so I removed it.

“Focus on Energy in the Image” was a strategy only mentioned once. I am not sure where to put it as it does seem to be its own unique approach, so I am leaving it as both a category and its only sub-code. This might be an interesting code to follow up on since it is an outlier.

I just looked at the codes for “Process of Interpreting Images” and it seems like these are really only going to be interesting by looking at their intersections with strategies since that will illuminate any problems or interesting occurrences that happened during the process of interpreting. I’m going to skip these for now.

November 25

The codes have been re-categorized into more meaningful groupings. One of the more difficult tasks was deciding how to categorize the process and strategy related codes since some of them are applicable to multiple activities and some are not. (This includes strategies for identifying Effort, Process of Identifying Effort, Process of Distilling Movement, and Process of creating Movement). Ultimately I have decided to merge them together into single categories as much as possible to avoid later confusion by having lots of duplicate codes in different parent categories.

I’m also trying to decide if I should apply a framework for the categorization of image features before the second round of coding or after it. If I apply it beforehand I will need to insert the current features that the participants identified into their respective categories and then use those categories to tag the transcripts. If I wait until afterwards I will be working directly with the material provided by the participants and will categorize the codes once I complete the second round of coding. This latter option keeps me more connected to the participants own language and ideas so it is likely what I will do.

December 3

Finished revising the codes and adding them back into MaxQDA. I ran into some left over codes that for some reason had not made it into the final version of my excel file, so I had to spend some additional time placing them into the tree structure.

I started to go back over the transcripts with the new coding scheme and already have changed some of the code organization. The biggest change is to the “Factors Influencing Interpretation and Movement Creation”. I added positive and negative code

categories and moved all the codes into these sections. I also added a code for being “free of judgment” since all my strategies for interpreting images deal with the presence of factors (e.g. judgment, etc.), not their absence. But I felt it was important to note when people commented on having no problems with over analysis or judgment.

December 5

I’ve been going back over the transcripts to recode them with the new code system, and I have found that I missed a lot of coding opportunities the first time through. I’m also noticing some really interesting phenomena in relation to how people chose efforts for the images and how they created movement. The two most prominent ones that I found today were in the Flow Final Discussion. The first code I labeled “Effort Classification based on liking or disliking image”. This came up when P1 mentioned that during the sorting exercise she noticed that all the Bound Flow images were ones that she disliked. And all the Free Flow ones were ones she liked:

> “I was going to comment on how much of our preconceived notions and ideas we bring into this exercise and how it informs our choices so much, so for example, we know that we both , for bound, we both chose images that we strongly dislike, or we both dislike doing the actions, or we don't support the object or the movement, and to us that really created an emotional state of tension and kind of shying away from -- and that really informed how we both represented those ideas.”

P2 reported another finding dealing with the presence of both Effort Polarities existing at once. She describes the process of choosing the effort polarity that appears to be dominant in a photo and how the act of movement creation informed her thought process and reversed her decision:

> “[With] The picture of the ocean slamming against the cliff. I thought the ocean is very free and when I got up to do it and hitting like that, that was the stop, the bound. So it did include both free and bound. But the action of the photograph was bound. “

P3 reported a similar phenomenon involving the co-existence of both Effort Polarities and how they work together:

> "My image for free flow was one that actually encompassed what I saw as the power of bound. So it seemed like it had more freedom and more direction if it was balanced by the bound energy. I also found the experience of trying to separate the two was very challenging at points because some images I found had definitely had both. "

December 11

Weight

I've been coding weight today and one of the primary findings that I am seeing is the tendency to over intellectualize weight in the quick enactment exercise. People compared it regularly to flow (which is the only other effort we had explored at this point) and many comments talk about how much easier and more intuitive Flow was than weight. Some of this I ascribe to the fact that weight is often misunderstood to be about heavy/light not Strong/light so it takes some getting used to intellectually. So that may have been what was going on with this group.

The sorting exercise game further insight into how the participants dealt with weight. Rather than being more difficult due to the number of photos to classify, many of the participants felt that sorting and classifying the images based on weight was easier than creating movement. This seems to be due partially to some of the clarifications that came out of the previous discussion, but also due to what many participants called the "dualistic nature of weight". Apparently this made it easier to classify in a binary manner where either there was exertion against gravity or there wasn't. At the same time, Cheryl was clear that there is always a spectrum and that focusing on this binary relationship is actually a misconception of weight effort.

Despite this perceived duality, there was a tremendous amount of discussion about weight and the participants seemed to get very interested in the nuances of the Effort and the ability to interpret in myriad ways depending upon ones perspective and perception.

Time

In the time coding, there is some really interesting use of breath and body awareness as a strategy for overcoming some of the challenges of responding to time in

an image. More than the other efforts time seems to be one that people really want to connect with in a person way and get frustrated when they cannot. This should be explored in depth.

December 13

Space

Started re-coding the Space discussions today and already it seems that there is something very different about the ways that people are responding to the images for this effort. The very first comments are about how a number of the participants could not figure out what they were responding to in the images, whether it was something in their body that responded, or an emotional association. This seems very different from previous discussions. It also clearly shows that selecting an Effort to focus on changes how we experience imagery which is really interesting.

Appendix D. Images Used in Quick Enactment Activity.

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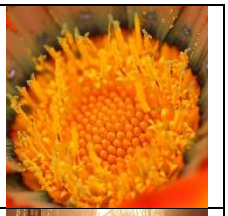
“flower eruption” by Mukumbura is licensed under CC BY-NC-ND 2.0 http://www.flickr.com/photos/mukumbura/3908911459/	
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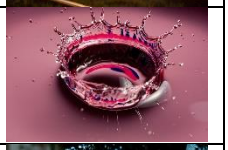
“water burst” by spettacolopuro is licensed under CC BY-NC-ND 2.0 http://www.flickr.com/photos/spettacolopuro/3891599149/	
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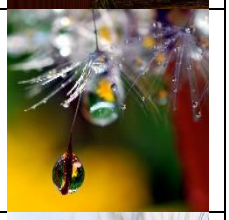
“droplet” by Steve Wall is licensed under CC BY-NC-ND 2.0 http://www.flickr.com/photos/stevewall/489788176/	
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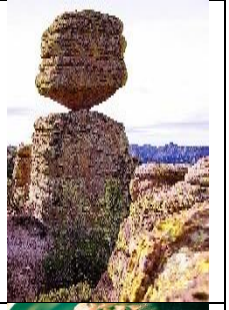
“balancing rock” by Alan English CPA is licensed under CC BY-NC-ND 2.0 http://www.flickr.com/photos/alanenglish/6773881663/	
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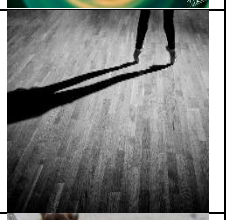
“tip toes” by Mait Jüriado is licensed under CC BY-NC-ND 2.0 http://www.flickr.com/photos/mait/5184800034/	
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Appendix E. Initial First Round Codes.

	Parent code	Code	Coded Segments
1		Visual Artist	0
2		City	1
3		Walking	0
4		Agreement with another participants idea	2
5		Affinities between gestures (where they align)	1
6		performing for an audience	2
7		Observing vs. Performing	3
8		Personal/emotional/cultural history	1
9		Less interpretation	1
10		Alternate way of thinking	2
11		differences between Efforts	1
12		Rules	1
13		Participant Contradicts Earlier Statements	1
14		Post movement reflection	2
15		Chaos	2
16		Differences from day one to day two	1
17		Dancing	1
18		"Not wanting to let go"	0
19		Acting/Actors	1
20		Athletes	1
21		Voice	1
22		Movement as a form of Investigation	1
23		Things that stopped the movement	4
24		Response Time	2
25		Benefit of Warm-up	2
26		Abstraction	2
27		Participants	0
28	Participants	Sierra	10
29	Participants	Monica	12
30	Participants	Manuela	26
31	Participants	Charlotte	15
32	Participants	Chu	7
33	Participants	Haley	18
34	Participants	Chantalle	21
35	Participants	Khadija	17
36	Participants	Light Weight	9
37		Efforts	0
38	Efforts	Flow	3
39	Efforts\Flow	Bound Flow	15
40	Efforts\Flow	Free Flow	7
41	Efforts	Weight	2
42	Efforts\Weight	Strong Weight	7
43	Efforts\Weight	In between strong and light	2
44	Efforts	Time	4

45	Efforts\Time	Sudden Time	6
46	Efforts\Time	In-between sustained and Sudden	1
47	Efforts\Time	Sustained Time	6
48	Efforts	Space	2
49	Efforts\Space	Direct Space	14
50	Efforts\Space	Indirect Space	13
51		Image Features	0
52	Image Features	Surveillance/Being Watched	1
53	Image Features	Bars/Jail	1
54	Image Features	Military	1
55	Image Features	Melting Snowman	1
56	Image Features	Giant (vast) Image	0
57	Image Features	Grand Canyon	0
58	Image Features	City Scape	2
59	Image Features	Action	2
60	Image Features	Animals	3
61	Image Features	Ballerina	1
62	Image Features	Breath	1
63	Image Features	Bucking Bronco	1
64	Image Features	Candid Shots	1
65	Image Features	Car	1
66	Image Features	cat	1
67	Image Features	Chains	2
68	Image Features	Cliffs	1
69	Image Features	Consuming vs. Expansive	1
70	Image Features	Desert	1
71	Image Features	Dew Drop	1
72	Image Features	Disorganization (inferred)	1
73	Image Features	Diving	3
74	Image Features	Dog	1
75	Image Features	Duration	1
76	Image Features	Emotional Intensity (Inferred)	1
77	Image Features	environments	3
78	Image Features	Eyes	1
79	Image Features	Facial Expressions	1
80	Image Features	Familial Dynamics	2
81	Image Features	Family Photo	2
82	Image Features	Fire	4
83	Image Features	Flower	2
84	Image Features	Gravity	2
85	Image Features	Gun	1
86	Image Features	Human Activity	1
87	Image Features	Implied Motion	3
88	Image Features	Landscapes	5
89	Image Features	Large Objects	2
90	Image Features	Laughing Woman	1

91	Image Features	Lightning	1
92	Image Features	Little Kid	1
93	Image Features	Metal	1
94	Image Features	Mother and child	1
95	Image Features	objects	4
96	Image Features	People	7
97	Image Features	People Performing Actions	2
98	Image Features	Posed Imagery	1
99	Image Features	Positive Emotion	1
100	Image Features	Power/Powerful	1
101	Image Features	Rock	2
102	Image Features	roots	1
103	Image Features	Running	2
104	Image Features	Running Dog	1
105	Image Features	Shape	2
106	Image Features	Splashing	1
107	Image Features	Sports	4
108	Image Features	Stationary/Rooted Objects	0
109	Image Features	Strength	1
110	Image Features	Tension	1
111	Image Features	Tension	1
112	Image Features	The Elements	5
113	Image Features	Volleyball	2
114	Image Features	Water	5
115	Image Features	Wood	2
116		Reactions	0
117	Reactions	enjoyment	3
118	Reactions	Surprise	1
119	Reactions	Un-Believability/Amazement	1
120		Activity Type	0
121	Activity Type	Working alone	1
122	Activity Type	Working with others	2
123		Experiential Elements	0
124	Experiential Elements	Split Focus	1
125	Experiential Elements	being too open to (or aware of) everything around you	1
126	Experiential Elements	Indirect focus	0
127	Experiential Elements	Need to direct focus	1
128	Experiential Elements	attention/focus	1
129	Experiential Elements	Simultaneity (experience of everything happening at once)	1
130	Experiential Elements	Expanding Outward	1
131	Experiential Elements	Greater sense of space	1
132	Experiential Elements	expanded attention	1
133	Experiential Elements	Focused attention	2
134	Experiential Elements	Experiencing both effort polarities during a movement sequence	1
135	Experiential Elements	Awareness of organs (insides)	1
136	Experiential Elements	Awareness of bones in body	2

137	Experiential Elements	Touching Space	1
138	Experiential Elements	Intensity of Effort	1
139	Experiential Elements	muscle tension	1
140	Experiential Elements	Experiencing movement	3
141	Experiential Elements	Presence	1
142	Experiential Elements	Dynamics	1
143	Experiential Elements	Experience of Suffocating	1
144	Experiential Elements	Being present	1
145	Experiential Elements	Experience of Time in photographs	1
146	Experiential Elements	Inner versus outer experience	1
147	Experiential Elements	Duration vs. Experience of time	1
148		Awareness Level	0
149	Awareness Level	Subtle or limited awareness	0
150	Awareness Level	Strong Awareness	2
151		Working with Others	1
152	Working with Others	Choosing same image for depiction	1
153	Working with Others	Similar movements to partner	1
154	Working with Others	Agreement with partner on effort dimension in photo	2
155	Working with Others	Similar experience to another group	1
156	Working with Others	Shared underlying thought process	1
157	Working with Others	Disagreement with partner over Effort interpretation	2
158	Working with Others	visibility of movement to partner	2
159	Working with Others	Interpreting others movements	3
160	Working with Others	Seeing from someone else's perspective	3
161		Relationship to Gravity	1
162	Relationship to Gravity	Active Exertion Against Gravity	1
163	Relationship to Gravity	Passive relationship to gravity (Just being)	1
164	Relationship to Gravity	"Letting go to the environment"	1
165		Duration of Movement	1
166	Duration of Movement	Duration: Long	1
167		Influences on interpretation	1
168	Influences on interpretation	Adjacent thoughts (before or after seeing image)	1
169		Process of interpreting movement	1
170	Process of interpreting movement	Relying on the face to differentiate effort polarities	1
171		Strategies for interpreting the images	3
172	Strategies for interpreting the images	Connecting to personal experience	1
173	Strategies for interpreting the images	Becoming the surroundings in an image	1
174	Strategies for interpreting the images	becoming the subject of an image	2
175	Strategies for interpreting the images	Connecting with the action in an image	1
176	Strategies for interpreting the images	Connecting with subject of image	1
177	Strategies for interpreting the images	Focus on energy in the image	1
178	Strategies for interpreting the images	Abstraction (Abstract Choices)	1
179	Strategies for interpreting the images	Reacting to something (unknown)	0
180	Strategies for interpreting the images	Bodily or sensory reaction	1
181	Strategies for interpreting the images	Cause and effect	2
182	Strategies for interpreting the images	Focus on Breath/Breathing	3

183	Strategies for interpreting the images	Connecting to people/animals in images	5
184	Strategies for interpreting the images	Metaphorical Interpretation	3
185	Strategies for interpreting the images\Metaphorical Interpretation	following a path	1
186	Strategies for interpreting the images	Imagining a Scenario	9
187	Strategies for interpreting the images	embodying the image	3
188	Strategies for interpreting the images	judging the image	4
189	Strategies for interpreting the images	observers relationship with the image	6
190	Strategies for interpreting the images	Observing the Image	3
191	Strategies for interpreting the images	Becoming the image	11
192	Strategies for interpreting the images	Immersion within the image	12
193	Strategies for interpreting the images	Reacting to images	17
194		Process of interpreting images	17
195	Process of interpreting images	Feeling free to make a decision	2
196	Process of interpreting images	Focusing on a particular body part	1
197	Process of interpreting images	New awareness after dialogue with partner	1
198	Process of interpreting images	Sense of limited options for interpretation	3
199	Process of interpreting images	Familiarity with the images (over duration of workshop)	1
200	Process of interpreting images	Preconceived Notions	6
201	Process of interpreting images	Acting on Impulse	21
202	Process of interpreting images	Analytical Voice/inner dialogue (Overthinking)	11
203	Process of interpreting images	Identifying the Effort in an image	1
204		Process of Sorting Images	7
205	Process of Sorting Images	Using other performance tools	1
206	Process of Sorting Images\Using other performance tools	Pachenko Clowning	1
207	Process of Sorting Images\Using other performance tools	Clowning	1
208	Process of Sorting Images	imagining becoming the object	1
209	Process of Sorting Images	Imagining ways to interact with object	1
210	Process of Sorting Images	Automatically accessing prior knowledge/tools	2
211	Process of Sorting Images	imagining a scenario	1
212	Process of Sorting Images	Using tools from animation	1
213	Process of Sorting Images	contextualization	1
214	Process of Sorting Images	Associations with image	1
215	Process of Sorting Images	image potential (what could happen next?)	2
216	Process of Sorting Images	Sense of the Dualistic nature of the effort polarities	2
217	Process of Sorting Images	Feeling of right and wrong interpretation	1
218	Process of Sorting Images	Contradictory Effort Elements	2
219	Process of Sorting Images	Personal Experience	2
220		Process of Distilling Images	6
221	Process of Distilling Images	clear difference between effort polarities	1
222	Process of Distilling Images	internalization of Efforts	1
223	Process of Distilling Images	clear concept of how to distill	2
224	Process of Distilling Images	instant Reaction	1
225	Process of Distilling Images	Focus on the INTENTION behind the movement	1
226	Process of Distilling Images	focus on the FORCE behind the movement	1
227	Process of Distilling Images	Distilled movements feel the same	3
228		Process of creating movement for images	7

229	Process of creating movement for images	Connection with internal experience	1
230	Process of creating movement for images	Focus on energy in image	1
231	Process of creating movement for images	Eyes leading movement	0
232	Process of creating movement for images	Features of images used to guide movement	6
233	Process of creating movement for images	Focusing on "energy" in an image	1
234	Process of creating movement for images	Reacting to other people	1
235	Process of creating movement for images	Mimicry	3
236	Process of creating movement for images\Mimicry	Figurative or metaphorical imitation of elements in the image	1
237	Process of creating movement for images	Re-enactment	3
238		Movements	0
239	Movements	Body parts involved in movement	0
240	Movements\Body parts involved in movement	Limbs (general)	0
241	Movements\Body parts involved in movement	Eyes	1
242	Movements\Body parts involved in movement	pelvis	1
243	Movements\Body parts involved in movement	legs	1
244	Movements\Body parts involved in movement	Skull hinge	1
245	Movements\Body parts involved in movement	Neck	3
246	Movements	Characteristics of movements	0
247	Movements\Characteristics of movements	Stare/Direct Gaze	1
248	Movements\Characteristics of movements	Directionless/Indirect	2
249	Movements\Characteristics of movements	Chaotic	1
250	Movements\Characteristics of movements	"Accepting" Movements	0
251	Movements\Characteristics of movements	"Boundaries between body and space dissolve"	1
252	Movements\Characteristics of movements	"Hungry" movements	0
253	Movements\Characteristics of movements	"slowly absorbing the atmosphere"	1
254	Movements\Characteristics of movements	Calm Movements	1
255	Movements\Characteristics of movements	Clashing	0
256	Movements\Characteristics of movements	Constant Movement	1
257	Movements\Characteristics of movements	curl	1
258	Movements\Characteristics of movements	Direction Changes	0
259	Movements\Characteristics of movements	down	1
260	Movements\Characteristics of movements	lifting	1
261	Movements\Characteristics of movements	Looking around	0
262	Movements\Characteristics of movements	Moving everywhere	1
263	Movements\Characteristics of movements	Open-ness - "Letting things come in to you"	1
264	Movements\Characteristics of movements	plié	1
265	Movements\Characteristics of movements	pumping	1
266	Movements\Characteristics of movements	repetition	1
267	Movements\Characteristics of movements	Searching Movements	1
268	Movements\Characteristics of movements	Sense of being grounded	1
269	Movements\Characteristics of movements	Sharp	0
270	Movements\Characteristics of movements	Slight Moves	1
271	Movements\Characteristics of movements	tiptoe-ing	1
272		Experience of Difficulty	0
273	Experience of Difficulty	one effort easier than another	1
274	Experience of Difficulty	Difficulty: Hard	10
275	Experience of Difficulty	Difficulty: Easy	4
276		Difficulties	5
277	Difficulties	Contradiction between effort polarity and movements	1
278	Difficulties	Losing the feeling of authentic movement	1
279	Difficulties	Contradictions between what is seen and what is felt	1
280	Difficulties	Difficulty differentiating between focused and expanded attention	1
281	Difficulties	Difficulty distilling movement	1
282	Difficulties	Limits of perception	1
283	Difficulties	Sense of having no control over how brain interprets images	1
284	Difficulties	Comparison with Others Interpretations	3
285	Difficulties	Seeing from within ("Need to get inside my inner eyeballs")	0
286	Difficulties	Difficulty Sorting	0
287	Difficulties	Difficulty with the medium (photography)	1
288	Difficulties	Dealing with time in still images	3
289	Difficulties	Expectations	1
290	Difficulties	Contradictory Interpretation	12
291	Difficulties	Feeling Boxed In	1
292	Difficulties	Desire to be Creative	2
293	Difficulties	Stereotypical or obvious response/interpretation	4
294	Difficulties	Self Judgement/Doing it wrong	5
295	Difficulties	Concerns about stopping moving	1
296	Difficulties	Difficulty overcoming realism of the Images	1
297	Difficulties	Not liking the imagery	1
298	Difficulties	Confusion with Instructions	2
299	Difficulties	Difficulty generating movement	3
300	Difficulties	Difficulty with LMA Concepts or Terminology	6
301	Difficulties	Difficulty interpreting effort polarity	11
302	Difficulties	Multiple Interpretations	2
303	Difficulties\Multiple Interpretations	Multiple interpretations of effort quality in image	3
		Total Coded Segments	**765**