

Good Times?! 3 Problems and Design Considerations for Playful HCI

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Abstract

Using Location-aware Multimedia Messaging (LMM) systems as a research testbed, we present an analysis of how ‘fun or playfulness’ can be studied and designed for under mobile and ubiquitous environments. These LMM systems allow users to leave geo-tagged multimedia messages behind at any location. Drawing on previous efforts with LMM systems and an envisioned scenario illustrating how LMM can be used, we discuss in detail what playful experiences are and three problems that arise in realizing the scenario: how playful experiences can be inferred (the inference problem), how the experience of capture can be motivated and maintained (the experience-capture maintenance problem), and how playful experiences can be measured (the measurement problem). We respond to each of the problems by drawing three design considerations for playful Human-Computer Interaction: 1) experiences can be approached as information-rich representations or as arising from human-system interaction 2) incentive mechanisms can be mediators of fun and engagement, and 3) measuring experiences requires a balance in testing methodology choice.

Keywords: Playful HCI, playful experiences, fun, location-aware multimedia messages, mobile and ubiquitous computing, context-awareness

Introduction

On a sunny afternoon in mid-July, Nicole and Nick are tourists shopping around Nejme Square in downtown Beirut, Lebanon. While Nick insists on seeing the cultural offerings of Saifi Village, a village completely rebuilt as a New Urbanist-style neighborhood after its destruction during the civil war, Nicole has a different notion of what is fun and enjoyable. Familiar with her interests in warm, foreign cities, Nicole’s mobile device sets her to experience ‘fun’ places nearby, suggesting several lively cafés along the Corniche, a seaside walkway with a glittering view of the Mediterranean. Skeptical about the suggestion, she makes a predefined gesture instructing her device to show her different multimedia (photos, songs, videos, text) that reflect people’s experiences there. The device presents her with a dizzying nexus of visual and musical perspectives captured by people enjoying themselves, complementing each multimedia message with related past and future events. Leaving Nick, she makes her way toward the Corniche until she reaches a café, where she sits outdoors, happily absorbing the scorching sun rays. Wondering where Nick went, she decides to capture her current experience. She takes a photo of the clear blue sky and sea (Fig. 1), which she annotates with the song by The Cure ‘Play for Today’ and writes: “That’s New Urbanist-style culture too!!” While she awaits her hookah and drink, she scans through other people’s experiences at the café she is at, only to realize the place attracts mainly an older crowd, which is no fun at all.



Figure 1: A mockup illustrating the photo Nicole took of the Corniche seaside and the corresponding annotations she added.

The preceding scenario illustrates ongoing research efforts within the MOCATOUR¹ (Mobile Cultural Access for Tourists) project. The aim of the project is to define computational methods that facilitate tourists with contextualized and media-based access to information while they freely explore a city. The provision of contextualized information anytime, anywhere, to the right persons as they go about their daily lives is part of an emerging paradigm dubbed as ubiquitous computing (Weiser, 1991), context-aware computing (Dey, Abowd, & Salber, 2001), pervasive computing (Ark & Selker, 1999), embodied interaction (Dourish, 2001), or everywhere (Greenfield, 2006). Irrespective of the name given, a central tenet of this paradigm is the promise of populating our everyday lives with context-aware services that make interaction with the world easier, more manageable, and more efficient. This endeavor is made possible through embedding (at times personal and imperceptible) low-cost and low-power sensors and devices into our everyday environment.

A major step in this direction has been the widespread adoption of location-aware technologies such as GPS-enabled mobile devices and automotive GPS. Yet with our cities becoming interfaces for computational experimentation that are intermixed with human activities, we need systems that go beyond location-awareness and towards context-awareness (Dey, 2001). In other words, we need to know more about context (Dey, 2001), its inference from human activity, and how that feeds into our everyday experiences. As Bellotti and Edwards (2001) state, inference and adaptation to human intent in context-aware systems is at best an approximation of the real human and social intentions of people. This raises the need to further explore the kinds of services and usability issues brought forth under real-world usage contexts.

One important shift from computing for the desktop to computing for the world is that systems need no longer be about work-related activities, but also about fun and playful² endeavors (Cramer et al., 2010). To realize the system that Nicole in the introductory scenario uses, context-aware systems need to know not only about locations, but about people's lived experiences and their relationship(s) to the location(s) they took place at. To this end, we make use of Location-aware Multimedia Messaging (LMM) systems. Such systems allow people to create multimedia messages (photos, text, video, audio, etc.) that are anchored to a place, which can be received/perceived and interpreted by other people at (approximately) the same place where the message was made (*cf.*, Nicole's photo portrait in the above scenario made

¹ <http://mocatour.wordpress.com>, last retrieved on 25-08-2010

² Throughout this paper, we will use the concepts of fun and playfulness interchangeably.

at the café on the Corniche). Given that locations within cities are rich sources of “historically and culturally situated practices and flows” (Williams & Dourish, 2006, p. 43), it is reasonable to assume that LMMs can reflect culturally entrenched aspects of people’s experiences at locations.

Given the above scenario, how can a system ‘know’ what fun or playful experiences are, in general and idiosyncratically as in Nicole’s case of not enjoying older crowds? What kind of contextual elements can be automatically acquired (e.g., date, time, place) to infer playful experiences, and are these contextual elements rich enough to disambiguate the meaning of a user’s activity, with and beyond interaction with the system (Dourish, 2004)? Should playful experiences be coded as representations to be used as information that the system makes use of (as in Nicole’s device), or should fun be understood as an enjoyable open-ended interaction dialogue between a human and machine (Cramer et al., 2010)? If the latter, what kind of mechanisms need to be in place to ensure that not only the information presented is ‘about’ fun and playful experiences, but the human-machine interaction is itself an enjoyable experience? If fun and enjoyable experiences can indeed be predicted and catered for, how can this be measured?

Below we will try to address the above questions, where the rest of this paper is structured as follows: first, we provide definitions for an experience in general and a playful experience in particular (Section: What is a Playful Experience?). Next, we discuss in detail that inferring playful experiences largely depends on whether context is viewed under a positivist or phenomenological lens (Section: The Inference Problem). Then, we briefly describe past research efforts with using a LMM prototype that allows capturing experiences into different media forms and discuss how the playful experience of capture can be maintained (Section: The Maintenance Problem). Afterwards, we briefly highlight common methodological problems that arise when measuring experiences of people under mobile and ubiquitous environments (Section: The Measurement Problem). In response to each of the mentioned problems, we draw three design considerations for the study and design for playful experiences under mobile and ubiquitous environments (Section: Design Considerations). Finally, we present our conclusions and direction for future work (Section: Conclusions).

What is a Playful Experience?

We agree with Law et al. (2009) when they state that the high degree of mutual consensus in the current Human-Computer Interaction (HCI) community over the importance of studying and designing for the user experience (UX) is truly intriguing. The trend towards thoroughly investigating the UX is in part a reaction to the traditional HCI usability frameworks that take user cognition and performance as key aspects in the interaction between humans and machines. With the advent of mobile and ubiquitous computing, human-technology interactions, even if they *involve* work settings, need not be *about* work (Cramer et al., 2010; Greenfield, 2006). This computing for everyday ‘non-serious’ life has shifted the attention of HCI towards user affect and sensations, where the user experience has become a desirable thing to have during the interaction with a system. Yet what exactly is this user experience? As Law et al. (2009, p. 719) write: “...UX is seen as *something* desirable, though what exactly *something* means remains open and debatable.” They move on to argue that embracing a unified definition of the user experience can reap valuable scientific and (industrial) design benefits by: a) facilitating scientific discourse within and across disciplines to avoid communicational breakdown b) aiding the operationalization and

evaluation of experience-centric applications c) helping understand the term, its importance and scope.

The term ‘user experience’ is already pregnantly associated with a wide range of fuzzy and dynamic concepts, with attached attributes such as pleasure, joy, pride, etc. (Law et al., 2009; Hassenzahl & Tractinsky, 2006). In a survey conducted to arrive at a unified definition of UX, Law et al. (2009) found that the elements of the UX provided by their participants largely conformed to the ISO definition of UX (1994), which states: “A person’s perceptions and responses that result from the use or anticipated use of a product, system or service.” We find that the ISO definition to be accurate, in part because it provides an abstraction without appeal to specific affective attributes (such as fun or pleasure). However, we find that its accuracy comes at the cost of being overly general in aiding the study and design of context-aware systems. Also, while the definition provides the future aspect of anticipating an experience, it is missing the retrospective aspect of looking at a finished experience.

In attempt to understand experiences, we took the present and past relational temporal properties of experience into account, allowing us to distinguish between prospective experiences (i.e., experiences as they are currently happening) and the retrospective understanding of experiences (i.e., the mental time travel to an experience episode in the past (Tulving, 2002)). This is in line with how Hassenzahl and Sandweg (2004) understand an experience, where they make a distinction between instant utility (a moment in product use within a larger experience episode) and remembered utility (a retrospective summary assessment of the product use experience). Not surprisingly, when they asked their participants how they felt towards a product after they used it, they found that remembered utility is not necessarily the sum of all measured instant utilities. As will be explained later, the decision to view an experience from within (during its occurrence) or from without (after its elapse) also relates to which epistemological stance (positivist or phenomenological) one adopts in conceptualizing and reasoning about the world³.

We distinguish between the process of an experience and the memory of an experience, where playful experiences are a subset of both. We define the process of an experience (based on Nack, 2003) as a sensory and perceptual process that some person undergoes (either through direct participation or observation of events and situations) that results in a change in that person. The high variability and subjective interpretation involved in predicting an experiential process indicates that it is useful to retrospectively capture a given experience; in other words, to consider the memory of an experience. Based on Tulving’s definition of an episodic memory (Tulving, 1993), we define an experience memory as the result of an experiential process, which can be manipulated and actively recalled. The memory of an experience consists of one or more actors, a spatiotemporal aspect, a social aspect, a cognitive aspect, and an affective aspect. We use these aspects of an experience memory as a basis for studying experience capture using LMMs. This approach is similar to the one employed by Wigelius and Väättäjä (2009), where they made use of five dimensions of the user experience to study and design for mobile work (e.g., mobile news journalism): social, spatial, temporal, infrastructural, and task context. However, while Wigelius and Väättäjä (2009) separate the characteristics of the user and system from the contextual factors involved, in our understanding of experiences we treat contextual factors as part and parcel of the user’s memory of a past episode.

³ While the field of epistemology involves more than just positivism and phenomenology, we are here concerned with only these two.

A playful experience, when understood as a process, is characterized by amusement, risk, challenge, flow, tension, and/or negative affect (Csikszentmihalyi, 1990; Nacke et al., 2009). However, we believe that only amusement, which is an affective reaction to a ‘playful’ activity, is a sufficient condition for playful experiences. While the other attributes (such as tension, risk, flow) can frequently occur in playful experiences, each by themselves, unlike amusement, do not uniquely give rise to a playful experience. According to the definition of playfulness provided by Cramer et al. (2010, p. 1), playfulness refers to “non-utilitarian (but not necessarily non-useful) aspects of interactions that provide pleasure or amusement.” While we do not fully agree with Cramer et al. (2010) that a playful experience is non-utilitarian (as playful experiences serve a practical goal of making one feel better as well as aid child learning and development), we do agree that playfulness is largely based on how an activity is approached, rather than an essential property of the activity itself (Csikszentmihalyi, 1990). While this indicates that playfulness is a mental state brought forth by users to an activity, it does not entail that playful interactions cannot be anticipated for particular user groups and explicitly designed for. In other words, if coupled human-system activities frequently draw users toward playfulness during the interaction process, the designer can reason backwards and identify what it is about the interaction that prompted the playfulness in the first place. As will be shown later, the problem of cleanly delineating the cause of a phenomenon (in this case playfulness) for intelligent inference is subject to what notion of context is adopted.

For fun and playfulness, we believe that the most common elicitors of playful experiences are games (e.g., board games, video games), where most games tend to be challenging, create tension, a sense of flow, induce positive and negative affect, and evoke amusement (Nacke et al., 2009; Poels, Kort, & Ijsselstein, 2007). However, something like The World’s Deepest Bin⁴, a bin that makes an elongated sound to indicate depth when someone throws something in it, only elicits brief amusement. Nevertheless, interacting with the bin qualifies as a playful experience because it elicits amusement. What characteristics of playful experiences (e.g., tension, amusement) are to be elicited in users depends largely on the purpose of the system: is the system designed to carry out tasks that are useful or serious (e.g., a context-aware tourist guide (Cheverst et al., 2000) or context-aware firefighter system (Jiang et al., 2004)), or is it meant to entertain (e.g., a location-based game (Benford et al., 2005) or a virtual storyteller (Lim & Aylett, 2009))? While the purpose of the system can aid in helping designers conceptualize the kind of playful experiences desired in interacting with the system, the real problem is how, if at all, can a system infer a playful experience when it happens.

The Inference Problem: Inferring Playful Experiences

How can a system automatically detect and recognize an experience as playful? What kind of contextual clues are necessary for a system to draw this kind of inference? The answer to these questions we believe lies in revisiting the concept of ‘context’. Dourish (2004) argues that the notion of context in ubiquitous computing varies with respect to two distinct schools of thought: positivism and phenomenology.

⁴ One of several initiatives taken by Volkswagen to improve people’s behavior: <http://www.thefuntheory.com/worlds-deepest-bin>, last retrieved on 25-08-2010

Positivist vs. Phenomenological Theories

Positivist theories, tracing back to sociologist Auguste Comte (1880), derive from a rich, rational and empirical history that takes the scientific method as the sole arbiter of objectively attainable knowledge. This epistemological stance seeks to reduce complex social phenomena into objective, clearly identifiable descriptions and patterns that are idealized abstractions of the observed social instances and situations that make up such phenomena. Phenomenological theories on the other hand, tracing back to Edmund Husserl (1893-1917), are essentially subjective and qualitative. Objective reality according to the phenomenologists is always channeled through the interpretive lens of human perception and action; as Dourish (2004, p. 21) writes, “social facts are emergent properties of interactions, not pre-given or absolute, but negotiated, contested, and subject to continual processes of interpretation and reinterpretation.”

According to Dourish (2004), the positivist account of context renders context as a representational problem whereas the phenomenological account makes context an interactional one. The representational problem is essentially concerned with how context (such as location, time or date) can be encoded and represented in a system so that the system can intelligently tune its behavior according to what values these precoded contextual factors take in a given situation. The main assumption here is that human activity and context can be cleanly separated. For example, the lighting of a room (a contextual factor) is seen as independent of the series of actions required to make coffee (activity) in the room.

By contrast, the interactional problem is primarily concerned with how and why people, through interacting with one another, can establish and maintain a shared understanding of their actions and the context they occur in? To revisit the coffee example, the phenomenological take on it would be that the lighting of the room and the coffee making within it are inseparable; they are tightly woven into an activity-context coupling that give a unified experience, without which that particular experience could not be said to have happened. For Dourish (2004), this underscores the distinction between viewing context as a set of stable properties that are independent of human actions and viewing context as an emergent set of features that are dynamically generated through common-sense reasoning and culturally entrenched beliefs about the world throughout the course of interaction. In other words, while positivism strives for universals (attained through the method of induction), phenomenology contests that the richness of particulars is irreducible to abstraction.

Playful Representation or Interaction?

How do the two accounts of context fare into our understanding of playful experiences? In the context of LMM, we make the distinction between playfulness as an information-rich post-hoc representation (*cf.*, experience memory and the positivist claim) and playfulness as interaction (*cf.*, experience process and the phenomenological claim). To illustrate, the kind of playfulness that Nicole’s mobile system in the opening scenario affords is retrospective, where the system representation of experiences is composed of a clearly identifiable collection of past, personal and publicized multimedia messages that have been annotated as ‘fun’. The very act of conceding that labeling these multimedia messages with an identifiable label such as ‘fun’ is possible arises from a positivist understanding of the world. Following the sequence of Nicole’s activities, the representational vehicle (the media presentation of other people’s experiences) which subserves the subsequent experiential process that she undergoes when sitting down at the seaside café (namely, absorbing the sun rays and making a multimedia message of her own) is seemingly no

longer within the scope of her interaction with the system (Dourish, 2001). This happens despite that causally, the system representation is what brought her to have the experience at the seaside café in the first place.

Following Nicole's interaction with the system to its interactional finish point, we see that the situation changes when Nicole consults her device while she awaits her hookah: the system's presentation of an older crowd, mistaken about Nicole's notion of fun, has now interfered with and altered her current joyful experience. This unanticipated system response can be seen as a flaw when explicitly designing playful human-mobile interactions, where 'playfulness' is scoped only between the interactional possibilities that rest between the user and the system. We believe this reflects the deeper issue of whether to treat playfulness as a representational problem independent of the actual activity process involved in playfully perceiving and acting upon it, or on the other extreme, letting the playful process bleed into interaction windows where the interaction is no longer playful. It is this problem of scoping that makes inferring playful experience a hard problem. Since the context-sensitive variables precoded into the system representation do not account for and update dynamically with the unfolding of the human-system interaction process, inferring playfulness becomes entangled between the system representation and the human interaction with this representation, leaving the system with poor inferential precision.

The Maintenance Problem: Motivating and Maintaining Playful Experience Capture

During past research efforts toward understanding experiences in mobile and ubiquitous environments, we studied using an exploratory approach the experiential and contextual factors surrounding LMM (El Ali et al., in press). Part of this effort involved field testing a LMM prototype application that allows leaving multimedia messages at locations using three different media types: text, drawing, and photos. The prototype was pilot-tested with 4 subjects where an *in situ* interview method (Consolvo et al., 2007) was used to measure experience capture behavior. By annotating locations, the prototype lets users capture their experiences by allowing them to create a digital *memory* snapshot of their experience (Fig. 1a). The generated message remains anchored to the location it was created at for later viewing by anyone who has the application installed on their multimedia-enabled mobile device and is at the same place where the message was created.

LMM Prototype

The LMM prototype was installed on the Android Dev Phone 1, a multimedia-enabled mobile device. The interface consists of three functions: Create, Snap, and Explore. In Create, a user can create a free drawing (Fig. 1b) using touch-based input or type text using the device's keyboard. Here, the location and orientation of the device is retrieved and the user is presented with a camera-view where she can choose to draw or write something. In choosing either option, a snapshot of the camera view is subsequently used as a background canvas for the user to draw or write on. Once a user is finished, she can save the annotated image. In Snap, a user is taken directly to a camera-view where she can snap a photograph.

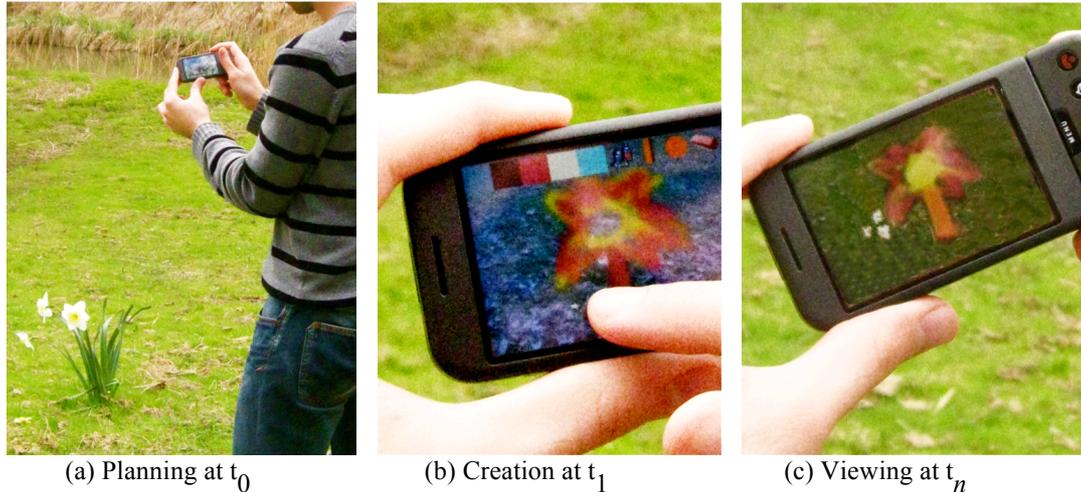


Figure 2: Interaction with the LMM prototype.

After generating a message, a user can view the message by being at the right position and orientation of where the multimedia message was made. In switching to Explore mode, a user is presented with a camera-view, where she is guided to a message by leading her to the creator's original position and orientation. An arrow is drawn on the screen to guide the user towards a message. To indicate the distance between the user's current position and that of the message, the color of the arrow changes within 200m of the message location. Once at the right position, the user can adjust her orientation by looking at a small green indicator arrow shown on the right or left edge of the screen. In doing so, the selected multimedia message appears as an Augmented Reality image overlay on top of the camera-view (Fig. 1c). The location-aware aspect of anchoring a message to a location is assumed to provide a deeper contextualization of the message maker's original experience.

Fun, But Not Useful

After briefly explaining how the prototype works and how to use it, we let subjects at a café create multimedia messages in all three supported media types: drawings, text, photos. For the drawn expressions, two of the subjects drew a cup of coffee to show that you can get coffee at the cafeteria. The other two made graffiti expressions, where their drawings augmented parts of the environment. For the drawings, we found that drawings were meant only as fun digital augmentations on the physical environment. When asked about his/her drawing message, S1 explained: *"Well that ['Dancer in the Dark' poster] is a poster that I enjoy looking at a lot when I'm drinking, and I always wondered about the frame, so I wanted to draw lines around it, but to do it freely. Doesn't have a purpose but it looks nice."*

For the textual messages, subjects used text for: recommending items (e.g., S4: *"You should try the green tea"*), a means for self-expression (e.g., S1: *"Beer Perspective"* and S2: *"Things are looking up"*), or as a warning to others (e.g., S3: *"Don't confuse gravy with soup"*). For the photo expressions, two of the subjects took a photo of the experimenter, and the other two a photo of the street. All photo messages made were used as a means to contrast the present with the future that others will witness (e.g., friends viewing photos of them with the experimenter at a later time).

When subjects were later asked about their overall experience with the LMM prototype, they all reported that it was fun to doodle over the environment and leave photos to share with public and private networks, but did not find either of them to be useful. On the other hand, they all found that it is useful to share text messages (such as recommendations) with others at a place. Using text for practical purposes is in line with what Persson and Fagerberg (2002) found in evaluating the GeoNotes messaging system and what Burrell and Gay (2002) found for the E-graffiti system. The lack of usefulness in drawing or capturing photos in the LMM prototype hinted that perhaps an incentive mechanism that motivates users to use the application is needed to ensure that the experience of capture using the LMM application is perceived as not only fun, but also useful (cf., discussion by Greenberg and Buxton (2008) on why designed systems must first be deemed useful, and only then usable). Equipping a system with persuasive techniques to increase personal and social gain has been explored in social media networks (e.g., Cherubini et al., 2010; Singh et al., 2009), where users are provided with a strong incentive to make contributions of a certain type (e.g., high quality media contributions). Likewise, if game-theoretic elements are designed into the interaction process, the playful aspects of using LMM can be maintained beyond amusement reactions, insofar as the LMM contribution behavior of users is reinforced with personal and social rewards.

The Measurement Problem: Measuring Playful Experiences

Finding an appropriate testing methodology to understand playful experiences that can unlock suitable interaction methods in mobile and ubiquitous settings poses a real challenge. This challenge is amplified by the difficulty in probing into the inner subjectivity of the cognitive and emotional lives of people under changing contexts and while on the move. There has been several successful attempts at measuring user's experiences, especially during interaction while immobile. Much work in this respect has focused on interaction with digital (video-)games (e.g., Nacke et al. (2009); Bernhaupt et al. (2008); Mandryk et al. (2006)).

Subjective and Objective Experience Measures

Broadly, experience measurements can be broken down into subjective and objective measures (Bardzell et al., 2008; Greenberg & Buxton, 2008). Subjective measures typically involve self-reports of a given experience, where methods for obtaining them typically include interviews, surveys, and ethnomethodological techniques in general (Kuniavsky, 2003). Objective measures, by contrast, evaluate *observable* aspects of a person's experience independent of that person's perception. These can range from observations of human posture and gait, button press count and task completion time, to physiological measurements such as Electroencephalogram (EEG) recordings, Galvanic Skin Response (GSR) recordings, Electromyography (EMG) recordings, or eye movement capture using Eye-tracking hardware (Nacke et al., 2009; Bardzell et al., 2008). Such objective metrics however are difficult to generalize to mobile and ubiquitous environments (Kellar et al., 2005), where not only is the user's location subject to change, but also the context at a given location⁵.

⁵ There are exceptions to this: mobile Electrocardiograph (ECG) can measure heart rate while a person is moving, the wearable EOG goggles (Bulling, Roggen, & Tröster, 2009) can measure (saccadic) eye movements in everyday interactions, and Brain-Computer Interfaces (BCIs) such as wearable EEG can measure brain electrical activity during daily interactions (Casson et al., 2008). While indeed these kinds of tools permit objective measurement, they are not without problems: a)

One methodology that promises to deal with the fuzzy nature of user testing in the wild is the Living Lab methodology (Leon et al., 2006; Eriksson et al., 2005). El Ali and Nack (2009, p. 23) defined the Living Lab methodology as research grounds for the testing and evaluation of humans interacting with technology in natural settings, to “better inform design decisions sprouted from what real-life users want, so that technology development becomes an intimate three-way dance between designers, developers, and users.” Two challenges to this ambitious research agenda raised by El Ali and Nack (2009), the risk of over-measurement and under-measurement, warrant recapitulation here. While these considerations are fairly general, they are stated here to underscore the importance of choosing the right testing methods for measuring experiences in mobile and ubiquitous environments.

Over-measurement and Under-measurement

Over-measurement can occur when a user is left to freely use a mobile and/or ubiquitous experience-centric application while on the move. Without informed understanding of what *kind* of data is being collected, extraction of meaning from the continuous flux of data (e.g., interaction history logs) proceeds in an ad hoc manner, and thus risks a loss in interpretation and quality of drawn implications. Consider Nicole’s complex behavior in the introductory scenario, where she initially accepted the seaside walkway recommendation from her device, but retracted the recommendation later in light of new information about the café she is at. Without being explicitly informed about what kinds of media she, or people like her, find enjoyable and fun, it would not be possible for a system to adequately adapt to her needs. This indicates that interaction behavior should be constrained to a small number of measurable units that provide (partial) immunity from the unpredictable nature of unsupervised human-technology interaction. Without minimal supervision exerted on testing conditions during system evaluation and early development, caution should be exercised concerning whether or not the elicited knowledge is trustworthy enough to solicit informed understanding and design of mobile and ubiquitous systems.

At the other end of the spectrum, rigorously controlled laboratory testing can result in *under-measurement*, where the main problems are: a) testing is confined to the walls of the laboratory. This means that ‘natural’, mobile behavior is by necessity beyond the scope of the method b) only a handful of experiential variables can be measured. This is due to the complexity and error-proneness of developing multidimensional designs that can properly incorporate several independent variables and tease out the possible effects on the dependent variables of interest. Together, these problems make controlled laboratory testing, by itself, insufficient for measuring playful experiences in mobile and ubiquitous environments.

Given the two highlighted problems, how can a middle-ground be reached for evaluating experiences in unconstrained environments? One immediate response (El Ali & Nack, 2009) is to split the evaluation process into two phases: subjective observation and objective measurement. In the observation phase, the researcher employs outdoor, *subjective* observational methods during the early design stages of application development as a means of reducing the phenomenon dimensionality down to a few *objectively* measurable variables. During the second phase, depending on their nature, these variables can be experimentally teased out under rigorously controlled indoor environments. There are two promising augmentations to the early observation

the collected signals are difficult to interpret (especially in noisy environments) and b) these devices are not always feasible for use in user tests.

phase, well-suited for dealing with the difficulties in evaluating context-aware applications under mobile and ubiquitous environments: using Urban Pervasive Infrastructure (UPI) methods (Kostakos et al., 2010; Kostakos et al., 2009) and context-aware Experience Sampling Methods (ESMs) (Consolvo & Walker, 2003; Froehlich et al., 2007).

UPI Methods and ESMs

Without going into excessive detail, the UPI methods (Kostakos et al., 2009) are built on the premise that the city can be viewed as a system, where the variables of interest are the combination of people, space, and technology that together aid in studying and deploying urban pervasive applications⁶. These methods deal with five characteristics of the UPI: mobility (e.g., human distance travelled or visit duration), social structure (e.g., social network analysis metrics such as degree of separation), spatial structure (e.g., space syntax metrics such as integration), temporal rhythms (e.g., time-based distributions of people's activities), and facts and figures (e.g., statistical characteristics such as number of devices detected at a defined area).

Focusing on the above characteristics, Kostakos et al. (2009) have developed methods of observation and analysis that reveal real-world values under these metrics. For example, in their 'augmented gatecount' observation method, gatecounts (using Bluetooth scanners) are used to define the flows of people at several sampled locations within a city. The main point here is that these concepts, metrics and methods can considerably aid in gaining an understanding of a city objectively, which in turn aids in the early design stages of application development. To ground it in context of playful experiences, the understanding of a city afforded by the UPI methods can identify spatial and social clusters in a city where people meet for entertainment purposes (e.g., the movies or the park), which provides support for narrowing down the objective of playful applications to the right target group or spatial structure.

Other methods that are useful in evaluating and narrowing down the early design space of mobile and ubiquitous application development are Experience Sampling Methods (or ESMs) (Consolvo & Walker, 2003). ESMs work by alerting participants each day to fill out brief questionnaires about their current activities and feelings. Sampling experiences throughout the course of a day make ESMs a great tool to evaluate a given application *in situ*. Moreover, unlike classical self-report techniques, ESMs do not require participants to recall anything and hence reduce cognitive load. Typical studies with ESMs involve a minimum of 30 participants, and are longitudinal. The longitudinal aspect also means the analysis of collected structured data from participant responses is amenable to statistical analyses. Together, these characteristics of ESMs make them not only invaluable tools in uncovering current usage of mobile and ubiquitous applications, but practical methods of investigating human 'technology' needs under different, real-world contexts. An exemplary translation into the opening scenario would be interval-dependent or event-dependent sampling of Nicole's experience of playfulness with her environment and/or with the device. By sampling Nicole's experiences, her device is able to build a predictive user model that probabilistically *knows* what things she finds fun, and can tailor the media presentation accordingly.

⁶ In this context, 'urban pervasive applications' is synonymous with ubiquitous applications deployed in a city.

Design Considerations

For each of the problems highlighted above (the inference problem, the maintenance problem, and the measurement problem), we provide design considerations that we believe are relevant in the study and design for playful experiences under mobile and ubiquitous environments:

Experience Representation vs. Interaction Experience

As explained earlier (Section: The Inference Problem), a distinction can be made between an experience representation, which is information ‘about’ an experience, and the experience itself, which is a process emergent from an undertaken activity. This reflects the difference in how one understands context. Under a positivist view, the focus is on capturing experiences while under a phenomenological view the focus is on eliciting experiences through coupled activity-context pairs. For capturing experiences, the aim is to provide an adequate representation of any experience that took place, of which playful experiences are an instance. This requires a computational method for annotating the media-based experience representations with the right kind of information (e.g., affective information about the degree of fun had) for later intelligent retrieval (*cf.*, Nicole’s device suggesting fun places nearby given her request of fun things to do).

For eliciting experiences, the aim is to subject users to activities and contexts that would strongly correlate to (if not cause) a desired *type* of experience (e.g., experiencing trust when interacting with a system). The concern here is not about which contextual elements are supported so as to sufficiently re-contextualize the experience of others, but rather about the scoped playful interaction between the user(s) and the system, where the user experience takes place during the interaction process itself. For example, the act of shaking a mobile device to indicate a change in preference for presented location recommendations can itself be a playful experience. In the domain of LMM, one way of enhancing the playful experience would be to provide the right kind of multimodal input and output support (Chittaro, 2009). For example, labeling a media expression (e.g., a photo) by means of textual input (*cf.*, Section: The Maintenance Problem) might be more intrusive and interruptive of a playful experience, whereas a voice command of ‘fun’ that achieves the same function can occasion a more seamless interaction experience. In short, researchers and designers alike should be aware of which epistemological stance (positivist or phenomenological) they commit to when studying and designing for experiences in general and playful experiences in particular.

Incentive Mechanisms as Mediators of Continuous Playfulness

We discussed earlier (Section: The Maintenance Problem) that our pilot study subjects had reported that their interaction with the LMM prototype for doodling and photo-capture was fun but not useful. This led us to consider that, at least for LMMs, users require an incentive to interact with the system that transcends merely playful interaction. In other words, the fun things such as tension and challenge, risk and unpredictability, positive and negative affect, have to be deliberately embedded in the interaction process. However, the fun aspects should be secondary to the user task of documenting and sharing their experiences as multimedia messages. Simply put, the perceived usefulness of a system should be treated as a first-class citizen.

Notwithstanding the importance of usability issues, this raises an important issue of whether the user should be made aware of the real goal of the performed task (i.e., task

transparency), and in what domains does it actually matter to apply such persuasive techniques. For example, implicit ambient light feedback is a useful mechanism to unobtrusively indicate excess electricity consumption during the day. A promising approach for applying incentive mechanisms in the context of LMM is to utilize game-theoretic approaches (Singh et al., 2009) to create competitive game-like environments that persuade users to perform a given task, such as tagging or rating people's generated messages (cf., Facebook's⁷ 'Like' button). This would not only motivate users to collaboratively rank the generated content, but given the competitive element, would make the experience of doing so fun and engaging.

Balancing Testing Methodologies when Measuring Playfulness

Measuring fun and playfulness is by now a well-known slippery endeavor (Cramer et al., 2010). As discussed earlier (Section: The Measurement Problem), the difficulty arises in deciding to test users in a natural setting, where objective experiential data is hard to acquire. At the other extreme, controlled testing permits objective measurement at the cost of narrowing explanatory scope. While there is no clear prescription for the most effective approach to evaluating experiences, it is likely that a gradual progression from unconstrained to controlled testing in the course of mobile and ubiquitous application design and development is an effective means to measure experience. More concretely, during early design stages, outdoor testing of mobile users can help yield design implications that help narrow down the set of observable phenomena to a few variables, which can then be experimentally teased out in a more controlled environment.

As we have suggested, there are two promising methods to augment understanding, analysis, and narrowing down of the early design space: UPI methods and ESMs. While UPI methods permit objective measurement and analysis of structures (social, spatial, temporal) within the city, ESMs can help shed light into individual human-technology needs under certain places and times. Due to the importance of objective measurement and analysis on the one hand, and the need to systematically understand human subjective responses on the other, we believe that a combination of both methods can strongly aid in both understanding the playground of existing playful interactions, and the subsequent development of future-generation mobile and ubiquitous tools to enhance these interactions. For example, the duration of a visit at a particular site in a park with a particular social setting (characterized for example by a minimum person co-occurrence frequency count) can be used as a trigger for unobtrusively sampling a person's experience. That person's response includes both the receptivity to the sampling interruption as well as the content of interruption (e.g., what activities he was engaged in at that moment and with how many people). This response in turn can on the one hand provide a useful feedback loop (Kostakos et al., 2009) into the quality and capacity of objectively measuring and inferring people's activities from such measurements, and on the other hand shed light into what kinds of experiences these people undergo at certain locations within a city (such as the park).

Conclusions

In looking at what playful experiences are, how they can be inferred, how the experience of capturing them can be motivated and maintained, and how to measure them, we have underscored what we believe to be fundamental problems underlying the scientific study of playful experiences in mobile and ubiquitous environments.

⁷ <http://www.facebook.com>; last retrieved on 25-08-2010

Drawing on past research efforts and an envisioned LMM usage scenario, we hope to have drawn attention to the importance of thoroughly examining the different aspects of playful experiences (inference, capture-maintenance, measurement) when designing LMM systems to be used under ubiquitous environments.

As highlighted in the introductory scenario, there are a myriad of cognitive and affective factors intermixed with the system interaction that are difficult to experimentally and computationally disentangle. This in part stems from which epistemological stance (positivist or phenomenological) one chooses to adopt in practicing HCI (Section: The Inference Problem). Intermixing the two views, at least in LMM, makes it difficult for a system to automatically acquire the right kind of experiential information (e.g., media tagged or rated as fun that corresponds to how fun an experience was) and to intelligently retrieve this information in the right situation (*cf.*, Nicole's desire to experience something fun), while at the same time ensuring that interaction with and cognitive processing of this information is itself enjoyable. The latter point, as we mentioned (Section: The Maintenance Problem), can be mediated by explicitly incorporating fun and enjoyable game-like elements in the experience capture process. Lastly, we considered the problems that arise in measuring experiences in general and playful ones in particular (Section: The Measurement Problem), and argued that a gradual progression from controlled to out-in-the-wild testing provides a systematic methodology which can aid in understanding the playground for future experience-centered mobile and ubiquitous systems.

In response to the highlighted problems, we have furnished playful HCI with three design considerations (experience representation is not the same as interaction experience, incentive mechanisms can be mediators of playfulness, and measuring playfulness requires a balance in testing methodology choice) that together serve as useful guidelines for scientifically studying and designing playful experiences in mobile and ubiquitous environments. The need for clear guidelines has been well-articulated by Adam Greenfield (2006, p. 232) when he wrote back in 2006: "Much of the discourse around ubiquitous computing has to date been of the descriptive variety...but however useful such descriptive methodologies are, they're not particularly well suited to discussions of what ought to be (or ought not to be) built." Yet to what extent it is possible to truly design and build mobile and ubiquitous systems that carry out the task of capturing experiences while making the experience of capture itself fun and enjoyable remains an open question.

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