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Contents

Original Articles

From the Editor in Chief

EVOLVING TECHNOLOGIES FOR A VARIETY OF HUMAN PRACTICES

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The fact that virtually every facet of life in the 21st century is imbued with technology is no revelation. From the most public aspect of life to the most private, technologies have been created and continue to be created to allow immediate and easy access to data that enhances one's experiences and activities and facilitates human interaction. In some ways, our technology-rich lives today are the stuff of science fiction just a generation or three ago.

The technological tools for accessing, manipulating, and sharing vast amounts of information and building knowledge in diverse ways have had a strong focus in human–technology research. This involves not only the focus of the research, but also the means by which researchers gather, analyze, and report on their investigations. The implications for student learning, thus, are immense. Contemporary cohorts of students, particularly in knowledge societies, are expected to be skilled in self-discovery, inquiry-based approaches, and critical thinking, as well as possess skills in community building and social networking. Of course, as members of the Internet society, many students have been immersed in technology since birth. Increasingly, technology forms the framework for education, business, hobbies, entertainment, creativity, communication, healthcare, transportation, and many other aspects of life.

Yet, as technologies are being continually developed, with new replacing "old," and as technologies become increasingly integrated with each other and become embedded within various human practices, it becomes clear that speculations and assumptions about the experiences of users and the outcomes and challenges of technology use will not advance the understanding of the role of technology in modern life. Thus theoretically sound and empirically grounded research is needed to explore the wide swath of technology applications—such as creative communities and social networking, telepresence in mediated communication, user experiences of virtual and 3D environments, and location-based services, to name a few.

Recent trends in the field of human–technology research have emphasized the potential of ubiquitous computing in supporting self-initiated and interest-driven activities, often in the contexts of informal learning, hobbies, or other everyday activities. Mobile tools, the social Web, and handheld devices have opened up new possibilities that go beyond intentional learning, in activities both within a set location and in the "great outdoors." And, as is typical for ubiquitous

computing, users are not necessarily even aware they are using an application and are most likely unaware of the complexity of design within a "simple" handheld device.

One recent trend in ubiquitous computing is related to location-based services. A variety of disparate services and physical locales, such as museums, nature reserves, and tourist attractions, mediate informal learning through location-based technologies (FizGerald, 2012). However, it is not only about physical mobility brought about by the wireless mobile technologies, but also how location-based technologies (e.g., GPS) enrich the learning context in many ways. The fluidity of context is created by a multitude of interacting people and the immediate and greater environments, as well as the result of the tools or resources used (Sharples, Milrad, Amedillo Sánches, & Vavoula, 2009). At its best, mobile tools can deepen the integration of activities that occur across multiple spaces, both inside and outside the classroom (Dillenbourg & Jermann, 2007), as well as in public, community, private, and intimate settings alike.

This issue of *Human Technology: An Interdisciplinary Journal on Humans in ICT Environments* presents research regarding the possibilities and challenges of human technology from the perspectives of creative communities, mediated communication and telepresence, technology acceptance in virtual environments, and location-based services. Each paper refers to how the human experience—particularly within one's social and private lives—continually evolves as a result of ongoing technological development.

We begin our current issue with **Smite's** research on creative network communities. The article focuses on the rise of network communities within Eastern and Western Europe in the early ages of the Internet, and the role of those communities within the era of Web 2.0. She discusses the interpretations of the concepts network and community, as well as the differences in practices and needs between early creative networks and the social networks of today. Drawing on interview data from networking experts and founders and analyzing posts from members of various networks from the 1990s, Smite establishes that *creative networks* reflect a translocal group of people with shared interests and loose connections, whereas *community* refers to personal relationships between network participants, whose contact often takes place both online and offline.

Lombard and Jones examine the phenomenon of telepresence, with a focus on a specific context: sexually arousing media content. Noting that those interested in pornography and the erotic arts have always been early exploiters of new technologies, Lombard and Jones carefully demonstrate how various aspects of telepresence can advance the technological applications in sexually arousing media, which in turn can help advance knowledge about and applications of telepresence in other realms and research. On the basis of their review of the evolution of relevant media technologies and telepresence applications, particularly related to human sexuality, they offer suggestions for further research.

The context of the article by **Tiainen, Kaapu, and Ellman** is a locomotion control device in a walk-in virtual environment. They conducted a test in which participants browsed virtual shopping items by controlling their personal locomotion either by walking or with a device. Research was focused on technology acceptance and use, which are assumed to be based on perceived usefulness and ease of use of the technology. However, the results of this study indicated no correlation between the actual use and ease of use of this simple device.

The final two articles in this issue focus on map-based services and applications. In the article by **Halkosaari, Sarjakoski, Ylirisku, and Sarjakoski,** a map-based multichannel

service is developed with the aid of a user-centered design process. The developed service would provide hikers with interactive maps through the integration of several channels. With the aid of this service, the same spatial information can be approached through multiple representations, such as printed, mobile, or Web-based maps. Various methods of user-centered design proved to be useful in involving users and research teams in the process of designing for variety of users.

The article by **Kässi, Krause, Kovanen, and Sarjakoski** focuses on positioning technologies (e.g., GPS) that aid the user in self-location on a mobile map. In this study, a field experiment was conducted to assess whether the plotting of user location on a mobile map assists the map reader in locating him/herself in the physical environment. Their results found that although plotting location alone is not enough, the positioning aid enables the user to narrow the search area and reduces the number of map–environment points required for self-location.

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CREATIVE NETWORK COMMUNITIES IN THE TRANSLOCAL SPACE OF DIGITAL NETWORKS

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Abstract: *What should sociological research be in the age of Web 2.0? Considering that the task of "network sociology" is not only empirical research but also the interpretation of tendencies of the network culture, this research explores the rise of network communities within Eastern and Western Europe in the early Internet era. I coined the term* creative networks *to distinguish these early creative and social activities from today's popular social networking. Thus I aimed to interpret the meaning of social action; the motivation of creative community actors, their main fields of activities and social organization forms; and the potential that these early developments contain for the future sustainability of networks. Data comprise interviews with networking experts and founders and members of various networks. Investigating respondents' motivations for creating online networks and communities, and interpreting those terms, allows for comparing the creative networks of the 1990s with today's social networks and for drawing conclusions.*

Keywords: *network, communities, creative networks, social networks, social dynamic, socio-technical formations.*

INTRODUCTION

It has been nearly 20 years since the Internet became publicly accessible and the first early virtual communities of specific interest groups engaged in online communication. Today, online social networking sites have turned the Internet into an integral communication medium for the masses.

However, new social communication and organization forms, and new social dynamics, in particular, have emerged within the environments of digital networks, yet remain challenging for sociological studies because of their virtuality and invisibility, as well as noninstitutionalized contexts and translocal (see p. 10, below) qualities. Today, many sociologists regard technology as the impetus for the most fundamental social transformations (Wajcman, 2002, p. 347). Additionally, these technologies tend to be understood in terms of technical properties and their relation to the sociological world to be constructed as one of applications and impacts (Sassen,

2002, p. 365). Examining the position of the Internet in modern sociology and looking at the reasons why a programmatic response to the Internet has proved so hard to generate, Allison Cavanagh argued that "interdisciplinarity, whilst a rich vein for innovation in research, has not allowed a clear agenda to develop" (Cavanagh, 2007, p. 3). Thus, the question remains relevant today: How and what should be studied, or what is the subject of social inquiry within digital networks in the age of Web 2.0 social networking, when an ever-growing number of people around the world are using the Internet and online activities are more integrated into daily life than two decades ago? Saskia Sassen (2002, p. 365) argued that, "the challenge for sociology is not so much to deny the weight of technology, but rather to develop analytic categories that allow us to capture the complex imbrications of technology and society." Other important sociologists agree. "We must treat technologies seriously" (Castells, 2000, p. 4) in order to better understand the new social dynamics created by virtual communities within the translocal space of digital networks. Moreover, Barry Wellman and his associates consider that "understanding the dynamic interaction between new technology and sociability should be a central concern of community research" (Wellman, Boase, & Chen, 2002, p. 152). I agree. Additionally, sociology in the case of network culture studies should not be based on empirical research only, but it must provide as well, referring to Weber's (1922/2002) sociology, interpretation of certain tendencies through understanding the meanings of social action carried out by the actors who are avidly involved in social networking, as well as the processes and impact of certain social actions. Hence, for the point of departure and as the object of my sociological study on network culture, I focus on the early *network communities* that emerged as a process of self-organization within the electronic media space in the early stage of the Internet, that is, in the 1990s.

RESEARCH TERMINOLOGY AND METHODOLOGY

> "A community without a network does not exist." (Kluitenberg, 2008, p. 306)

The general term *network* refers precisely enough to sociotechnical formations that have developed as a result of complex interactions between social action and technical properties of digital networks. However, in my research on early network culture, I prefer to use the term *network communities,* despite the fact that the word *community* has different associations in Western and Eastern (post-Soviet) European societies and, based on my experience, may seem controversial or contested today. "In Western societies, community has traditionally been anchored in local, neighborhood interactions and enshrined as a code word for social cohesion" (Wellman et al., 2002, p. 153). In these societies, people (e.g., both producers and listeners of a community radio) typically share a common history and have developed rather positive experiences in group-like relationships and collective organizations. However, in societies of post-Soviet countries, in which "collectiveness" was not free will but a forced form of social organization, people obtained a mainly negative experience of group-like formations (e.g., collective farming, such as *kolhozs*, which were built by taking away people's property). Thereby, the word *community,* which in Eastern Europe has been used mainly since the advent of the Internet, still has a slightly negative connotation to many.

Yet, the meaning of *community* in Western societies also has changed over time. Wellman and his associates argued that it is not useful today to think about communities as group-like neighborhoods and that the network understanding of communities in modern times has become much more relevant (Wellman et al., 2002). I also do not use the commonly used term *online communities* (Hampton & Wellman, 2002, 2003) in the cases of these early sociotechnical formations of the '90s. Although the members of these groups used online platforms (e.g., mailing lists), they also felt it important to organize activities in offline spaces. Both formal network gatherings (e.g., conferences) and the informal meetings (e.g., joint dinners and personal conversations) that were hosted during the festivals of the emerging new media culture in various cities in Europe were key elements for strengthening the communities of these networks. Additionally, various collaborative projects and joint activities were organized by these networks, combining both online and offline spaces (e.g., on-site events—performances and conference discussions—that also involved online participants via the Internet).

These early formations also differ from today's social networks due to various other reasons. During its early period in the mid-'90s, the Internet was used primarily by specific groups of people because a certain amount of effort had to be put into acquiring access to the Internet and in learning how to create and publish one's own Web site. Moreover, most of these users felt motivated to explore the possibilities of the new communication technology as a means to exchange information, to meet and to communicate with other like-minded people on a global scale, and to establish a translocal collaborative network. Following the fall of the Berlin Wall in 1989, the 1990s allowed the opportunity to establish more active connections between Eastern and Western Europe. Internet access was relatively inexpensive in Eastern Europe; without a doubt, Eastern European artists and social activists were as eager to explore the new cyberspace as their Western European counterparts. Finally, because many of the active network founders and members were primarily artists, theorists, and other creatively thinking people (e.g., open-minded youth and subculture activists, organizers of new media culture events, programmers, hackers, etc.), I have termed these early formations of the '90s *creative networks*. This also helps to distinguish them from contemporary social networks that emerged within the so-called Web 2.0 social media platforms. Because creative networks are associated mainly with the early stage of the Internet, I also use the term Web 1.0, in opposition to Web 2.0, when referring to the early Internet period of the 1990s.

With regard to methodology, I used case studies as the primary research strategy among several methods. The theoretical overview of network context interpretations and issues regarding the terminology are discussed in this paper as groundwork for the empirical research. To discover the meaning of the social action and the aims and motivation of network participants, I used mainly qualitative methods, that is, interviews with the creative network founders, the most active participants, and experts. In total I interviewed 15 people. With most of these informants, I conducted in-depth face-to-face interviews, whereas the rest were administered either via e-mail or Skype (see Table 1). This was combined with quantitative data analysis, for example, analyzing the dynamics of the respective network mailing lists (Table 2). Another method complementing my research was the analyses of a wide variety of documents, primarily publicly available data from Internet Web sites and mailing list archives, as well as translocal and local network community publications issued in the 1990s. Finally, to better highlight the structure of the network cases studied, I used social network analysis and performed creative network mapping.

Table 1. Individual Interviews with Network Founders, Active Participants, and Experts.

Name	Network/Community /Initiative	Role	Nature of interview	Interview Date	Interview Language
Geert Lovink	Nettime	Founder	E-mail interview	02.Feb.10	English
Pit Schultz	Nettime	Founder	In-depth interview (transcript from audio recording)	30.Jan.09	English
Andreas Broeckmann	Syndicate / SPECTRE	Founder	In-depth interview (transcript from notes taken by this researcher)	05.Sept.09	English
Kathy Rae Huffman	Faces	Founder	E-mail interview	17.Feb.10	English
John Thackara	Doors of Perception	Founder and director	Skype interview	04.Dec.09	English
Armin Medosch	Art Servers Unlimited	Symposium organizer	Skype interview	05.Dec.09	English
Normunds Kozlovs	Baltic Center for Peace		In-depth interview (transcript from audio recording)	10.Feb.10	Latvian
Kaspars Vanags	Open	Founder	In-depth interview (transcript from audio recording)	22.Feb.10	Latvian
Sergejs Timofejevs	Orbita	Founder	Skype interview	11.Feb.10	Latvian
Pauls Bankovskis	Collaborated with E-Lab	Expert	In-depth interview (transcript from audio recording)	23.Feb.10	Latvian
Martins Kibers	Casablanca 2000	Founder	In-depth interview (transcript from audio recording)	15.Feb.10	Latvian
Kristine Briede	Locomotive / K@2	Founder	In-depth interview (transcript from audio recording)	15.Feb.10	Latvian
Janis Garancs	E-Lab	Co-Founder	In-depth interview (transcript from audio recording)	09.Feb.10	Latvian
Alise Tifentale	E-Lab	Founding member	In-depth interview (transcript from audio recording)	11.Feb.10	Latvian

Note. Interviews in languages other than English were translated to English by this researcher.

For this research, I examined and analyzed five creative network cases: three translocal network studies (Nettime, Syndicate, and Faces), one local network case (E-Lab, in Riga, Latvia), and one mixed type (the translocal network Xchange founded by E-Lab but extended globally), although material from other data gathered also informed my analysis. I carried out my research from the perspective of Eastern Europe and post-Soviet Latvia. However, my intent was not to focus on the differences between Eastern and Western societies, which were significant in the '90s, but rather to develop common ground for contextualizing and examining the important developments of early network communities. Therefore, this research addresses a broad set of questions:

- Which network theories are applicable when studying digital network communities?

Table 2. Messages from Various Email Lists for Analysis.

Mailing List	Date range	Number of Messages	Status of archive	Language
Nettime	October 1995 - December 2009	19,454	Archive is available online (http://www.nettime.org/archives.php)	English
Syndicate	January 1996 - August 2001	11,067	Archive is not available online (data from author's personal, partial archive)	English
Faces	1997 - 2001	±1,200	Archive is not available online (data from author's personal, partial archive)	English
Xchange	December 2007- September 2007	4,478	Archive is available online (http://xchange.re-lab.net/2009/mailinglist/)	English
Rezone (E-Lab network mailing list)	1997 - 2001	±900	Archive is not available online (data from author's personal incomplete archive)	Latvian
7-11	1997 - 1997	400-500	Archive is not available online (data from author's personal, partial archive)	English

Note. Messages in languages other than English were translated into English by this researcher.

- What were the motivations and meanings of social action that lay behind early creative networks?
- What were and are their main fields of activity as well as forms of social organization in creative networks?
- How do the members themselves interpret the ambiguous terms *network* and *community*?
- What are the most important differences between early creative networks and social networks nowadays, namely, between the communities of Web 1.0 and Web 2.0 platforms?
- What potential do these early developments by creative networks have for the future development of network culture?

THE NETWORKED PERSPECTIVE: THEORETICAL BACKGROUND

The networking form of social organization has existed in various times and spaces. Every society consists of multilayered networks that intersect, overlap, and interact in countless ways: on a physical and technical level (e.g., transportation and telecommunication networks), on a social level (e.g., families and community networks), on political and economic levels (e.g., financial and commercial networks), as well as on cultural, organizational, and many other levels. Networks as social relation systems have been implicitly sketched out in the works of such late 19th century authors as Émile Durkheim, Max Weber, and Ferdinand Tönnies, who described the ways in which social groups formed.

German sociologist Ferdinand Tönnies (1887/2001) counterstated two distinguished social relations—*Gemeinschaft* (mainly characterized by emotional ties, such as family) and *Gesellschaft* (communities based on a more rational and goal-oriented foundation for particular social interests, as in urban culture, for instance). *Gemeinschaft*, in Tönnies' opinion, dominated mainly in traditional societies, whereas *Gesellschaft* dominated in modern societies. Emile Durkheim (1893/1997) also introduced two types of social groups: the mechanical solidarity of traditional societies and the organic solidarity of modern societies. In turn, Max Weber (1922/2002, pp. 271–272), in describing the two main modes of social relationships, called them communal (based on a subjectively felt unity) and rational (based on relations of rationally motivated interests).

Therefore, I suggest that, in terms of social relations, a similar distinction can be applied to network communities: Creative network communities may feature *rational* relationships (i.e., their common goal typically is rationally motivated, e.g., to foster collaboration between Eastern and Western European media artists, as was the case of the Syndicate network), whereas today's social network communities can be associated more often with *communal* relationships (i.e., they are based on subjectively motivated social ties, such as, e.g., among classmates, friends, or relatives).

In the beginning of the 20th century, Georg Simmel (1971) was one of the first sociologists to start viewing social relations as networks instead of just groups. His work thus demonstrated the emergence of individuality within society, and how that societies simultaneous allow and impede individuality development.

Jacob L. Moreno (1934/1977) started studying social networks by using quantitative methods, thus becoming the pioneer of social network analysis and sociometry. Moreno is also author of the earliest graphical representations of social ties that analyzed the role and relationships of individuals in the group or community.

The concept of the network became even more popular with postmodernism, when sociology researchers began analyzing society not as a whole but as a constellation of various structural elements from different perspectives. A few important and more general network concepts were developed in the 1960s and '70s, before the computer communication networks emerged. Nowadays the contributions of such authors as Gilles Deleuze and Félix Guattari are still applied and adapted. For instance, their rhizomatic network concept (Deleuze & Guattari, 1987) strongly impacted the development of early network communities. Nevertheless, it was the end of the 20th century, when new information and communication network technologies (i.e., the Internet) were developed, before the term *network* gained not only a new meaning (i.e., no longer just a synonym for the Internet), but also a twofold image. On the one hand, the network is manifest in the form of a digital computer network on a physical/technical level; on the other hand, it has become a virtual social space. In 1996, when Manuel Castells introduced the term *network society*, he basically referred to a new mode of modern society where all the main social structures and activities are organized around electronically processed information networks. Castells argued that, "the new information technology paradigm provides the material basis for its pervasive expansion throughout the entire social structure" (Castells, 2000, p. 500). More than that, he also foresaw that this would be the dominating factor.

In the mid-'90s, the global distribution and public accessibility of the Internet created a new niche for social activities that were self-organizing in various virtual communities whose

members communicated via the Internet. The way in which global digital network technologies opened up new possibilities for community development was analyzed by Howard Rheingold in his book *The Virtual Community* (1993), in which he introduced and conceptualized the term *virtual communities*. Rheingold (cited in Kluitenberg, 2008, p. 307) distinguished two types of virtual communities in regard to their geographical placement. *Translocal communities* form themselves around a shared interest, subject, or theme; they are completely decentralized and spread out around the world. Given that these communities most often are "debating societies" and use the simplest electronic communication options (e.g., mailing lists), their members may be located almost anywhere in the world, given an available Internet connection. Digital network technologies also may be used in the context of geographically localized communities, for which Rheingold used the term *community networking.*

Meanwhile, digital networks also can be used "for strengthening local communications and transactions inside the city" (Sassen, 2002, p. 380). The Internet has also facilitated discussion and mobilization around local issues (Hampton & Wellman, 2002, 2003). Thus globalization and digital networks do not imply losing the aspect of the local; rather, they can be seen as a possibility for the local communities to extend and develop their social action and communication field on different scales: globally (i.e., the worldwide transnational flow of capital and information) and translocally (i.e., local issues embedded within a global context; Wojtowicz, 2002), as well as locally.

TRANSLOCAL NETWORK CASE STUDIES: NETTIME, FACES, SYNDICATE

Mailing lists were one of the first network community forms of social organization during the very early stages of the Internet in the 1970s and '80s. A mailing list is a simple electronic mail (e-mail) program where subscribers (members of the respective network) receive messages within their personal e-mail inboxes, but also are authorized to freely publish their own e-mail messages by sending them to a specific address, which automatically delivers it to other subscribers. In the mid-'90s, when the Internet became publicly accessible, other Internet communication possibilities were limited, for instance, due to low bandwidth; the mailing list was the main platform for online communication and social organization. At that time, mailing lists were used not only for communication, information exchange, and discussion, but also for organizing the field, meetings, and other collaborative activities of respective translocal communities.

This paper is based on research into three early network communities: Nettime, Faces, and Syndicate. For direct quotes from interviews conducted in English, the wording is edited only for clarity; direct quotes from the data are presented in italics. I begin by examining one of the very first creative network cases, the Nettime mailing list.

> Nettime has been widely recognized as one of the leading forums for the discussion and practice of innovative Internet culture and Internet-based art. Its aim has been to bring together different disciplines and practices such as electronic arts, computer science, IT journalism, and media activism. (Lovink, 2002, p. 68)

The launch meeting of Nettime, called <net.time> at the beginning, took place in 1995 in Italy, during the Venice Biennale that was organized by network activists, media theorists,

and the founders of Nettime, Geert Lovink and Pit Schultz. It gathered an international group of activists, artists, organizers, theoreticians, writers, and others with an interest in the new Internet network, net art, culture, and politics. Later the same year, the Nettime mailing list was founded. When asked if Nettime was a network, a community, or just a mailing list, Geert Lovink replied,

> *It has changed over time. It was very much a movement in its early days. Then it became a scene and very briefly, around May 1997, even a group-like thing, but that didn't last long and then it fell apart, step by step. Slowly it turned into a loose collection of mailing lists.* (Lovink, 2010)

In May 1997, the first Nettime conference[1] gathered 120 Nettime participants (of its 400 subscribers) from countries in Eastern and Western Europe in an old school building that housed Ljudmila,[2] the Soros-supported media laboratory (Lovink, 2002, p. 68). Although Nettime organized a few additional significant events over the years,[3] I agree with Lovink's 2010 interview comment that none succeeded in creating anything similar to the Ljubljana conference regarding the sense of community.

Opinions of what a network is and what a community means for Nettime founders differ. From Lovink's perspective,

> *I personally do not like the term community because of its religious connotation, it suggests unity and harmony, which, back then, wasn't the aim. ... I doubt if Nettime ever was a network in the way we use the term right now. For sure it's a loose connection of people that share a common history.* (Lovink, 2010)

Meanwhile, Schultz tells that, to speak of community, the communication should take place in real time and space. According to Schultz, community starts when people can personally meet each other:

> *I totally believe, out of all what can be community, it is ...when [what is] involved is human interaction, which can't be mediated.... What is happening between people in terms of exchange is body and language, which is so rich [that] it can't be replaced with [the] computer and Internet.... Community, I would say, is substantially to do with what we call* meet–space *these days. It deals with time and space and necessity to interact—in real space. I don't want to become too esoteric, but there is [a] difference [in] what people feel when they are together in real space. Maybe there will be technologies in future [that] can replace that, but definitely not now.* (Schultz, 2009)

One can conclude that Nettime never set the goal of establishing a community, which in principle is characteristic to all creative networks. The primary motivation of Nettime was organizing the field through developing critical discourse and a network culture via the Internet.

After the turn of the 21st century, Nettime became only a mailing list, or, rather, a set of mailing lists: Nettime started to operate in versions for Dutch, French, Romanian, and other language communities. Still, the primary mailing list, nettime-l, was (and is) dedicated to discussions in English. The number of subscribers grew rapidly until 2002. The Nettime mailing list consisted of only few people in the beginning (1995). By 1997 its membership had reached 500 people, and grew until 2000, when it reached 2,500 members. Since then the number of subscribers has not changed significantly: In 2011, 2,534 subscribers receive regular postings and 1,345 are subscribed for digest posts.[4]

Regardless of the fact that other social communication forms have emerged along with Web 2.0, mailing lists today, including Nettime, continue to work just as actively as before. Geert Lovink argued that, "*social networking sites are not ideal community tools and do not constitute counter public spheres*" (2010). He explained that social networking tools are good for expanding one's social horizon but not for organizing a field; they are good for promotion and campaigns, but "*they are less suitable as mediators between the real and the virtual. That's what lists do best*" (Lovink, 2010).

Nettime most definitely was, and to a certain extent still is, the heart of the early network culture. During the second half of the '90s, other mailing lists, Nettime's "neighbors," continued to grow and to form around it, including the Faces list, which is a platform for cyberfeminism. Although the open structure of Nettime aimed to involve a variety of participants, even women who had "full online access, good education, and excellent English writing skills could find *Nettime* a difficult forum to crack" (Nettime, 1999, p. 21). Regardless of the fact that a growing number of women use the Internet, there remains a remarkable lack of female representation (Sassen, 2002, p. 379).

Curators, artists, and activists Kathy Rae Huffman and Eva Wohlgemuth came up with the idea of the Faces list in the beginning of 1997, during a conversation at a dinner party in Vienna. Moreover, as Huffman related, "*We were hosting dinners and discussing Internet and technology in general with women curators, artists, et cetera, in several cities*" (2010). Later that year, Huffman, together with new media activists and organizers Valie Djordjevic and Diana McCarty, founded the international cyberfeminist mailing list Faces, which still works actively today. The aim of the Faces mailing list was to create an environment in which it was possible to speak in a more liberated and private way but with more topic flexibility than on Nettime. It was decided that male subscribers would not be allowed in this mailing list. Eventually Faces became a translocal network for women who worked with new media: It includes artists, programmers, disc jockeys (DJs), curators, activists, theoreticians, researchers, academics, and others. In 1997, 30 women subscribed to Faces, and during the following years the number of mailing list subscribers grew to its peak of more than 400 women. Currently, the Faces mailing list includes approximately 300 women, primarily from many European countries, the USA, Canada, and Australia.[5]

Internet communication has become easier, and the cyberpresence of women has slightly increased, particularly with the ubiquitous social networking opportunities. Yet Facebook has not replaced Faces. For sustaining a network—or yet more, a community—it is important, as Huffman suggested, to know the audience of the network, meaning who the people are and what they need. "*I think Faces is much more personal* [than Facebook], *and even if one doesn't post, one feels a loyalty to the idea of it, the tradition of it, and the potential for it to bring new information and ideas between women*" (Huffman, 2010). As both a member and a researcher, I can only agree with Huffman. This mailing list began operation with an emphasis on providing a responsive and friendly atmosphere, and they have been able to maintain that throughout their duration.[6] In my professional assessment, it seems that the merits of the founders of the mailing list are a significant reason why this particular mailing list remains sustainable. Their ability to take care of their community can be compared with the skills of a hostess caring for her guests. During any of the offline cyberfeminist events (e.g., symposiums, conferences, workshops, and exhibitions), meal preparation, and partaking were just as important as discussing the development of the Internet or video- and sound-editing activities. In other words, as Dutch

media theorist Eric Kluitenberg put it, "community results as an emerging property of these networks, but not without a decided effort" (Kluitenberg, 2008, p. 306).

After analyzing the practices, topics, and commitment of the Faces mailing list, it is possible to conclude several things. First, Faces may be considered in terms of the totality of four notions. First, Faces is a mailing list, but it is also a network and a community. Second, in regard to the community aspect, that is, what creates the feeling of community in Faces, most respondents mirrored Pit Schultz's (2009) feelings that community results from human interaction (although they did not concur that community can only exist in real space). Specifically, these informants emphasized that meetings in real space are necessary for an online community to exist. Third, the respondents thought that the responsive and supportive environment that exists in the Faces mailing list also plays a great part in creating a sense of solidarity, thus decreasing the self-representation and competition frequently characteristic of other mailing lists. And lastly, the Faces mailing list has managed to balance its content, which is "*a mix of media art, theory discussion and domestic announcements*" (Faces respondent Melinda Rackham, March 2, 2010). Namely, no duality exists between discussions and announcements, which is a crucial problem in other lists; for example, Nettime list founders decided that the discussions are more important (for developing theoretical discourse), whereas for Syndicate list members announcements (about participation possibilities, forthcoming events, e.g., festivals, exhibitions, etc.) seemed more useful then theoretical discussions.

Another important Nettime neighbor was the Syndicate network and mailing list, which was launched in 1996 and existed until 2001. It was one of the first attempts to foster the cooperation between the Eastern and Western European media art and digital culture scenes after the fall of the Berlin Wall. On an institutional level, the practice of networking in Eastern Europe in the beginning of the 1990s was initiated by the Soros Open Society institutions, such as the Soros Contemporary Arts Center network. Although this latter network developed under the influence of the Soros policy, the Syndicate network was self-organized. Furthermore, the Syndicate network connected, on equal terms, both Eastern and Western European artists, groups, and organizations, all of whom were interested in translocal cooperation with the aim of developing the emerging field of electronic networked media art. But such networking was only possible among people who were online, as explained by Syndicate founder Andreas Broeckmann:

> In the mid-1990s, it was a very particular group of people who could be involved. And this grew of course, but it meant that people like you and us, we could say, "Ok, we go online," but it means that we deal with technological determinacy and social anti-technologic. So these were people who wanted to discover how these technologies could allow communication. (Broeckmann, 2009)

The number of Syndicate mailing list subscribers in 2001 reached 500. The main fields of activities of the Syndicate network and mailing list involved information exchange, organization of the network and mailing list, and initiating collaborative projects. Syndicate operated successfully until the summer of 2001, which was a turning point for this network due to three important events, as revealed in my 2009 interview with Syndicate founder Andreas Broeckmann. First, few members attended the Syndicate meeting in Bulgaria and, because of this, members began to believe that the network was created by the mailing list and not the meetings. Second, the list owners could not suppress an aggressive spam campaign on

the e-mail list by a recalcitrant artist-member. And a highly professionally organized exhibition of young Albanian artists marked the third event, which demonstrated a lack of relevant differences between Eastern and Western Europe artistic expression. All three reasons made the Syndicate founders come to the decision to discontinue Syndicate's work in summer 2001. To fill the gap, the new mailing list Spectre was created in August 2001. However, Spectre was solely a mailing list. Broeckmann explained the difference:

> In the Syndicate days, in people's minds, it was clear who is on the list: Fifty, 60 people, of who at least five knew each other personally, some of them knew even more than 30 others personally. For newcomers [of the Syndicate list], they had a feeling that there is a spirit. Also they realized that there are these meetings during which people talk, and, after meetings, exchange information. (Broeckmann, 2009)

Such personal communication was important also for those who did not attend the offline meetings, yet it was different from Nettime, which had organized just a few initial meetings. The case of Syndicate's closing demonstrates how fragile networks can be: They are not immune to inner disagreements and attacks, and personal difficulties among the members may tear apart the structure of a network. In 2001, the core participants of the Syndicate mailing list remained the core within the newly created mailing list Spectre. The topics of focus—media art and culture—also remained the same. What did change, however, was that "deep Europe"[7] was the scope of the context, acknowledging that Eastern European as the prime focus was no longer as important as it was in 1996.

THE LOCAL COMMUNITY NETWORKING CASE OF E-LAB AND ITS GLOBAL EXTENSION, *XCHANGE*

Xchange provides an example of the creative network initiatives that emerged in Eastern Europe. This global Internet radio network community was launched at the end of 1997 by E-Lab,[8] a new media artists and network activist group from Riga, Latvia. This community developed in collaboration with other small-scale initiatives, such as sound and new media artists, electronic musicians and DJ groups, community radio activists, and independent journalists, from Eastern and Western Europe, Australia, Canada, and other locations around the world.

Xchange participants were motivated by a particular shared interest: creative experimentation with novel streaming audio technologies. Unlike other creative networks that were discussion and debate societies (i.e., text-based communication), the Xchange community aimed to explore the Internet's social communication through exchanging sound material. With the guiding idea of exploring the "acoustic cyberspace,"[9] Xchange participants organized collaborative Internet streaming sessions throughout the year 1998, which was the most active period of this network. They created a streaming audio loop that consisted of several sound inputs from a different location in the world. The online streams were picked up and remixed by another streaming unit in another location, and then returned to cyberspace. The initiator of these collaborative streaming sessions most often was someone within Riga's E-Lab or its local Internet radio project Ozone. Other significantly active Xchange streaming session contributors were from MZX (Ljubljana, Slovenia), XLR (Berlin, Germany), Backspace (London, UK), Radio 90 (Banff, Canada), and L'audible (Sydney, Australia). The call for joining the

collaborative sessions was announced via the Xchange mailing list, and the live streaming loops were coordinated using Internet relay chat (IRC). What was streamed, in terms of the sound content, could be noise from the microphone, a sound art piece, ambient recordings of the surrounding environment, sirens in the street, a DJ mix, or spoken words, in other words, just about anything. But the content was not as important as the participation. However, the ultimate purpose was the meaning found within the creative communication process itself. Diversity of creative Internet radio initiatives and the sound artist groups involved in Xchange events is represented in the Xchange network map (see Figure 1). The map also depicts which type of initiatives (in terms of form and content) were involved, meaning an online radio project or an FM radio streaming online, a live 24h stream or an online archive of recorded sessions, a live stream from club music or a sound project, and so on.
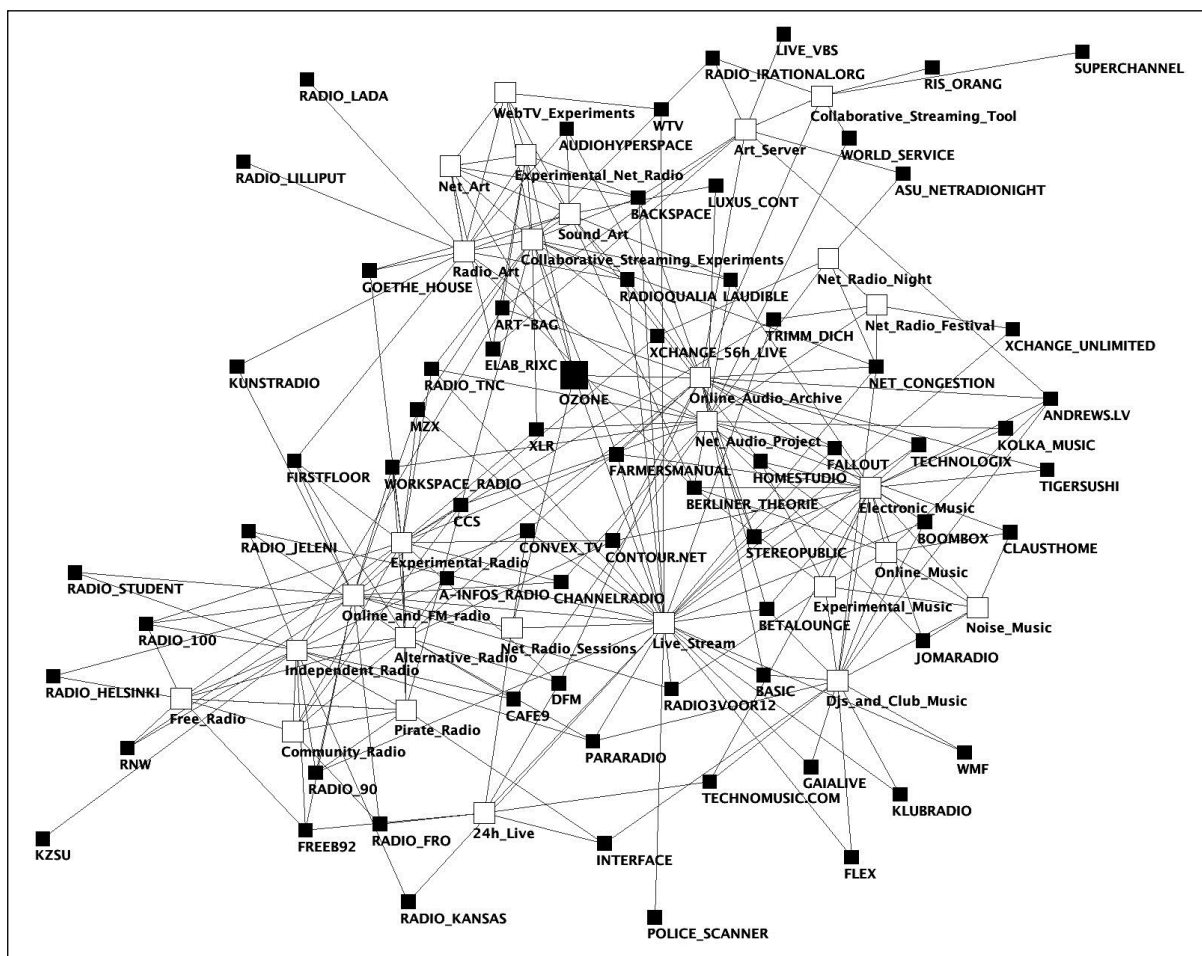
Figure 1. A map of the creative Internet radio network *Xchange,* showing the Internet radio projects, their key participants, and the diversity in their fields of activity during 1996–2000. Data were obtained from *Xchange* Web site in 2012.[10] The black boxes show creative Internet radio and sound artist initiatives who were involved in Xchange network activities, and the white boxes show to which categories (in terms of form and/or content, indicated by its label) each of these groups belong. The map was created with a social network analysis tool developed by Valdis Krebs in conjunction with researchers at the Institute for Informatics and Mathematics at the University of Latvia.

With regard to the community aspect, the Xchange network organized real-time meetings online via IRC that took place in conjunction with the live streaming sessions, thus undoubtedly strengthening its community. However, in line with Pit Schultz's perspective on community, I concur that these events could not replace the offline programs, called net.radio nights, that the Xchange organizers held during various festivals and other international media art events in 1998 and 1999.

However, in 2000, the founders of Xchange and E-Lab turned their interests toward other directions (e.g., experimenting with signals from the Irbene radio telescope, working with satellite technologies, and initiating locative media projects) and stopped organizing online and real space meetings. As a result, the Xchange community slowly dissolved. It remains in network form, although with very weak links that appear through rare mailing list postings.

Nevertheless, during its most active period, Xchange succeeded in creating novel hybrid forms of communication. Although Xchange is considered a creative effort, it lacked any real content because its underlying motivation was pure experimentation in order to become "a global network of *audionauts* festively exploring virtual frontiers" (Lovink, 2004, p. 230; italics added). But when regarded as a social activity, the network became a medium for participation, because participation became a goal (Hyde, 2007), although in a rather autonomous communication space. By exploring such unique features as simultaneity and (remote) presence that exist only in online networked environments, Xchange became an example of new social dynamics.

Obviously the case of Xchange can be studied as a translocal community (similar to Nettime, Syndicate, and Faces). However, because it involved a strong local aspect by being founded by the E-Lab artists group from Riga, it is also interesting to study it as an extension of the local community networking that was developing in Riga and Latvia, in parallel to E-Lab's activities in translocal networks.

New contemporary art tendencies and forms of subculture emerged in Latvia during the mid-1990s. Although influenced by globalization, the artistic outputs were transmitted within various local contexts. The "live" formations of young artists, that is, musicians, DJs, club event organizers, fashion designers, poets, and other young creative people, manifested themselves as a hybrid of techno music culture and experimental contemporary art. One of the "connectors" that not only introduced the techno culture to Latvia but also established new connections between the more active creative people of that time was the Open initiative.[11] "*I think I was looking for my own crowd or environment to fit in and to be in my element. While searching for this, I somehow stirred it all up, maybe even unintentionally*" (Vanags, 2010). The events organized by Open could not be described just as subcultures or techno parties. Indeed, they were large scale and involved a large number of participants and visitors, but they did not amount to being commercial raves. "Altogether these expressions manifested an alternative reality which pointed towards new perceptions, towards fundamental changes in the society" (Kluitenberg, 1999, p. 52). Within such an energy-saturated grassroots cultural environment, the E-Lab initiative emerged and developed in 1996.

From the point of view of organizational structure, E-Lab was an example of an Eastern European artist organization, with its content an electronic art laboratory open and freely accessible to everyone interested. Physically (and locally), E-lab was situated in a tiny room in the Artists' Union building, the laboratory that was equipped in 1997 with its own Internet connection and its first set of computers purchased through a Soros Foundation Internet Programme competition grant. When its first server was installed in 1997 and in conjunction

with the translocal Xchange mailing list, E-Lab established a Latvian-language mailing list, titled Rezone, for the local community to discuss and exchange information on local and international contemporary culture, new media, and urban and club culture events. Thus, Rezone established a bridge between the local and translocal media cultures. The Rezone mailing list still exists with about 400 subscribers and an average of 15 messages per month. The activity of the mailing list during these past 14 years has remained relatively steady, perhaps even growing slightly. Thus Rezone today has proved itself to be one of the most active local mailing lists for electronic art and contemporary culture in Latvia.

However, E-Lab artists viewed the Internet as more than just an information exchange platform or a new media and material for creating artworks. The Internet was associated with a new and unexplored space, where it was possible to implement many ideas that would not have been possible offline or in the mid-1990s, with its post-Soviet society and cultural system. Being overwhelmed with the idea of freedom, openness, and autonomous zones, E-Lab members primarily focused their activities on audial communication, using the early audio live broadcasting technologies that appeared in the Internet (e.g., Real Audio). In 1997 E-Lab established its local Internet radio node Ozone, which, through communicating with other similar small-scale Internet radio initiatives from all over the globe, grew into the global Xchange network project. With broadcasting and archiving possibilities, the E-Lab (now RIXC.lv) server today hosts a sound art collection from more than a decade. A collection that includes Internet radio Ozone recordings of live sessions and archived files of early live streams that were provided from different local and international events (festivals, conferences, etc.), as well as collaborative experiments by the Xchange community. In 2009 the Xchange Web site was redesigned into an archive, making its previous works available for future research. The Xchange online archive includes a mailing list archive (with all messages from 1997–2009), sound files (a selection of previously recorded Xchange collaborative broadcasting sessions), and information about the most important Xchange community members.

During the rise of the Internet broadcasting age, Riga and E-Lab, with its experimental Internet radio projects Ozone and Xchange, was described as the epicenter of global network radio, or "something of the World Capital of net radio" (Kluitenberg, 1999, p. 52). By being actively and creatively engaged in the network, the small E-Lab organization with practically no budget somehow managed to find its way into the very heart of an international cooperation network created by artists, theoreticians, and organizers, who were eager to explore the boundaries of the new digital media (Kluitenberg, 1999, p. 52). Thus the local networking case of E-Lab, together with its translocal extension, the Xchange network, demonstrates the way in which the potential of digital networks may be used in strengthening social action fields locally, as well as in broadening it to translocal and global scales.

CONCLUSIONS

As a result of my research, I draw several conclusions. Additionally, I wish to clarify the main differences between Web 1.0 and Web 2.0 communities.

Regarding the meaning and motivation of social action that undergirded the rise of early creative network communities, I have three points. First, such growth requires a well-prepared ground. In this case, the collapse of the Soviet system in Eastern Europe and the

opening of boundaries towards Western Europe facilitated the motivation to communicate and to cooperate on a translocal level, and the new communication technologies (e.g., the Internet) made this possible. Second, an initiator is needed, one who has the ability to assume the role of a connector and who possesses his or her own subjective motivation to establish such networks and sustain its communities. And third, there must exist a shared goal and a common idea that corresponds with the network members' own subjective motivations.

As for the interpretations of the terms *network* and *community* from the network participants' points of view, I suggest that my research supports specific ways by which these concepts can be distinguished. *Networks* refer more to the structure of social ties. In case of creative networks, this means a group of like-minded people with shared interests and loose connections that can be activated, if needed. Meanwhile, *community* refers to a much closer level of personal relationships between and among network participants. Thus, it is possible to talk about a community only in those online network cases or stages of a particular network when meetings of members take place in the physical realm in addition to the virtual communications.

With regard to the activities and forms of social organization of creative networks, the field has always defined these very clearly, with its particular aim recognized and shared by the community members. For instance, during the early stage of the Internet (i.e., the Web 1.0 period), the aims were related to the development of the Web in general and its critical discourse in particular; the social networks were organized around different interests or topics and related primarily to social relationships. However, the main difference between creative networks and social networks—between Web 1.0 and Web 2.0 communities, respectively— lies in technological platforms. This is particularly true in the case of Web 1.0, when creative communities were involved in building their own tools and network infrastructure, as compared to Web 2.0, where communities typically use already created, privately owned social media platforms, such as Facebook or Draugiem.lv.

But more than either of these, however, I argue that the important difference lies in the structure of ties and social organization: what and who are linked and in which way. I completely agree with Tiziana Terranova and other contemporary authors who consider that Web 2.0 refers to the transformation phase from the (hyper)linking of documents and individuals to the linking of social relationships (e.g., friends on Facebook or followers on Twitter).[12] Thus it is possible to conclude that Web 1.0 platforms are more about linking individuals (whose shared personal interest is to promote collective ideas) and about creating and linking new media objects (e.g., collective artworks on the Web, collaborative streaming experiments, development of artistic software), whereas Web 2.0 communities are about linking social and/or business relationships between countless people-to-people exchanges, consisting of individually managed profiles on social network sites, numerous posts and comments on blog sites, and the intense activity of uploading and downloading enormous amount of new media objects, such as photos and videos.

In other words, the linking of individuals who collectively discuss the ideas for the advancement of the field (in the case of Web 1.0) has been supplanted today by linking social relationships with invisible input for the common field of interests of a community. For example, Lovink (in his 2010 interview) suggested that "*maybe it is good that there is no* Xchange *on Facebook.*" Perhaps it would not even be possible, for two reasons. First, it was equally important for members of Xchange to be able to create and hyperlink new media

objects (e.g., collaborative streaming sessions resulting in sound loops traveling throughout cyberspace) while, at the same time, to link individuals, that is, community members who were physically located on different continents but who all shared the common goal: to explore the acoustic dimension of cyberspace. Second, because Xchange was a mailing list and not a profile in Facebook, it allowed the establishment of connections and links among people who have different backgrounds, different ideas, and different voices, yet who all promote primarily *collective ideas* and contribute for advancement of the field (i.e., streaming media). Even if Xchange were possible on the Facebook, it would most likely achieve different results: Instead of joint experiments, members would then primarily promote their individual projects because today's popular social media format is built for facilitating self-promotions. Thus, in a way, creative networks can be considered mailing list-based communities in terms of both daily communication and organization of the specific fields of activity; this form of communication may be regarded as a product of the early Internet, or Web 1.0. Yet Web 2.0 platforms can be and are used today by creative networks, but mostly for promotion purposes, that is, for providing information about the community, its members, current and past projects, forthcoming events, and so on. For example, in the case of Faces, their blog is used as a "public face" for this community, whereas the "everyday life" of this community still exists within the mailing list, and not for public consumption.

In short, Web 2.0 platforms are good options for making public the information about the community, its members, and activities, but are not as suitable for developing and promoting collective ideas and organizing the field. This role is much better fulfilled by mailing lists, the key driver of Web 1.0. Therefore creative network communities continue using mailing lists today because, as Geert Lovink noted in his 2010 interview, *"They are bridges between events and the Net,"* just as they bridged the East and West European artist communities in the 1990s.

ENDNOTES

1. The Nettime "Beauty and the East" conference in Ljubljana took place in May 1997 (http://www.ljudmila.org/nettime/) and was co-organized and hosted by Ljudmila Digital Media.

2. In 1994, the Ljudmila (short for Ljubljana Digital Media Lab; http://www.ljudmila.org) was founded by Mitja Domo and a group of Slovenian new artists and activists (Luka Frelih, Marko Peljhan, Vuk Cosić, and others). Throughout the '90s, Ljudmila was an important contributor to East-West European new media art and culture networks (e.g., Nettime, Syndicate). Until 2000, Ljudmila was a key contributor to the media program (later, the Internet program) at the Open Society Institute (OSI) in Slovenia. The network of OSIs throughout the former Soviet Union bloc countries in Eastern Europe was founded and supported by investor George Soros. The aim of the OSIs was to support the development and shaping of democratic governance, social reform, education, independent media, and civil society organizations in these countries so as to encourage participation in democracy and society.

3. For instance, the "Hybrid Workspace" event that was a temporary media lab that operated for 100 days during Documenta X in Kassel, Germany, June–September 1997. It gathered more than 200 participants (http://www.medialounge.net/lounge/workspace/)

4. Data received via e-mail by the author on March 31, 2011 from current Nettime moderator Felix Stalder.

5. The Faces community blog on the Internet (http://faces-l.net/) provides additional public information.

6. I became involved with Faces as a result of my interest in cyberfeminist issues in the late 1990s and attended "The First Cyberfeminist International" symposium that took place within the framework of

the "Hybrid Workspace" event series at Documenta X in September 1997 in Kassel, Germany (http://www.obn.org/kassel/).

7. "Deep Europe" was a term used by Syndicate list members to embody the concept of improved connections between Eastern and Western European members.

8. E-Lab—the Electronic Arts Laboratory—was founded by Raitis Smits, Jaanis Garancs, and Rasa Smite in 1996, in Riga, Latvia. On the basis of E-Lab, the Center for New Media Culture (RIXC) was founded in 2000, in Riga (http://rixc.lv).

9. "Acoustic Cyberspace" was a concept used by Xchange. It was developed by Erik Davis, based on a talk he delivered at the 1997 Riga Art+Communication festival.

10. The information source can be viewed from http://xchange.re-lab.net (and was retrieved July 16, 2012).

11. Project "Open" was founded in 1995 by art curators Kaspars Vanags and Ilze Strazdina in Riga, Latvia.

12. This point was drawn from a June 19, 2012, lecture by Terranova, titled "Restart the social: Gabriel Tarde and the Web 2.0," at the Post-Media Lab at Leuphana University. Lüneburg, Germany.

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TELEPRESENCE AND SEXUALITY: A REVIEW AND A CALL TO SCHOLARS

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Abstract: *Scholars have examined the phenomenon of telepresence, a perceptual illusion of nonmediation experienced by media users, in a wide variety of contexts. This paper explores telepresence theory and research in the rarely examined but important context of sexually arousing media content. After defining key concepts, the paper presents reasons scholars should study telepresence in the context of sexuality, reviews the evolution of relevant media technologies and the nature of relevant telepresence responses, and considers potential theoretical contributions and avenues for future research in interpersonal communication, media studies, and presence scholarship.*

Keywords: *telepresence, sexuality, human-technology, media, parasocial, social richness, realism, immersion.*

INTRODUCTION

Telepresence, hereafter shortened to presence, is an interdisciplinary topic of increasing interest to both scholars and the business community. Most often defined as the sense of "being there" with real or fictional people and objects via communication technology, scholars have explored the role of presence and presence technologies in a wide range of settings and contexts, including business (Lombard & Snyder-Duch, 2001; Mollen & Wilson, 2010; Suh & Chang, 2006), entertainment (Bracken & Skalski, 2009), health and medicine (Latifi et al., 2007; Riva, 2004), space and undersea exploration (Ballard, 2008; Terrile & Noraky, 2012), art (Barbatsis, 1999; Saltz, 2001), and many others (see Lombard & M. T. Jones, 2007). But researchers and theorists have not explored presence in the context of sexuality, even though sex is a primary biological need, sexual media products generate billions of dollars globally each year, and exploring this context holds promise for expanding our understanding of a variety of presence-related interpersonal and mediated communication processes and effects.

In this paper, we explore the topic of presence and sexuality. First, we define relevant key terms and outline reasons scholars should examine presence concepts and theories in the context of sexuality. We then review the evolution of technologies in this area and consider the nature of

presence responses in the context of sexuality. We close the paper with potential theoretical insights and avenues for future research suggested by presence developments in this area.

DEFINING KEY TERMS

To sufficiently examine presence and sexuality, it is first necessary to define the terms presence, sexuality, and sexual media content. Presence is defined here, following Lombard and Ditton (1997), as "the perceptual illusion of nonmediation" ("Presence Explicated," para. 1). This refers to a phenomenon in which an individual perceives a mediated experience as an authentic first-hand experience to which they may respond as physiologically, cognitively, and emotionally as they would in the nonmediated setting. Although there are many definitions of presence (for a review, see Lombard & M. T. Jones, in press), this often-cited definition, similar to that in the detailed explication of the International Society for Presence Research (2000), can be productively applied to a wide variety of relevant phenomena. This inclusiveness can be seen in the key dimensions or types of presence discussed in the Characteristics section below.

Sexuality refers to physiological and psychological phenomena related to the arousal of human reproductive organs (see Heiman & Pfaff, 2011). Sexual media content includes pornography and erotica, both of which are notoriously difficult to define (e.g., Supreme Court Justice Potter Stewart's famous "I know it when I see it" quote from *Miller v. California*, 1973; for reviews, see Andrews, 2012; Linz & Malamuth, 1993; Mosher, 1988). Sexual media content describes any content presented or experienced via technology and which is designed in part to elicit or enhance the sexual arousal of users. This includes pornography (defined here as mediated sexually explicit materials in a commercial product), erotica (typically less explicit, with artistic or educational aspirations), and, although not the primary focus here, nonexplicit sexually arousing content, for example, swimsuit issues of sports magazines, Victoria's Secret television specials, and beer commercials featuring attractive, scantily clad models and celebrities. In any of these contexts, the content may be fictional, nonfictional, or a combination of the two, and may or may not follow a narrative. With technology defined broadly as the systematic application of human industrial arts, the media forms that carry the sexual media content can logically include not only print and digital media, but also adult products such as vibrators, dildos, and sex dolls. All designed and manufactured physical products mediate human sexual experiences. Sexual media content and form are created for and used by people with different sexual orientations and preferences and for use independently and/or with others.

REASONS TO EXAMINE PRESENCE AND SEXUALITY

Clearly, sexuality deserves scholarly attention. Along with air, food, water, sleep, and warmth, sex is classified as a biological or physiological human need at the base level in Maslow's hierarchy of needs (Maslow, 1954/1987, 1968/1998; see also Alderfer, 1969; Heiman & Pfaff, 2011). Beyond the biological imperative to reproduce, humans need and highly value emotional intimacy and connection with sexual partners, aspects of the belongingness and love needs in Maslow's hierarchy. Whether based in evolution or culture, it is clear that sex and

intimacy are critically important to most human beings. How and with what success they seek fulfillment of these needs via sexual media content and technology, then, should be of great interest to scholars of sexuality as well as technology, media, and many other fields including, of course, presence. Such research interest is imperative particularly because, although it encompasses much more (see Noonan, 2011), the essence of sex has been characterized as "the ultimate in embodiment—a corporeal experience in which physical bodies interact" (Waskul, Douglass, & Edgley, 2000, p. 375) and the essence of (at least many conceptualizations of) presence is physical interaction with/in a mediated environment.

Although creators and distributors of sexual media content do not use the term explicitly, they clearly seek to produce an experience of presence, a sense of being physically, and in some cases emotionally, close to the people represented in their media products. Their efforts have been closely tied to the evolution of media technology and, in many cases, have driven the development, innovative use, and profitability of such technology, from the printing press to photographic processes to interactive, real-time, remote sex toys (see the Evolution of Media Technology section below). We, as researchers and humans, need to better understand how the long pursuit of presence in this context has guided, and especially how it is likely to guide, the evolution of all media technologies, as well as the consequences of this evolution.

Like only a few of the many contexts in which presence concepts have been studied, a large, diverse, and global public already is regularly consuming mediated sexual content and experiencing presence. Estimates of the size of the adult entertainment industry vary widely from US\$1–14 billion annually in the United States (Leung, 2007; McAlpine, 2002; Rich, 2001; see also Belle, 2010) to up to nearly US\$100 billion globally (Belle, 2010). Major media, hotel, and other, often multinational, corporations may not publicize it, but they make millions of dollars in profits (Kirk & Boyer, 2002; Leung, 2007; C. Taylor, 2002). Beyond revenues, there are many other indicators of the public's intense interest in the intersection of sex and technology: Researchers struggle to find men who have not viewed pornography (United Press International, 2009); up to a third of young people send sexual text messages (Constantinescu, 2009); the most frequently searched-for words on the Internet consistently include *sex*, *porn*, and many other sexual terms (Wordtracker, 2009; see also Spink, Partridge, & Jansen, 2006); the most shared stories on Facebook refer to sex (Smith, 2011); and some estimate that "over 60 percent of all visits on the Internet involve a sexual purpose" (Schneider & Weiss, n.d., para. 1; see Döring, 2009).

Sexual media content also increasingly is considered mainstream and acceptable: "Pornography has gone mainstream all over America. From movies to television shows to music videos and magazines, porn stars and porn iconography are everywhere, pointing to a national comfort level that few would have predicted even a decade ago" ("XXX-ceptable," 2003, para 3). If anything, the trend has accelerated in recent years, with porn stars, Playboy Playmates, and sexually promiscuous reality TV personalities gaining acceptance in popular culture; the sexually explicit discussions of popular radio "shock jocks"; the prominent display of erotic books in stores (Wyatt, 2004); new, edgier sexuality in advertising (Babej & Pollak, 2006); and more sexuality in television programming (see Rich, 2001; Strauss, 2010).

The potential negative and positive consequences of mediated sexual content, which are likely to be intensified, or at least modified, by presence, provide a rich and important context for the application of presence research and theory. Pornography (and other sexual media content) has long been the subject of controversy, with some arguing it is harmful in a variety

of ways and others arguing for its benefits (see, e.g., Malamuth & Billings, 1984; Weaver, 1991). Pornography, especially violent pornography, has been charged with causing people to objectify and disrespect women, to become callous and desensitized toward their mistreatment, to become sexually promiscuous, and to behave violently toward women (Donnerstein & Malamuth, 1997; Fisher & Grenier, 1994; Lipton, 1973; Mulvey & Haugaard, 1986; Steinem, 1980). Internet pornography also is associated with cybersex addiction (Griffin-Shelley, 2003; Schneider & Weiss, n.d.; although the classification is controversial; see J. E. Grant, 2008; Ley, 2012), and may have harmful effects on relationships (Cooper, Boies, Maheu, & Greenfield, 2000). Other negative consequences of pornography are said to include social alienation (Hundley, 2000); loss of identity, individuality, and sense of mystery (Heim, 1991), as well as unsatisfying sexual experience due to failure of technology (e.g., electric sex toys; Baldwin, 2000). Sexual technologies have also evoked concerns about mechanization and the replacement of "natural" sexuality. Juffer (1998) reviewed historical discourses regarding vibrators that demonstrate "the fear of the cyborg, the paranoia that women using machines would turn into women *as* machines—robots addicted to endless orgasms" (p. 90).

Although negative impacts have received more attention, consistent with a third-person effect in which we perceive greater harmful effects of pornography on others than ourselves (Lo & Wei, 2002), some argue that pornography and other sexual media content provide important educational and therapeutic (Springer, 1996), hygienic (Schneider, 2000; Steinberg, 1993) and safety (Russell, 2004; Schneider, 2000) functions. It may expand opportunities for exploration and learning (Hundley, 2000; Springer, 1996; Whitty, 2008) and lead to "a more public acknowledgement of diverse desires" (Zimmerman & Lewsen, 2007, "Good Ol' Family Porn" para. 8). Some feminists (McElroy, 1995; Strossen, 2000) argue that it provides a range of personal and political benefits to women (see Snyder, 2008, for an overview of the debates).

The evolution of presence-enhancing technology regarding sexuality also raises critical new ethical issues. Commenting on the US$5,000 life-size, anatomically correct, silicone love doll, Realdoll,[1] attorney and feminist M.C. Sungaila said, "Knowing that it's out there and that somebody thought this was a good idea—to make money off the complete objectification of women—is discomforting to say the least" (Lemons, 2000, para. 22). Steinberg (1993) looked to a day when people will ask, "Why settle for real sex with real people when you can have virtual perfection?...Why risk disease, embarrassment, disappointment, frustration, and heartbreak when you can program an ideal partner to satisfy you ideally?" ("Virtual Dancing," para 7). Although many of the technologies that raise concern, including virtual reality (VR) technologies described in sections below, remain in the lab at this writing, presence-evoking sexual media are evolving quickly. Rheingold (1991) noted that,

> Given the rate of development of VR technologies, we don't have a great deal of time to tackle questions of morality, privacy, personal identity, and even the prospect of a fundamental change in human nature. When the VR revolution really gets rolling, we are likely to be too busy turning into whatever we are turning into to analyze or debate the consequences. (p. 350)

Although predictions about the rate of technological progress have often been overly optimistic (Mims, 2010; Woolley, 1994), the progress continues. At this writing, new virtual assistant applications (Elgan, 2012), motion-based controllers (e.g., Leap Motion[2]), and virtual and augmented reality systems (e.g., Oculus Rift[3] and Google Glass[4]) show great

promise, and sexual content is being developed for most of them (Brown, 2013; Campbell, 2013; Segan, 2012).

For these reasons and others, and despite the culturally sensitive nature of the topic (Keilty, 2012; C. Taylor 2002), we believe scholars should turn their attention to the context of presence and sexuality. The following sections provide historical context, examine the characteristics of different forms of presence in response to mediated sexuality, and suggest avenues for future theory and research in this area.

EVOLUTION OF MEDIA TECHNOLOGY FOR SEXUAL MEDIA CONTENT

The technologies used to deliver sexual media content have evolved substantially, especially since the end of the 20th century. The evolution from technologies that transmit abstract symbolic representations to those that provide first-person interactive experiences suggests that media users are having increasingly vivid sexual presence experiences.

As Springer (1996) observed, "Historians of technology have pointed out that new inventions have been accompanied by sexual impulses throughout history" (p. 8). Tierney (1994, p. 9) reviewed how communication media have been used for sexual expression "from the invention of the printing press to the introduction of the novel, photography, films, videocassette recorders, computers, and pay-per-call telephone services" (see also Coopersmith, 1998).

Some of the earliest media with sexual content may be found in the Ice Age Venus figurines of Europe, which feature large breasts and buttocks sculpted with considerable attention to detail. Drawing from Absolon (1949) and others, T. Taylor (1996) went so far as to question whether these artworks were "made by men as the prehistoric equivalent of Playboy centerfolds" (p. 116). In addition, Taylor suggested the possibility that Stone Age phallic batons, which served as primitive dildos, may "have been a part of our own evolutionary and early cultural background" (p. 128).

T. Taylor (1996) also noted that the earliest preserved history of written records made reference to a multitude of sexual practices. The word *pornography*, taken from the Greek *porne* (whore) and *graphein* (to write), means "writings of harlots" or "depictions of acts of prostitutes" (Linz & Malamuth, 1993, p. 2). Writing as a vehicle to convey sexually arousing content grew with the proliferation of printing and literacy. Famous authors such as D. H. Lawrence (1928), Emile Zola (1928), Henry Miller (1935), and Frank Harris (1963), along with countless other authors, have published stories that describe the explicit details of sexual behavior.

The invention of photography in 1839 brought a new level of detail and impact to mediated experience, and sexuality was a subject of considerable interest and value to the first producers and consumers of photographic images. Koetzle (1994) referred to an 1874 police raid in which 130,248 pornographic photographs were confiscated to demonstrate "both the trade's production capacity and the wealth of public demand for [photographic] erotica" (p. 228). Nazarieff (1993, inside front cover) aptly described the presence evoked by the erotic photograph: "A woman you can almost touch, yet who is captured only on paper." Stereoscopic photography was also used extensively for photographs with sexual content (Nazarieff, 1993).

When motion pictures became a reality in the 1890s, more precisely capturing the experience of the human visual system, it is not surprising that the earliest content was sexual. Because real, unmediated sex does not occur in static frames, the introduction of a

medium able to capture rhythm and motion—key aspects of the sex act—became a particularly effective form to record and display sexual content. Pornographic films from the very early 1900s are still available (e.g., see Vintage Erotica[5]).

More contemporary electronic media, such as the video cassette recording (VCR), also have been exploited for their capacity to mediate sexual content. Weaver (1991) observed that, "Producers of pornography were among the earliest adopters of videotape technology for distribution of their software" (p. 330). With the advent of the videotape, consumers were able to take sexual content into the comfort of the intimate setting rather than experiencing it in a public theatre. "Prior to home video, pornography had a far smaller audience, limited mainly to men willing to venture into the muck of a Pussycat Cinema" (Rich, 2001, para. 14). With this new-found privacy, the user was free to have a more complete experience through simultaneously viewing and masturbating (or via activities with a partner). Video-on-demand services further facilitated privacy because the user need not even venture into the back room of a video store.

One crucial aspect of modern media technology's intersection with sexual content is its potential for interactivity. "As sexual content was the eminently marketable application that drove the VCR and camcorder markets, it's proven a 'killer app'—let's say 'lover app,' please—that has driven interactive Web video technology too" (Mosher, 1998, "Sex Without Socialism," para. 5).

The home video camera–recorder (camcorder), Web camera (Webcams; Rossney, 1995), text messaging (text sex; Jeyes, 2008), Internet compatible sex toys (Jardin, 2004), and DVDs with an array of interactive menu functions (Kennedy, 2003) enable not only privacy, but a sense of dialogic give-and-take previously available only in face-to-face interactions. Mobile and social media have provided new venues for interaction, including sexting and sexcasting (i.e., sending sexually explicit images, texts, and videos via cell phones and other technologies; Henderson, 2011; Shaw, 2012); Internet chat rooms, communities, and games; and virtual worlds (see Döring, 2009). Professional and do-it-yourself material available on-demand on desktops, laptops, tablets, and smartphones; a wide variety of adult blogs; live telephone and Webcam services; online dating services; adult social networking sites; and massively multiplayer online role-playing games, along with remote-controlled sex toys and Realdolls, are providing sexual media users with an increasing number of interactive and social options. Sexuality is a key feature in the virtual world Second Life (see Gilbert, Gonzalez, & Murphy, 2011), and other services are dedicated to a variety of interactive and social experiences (e.g., Red Light Utherverse[6] combines an adult 3D, avatar-based role-playing game with a personal profile-based social networking Website).

Looking into the future, inventors, theorists, and science-fiction writers have further explored the interactive and immersive potential of the media and sex equation. Examples include the amoebot bed, capable of becoming physically intimate with its occupant (Dery, 1996); artificially intelligent robot and android sex partners (Lemons, 2000; D. Levy, 2007; Yeoman & Mars, 2012); and Howard Rheingold's (1991) description of teledildonics, a hypothetical scenario in which long-distance partners, clad in sensor enmeshed bodysuits and virtual reality helmets, caress each other electronically. What each of these not-yet-realized libidinal technologies seems to maximize is the interactive and immersive qualities of the experience they offer. Even farther ahead, scholars, including telepresence pioneer Marvin Minsky (quoted in Tanner, 2006), have forecast drugs and devices that manipulate the brain

to create a sexual experience, with the possibility of recording and replaying them (Jaccoma, 2001; see also Halley, 2009).

To summarize, media have long been developed or adapted for the purposes of presenting sexually arousing content and to induce a sense of mediated presence in the user. The trend has developed from abstract and distant representations to more first-hand, interactive, and direct representations. In this evolution, interactivity and perceptual immersion have increased. In technologies that address the sexual needs of a single individual, the interactivity of nonmediated sexual activity is approximated, as in interactive DVDs. In technologies that facilitate the sexual interaction of two or more people, sensory input channels are maximized and coordinated through combinations of text, audio, Webcam images, remote-control, computer-interfacing devices and, perhaps in the future, virtual-reality headsets and datasuits.

CHARACTERISTICS OF PRESENCE IN THE CONTEXT OF MEDIA WITH SEXUAL CONTENT

Having explored the history of mediated sexuality, we can now investigate the specific dynamics of the presence experience as it is elicited through media with sexual content. Presence is a multidimensional concept, and, as noted above, a variety of dimensional structures have been proposed (see Freeman, 2004; International Society for Presence Research, 2000; Lombard & M. T. Jones, in press). Here we use the dimensions or types of presence identified by Lombard and Ditton (1997), based on their review of diverse literatures, to consider how each of six dimensions applies in the context of the intersection between media form and sexual content. The goals are to further explain and illustrate the nature of presence phenomena in general and specifically in the context of sexuality, as well as to provide the background for the discussion that follows regarding how we can fruitfully theorize about and study these interesting phenomena.

Social Richness

Informed by social presence theory (Short, Williams, & Christie, 1976) and media richness theory (Rice, 1992), Lombard and Ditton (1997) identify the first dimension of presence as social richness. As a characteristic of a medium, social richness generally refers to the amount of information that can be transmitted through one or many sensory channels; as a characteristic of the medium user, it refers to the subjective experience of warmth and intimacy in the mediated interaction. Social presence and media richness theories were developed to better match communication media and organizational tasks to maximize efficiency and satisfaction. Interactants are said to select a "lean" medium, such as e-mail, for basic information exchange and a "rich" medium, such as videoconferencing, for relationship building. Similarly, in the context of sexual intimacy, rich media and maximum intimacy are not always desirable. Thus interactants may choose from a variety of lean media (e.g., phone texting, text-based chat rooms, instant messaging) and rich media (e.g., interactive, real-time, remote sex toys) to create the desired level and type of intimacy.

Beyond current commercially available products, a variety of prototype technologies evoke presence as social richness in interesting ways. The Hug is a soft anthropomorphic object that uses sensors and actuators to record and transmit "hugs" (i.e., pressure, heat, vibrations) along

with voice via wireless telephony (Gemperle, DiSalvo, Forlizzi, & Yonkers, 2003). Pro Invention's KissPhone[7] records the physics of kissing (e.g., pressure, temperature, sucking force) when the device is kissed and transmits the "kiss" to another cell phone user. The Human Connectedness research group at Media Lab Europe has created a series of innovative intimate interfaces. Mutsugoto (Pillow Talk) is "an intimate communication device placed in the bedroom environment.... A specialized computer vision and projection system allows users to write or draw on their own bodies while laying [sic] in bed. Drawings made by one partner are transmitted to and revealed on the body of the remote partner" (Hayashi, Agamanolis, & McGrath, 2005; para. 1).

Realism

The second dimension Lombard and Ditton (1997) identify is realism. They describe two distinct forms: perceptual realism and social realism.

Perceptual Realism

Perceptual realism refers to a presence experience in which the mediated representation accurately simulates or reproduces the sensory experience that would be expected in the nonmediated context. Malamuth (1996, p. 25) observed that because "mass media did not exist in our ancestral history, our mechanisms for discriminating fantasy versus reality may not be sufficiently sharp to totally avoid any long-term impact of exposure on our feelings, thoughts, and behavior." J. D. Anderson (1996) and Reeves and Nass (1996) similarly pointed out the deceptive effect that media (particularly film) have on human perception. In *The Media Equation*, Reeves and Nass (1996) stated explicitly that,

> The human brain, at least at the level of primitive cortical arousal, does not have a switch that activates a different type of processing when media are present. As far as neural activity goes, mediated pictures and sounds produce the same results that would occur if the people, objects, and places were actually present. (pp. 115–116)

Extending this logic, we assert that the reason mediated sexual images arouse is that, on some primitive level, we respond to mediated bodies as if they were nonmediated bodies. It makes sense to suggest, then, that the more perceptually realistic sexually stimulating content seems, the more likely it is to evoke sexual arousal. Consistent with an evolutionary perspective, genital arousal covaries with explicitness (Laan & Janssen, 2007), but the relationship between perceptual realism of sexual stimuli and arousal should apply regardless. To illustrate, visual erotica at the beginning of the computer era that took the form of ASCII porn—figures created from numbers and letters in a nonproportional font (Newitz, 2001)—was much less arousing than today's digital high-resolution color photographs.

Film and video add motion, creating a more realistic and arousing stimulus. The latest audiovisual digital technologies provide even greater perceptual realism. Playboy was among the first media providers to introduce adult material in high definition (HDTV), with its Spice HD channel delivering "a picture so clear that many have compared it to looking through a window" (Swann, 2002, para. 3; see also "Skin-deep," 2004). In a 2007 CNN Money article, adult film director Joone, founder of the Digital Playground adult studio, said about high definition, "You

feel like you're there watching it live… It's more real" ("Adult Movie Industry's," 2007, last para.). Adult content makers are also beginning to use 3D technology to enhance realism (Albanesius, 2010).

Some producers of sexual media have focused on the single sensory channel of audio to create perceptually realistic experiences.

> Unlike stereo, where sound comes from either the left or the right, Virtual Audio provides spatial cues telling you if the sound is in front of you, behind you, close or far away. And it's digital—there's no analog tape hiss—so when you're listening, it feels like *you are there*. (Producer Ron Gompertz, quoted in Palac, 1997, p. 77; italics in original)

Recordings such as *Encounters Erotica*[8] and *Private Pleasure TraXXX: A Virtual Erotic Audio-Sex Experience*[9] use this technology to create vivid reproductions of sexual activity.

Efforts by manufacturers of adult novelty toys have also placed a premium on developing products high in perceptual realism. Companies such as TopCo and Doc Johnson have developed and produced artificial genitals out of various materials designed to replicate the qualities of real skin. Patented compositions with names like Cyberskin, Futurotic skin, Realistic skin, and Ultra-Realistic 3.0 skin demonstrate increasingly sophisticated attempts to evoke presence in the form of perceptual realism.

Social Realism

As opposed to perceptual realism, social realism describes a presence experience wherein the behavior and language of depicted social actors are true to life. The proliferation of amateur and reality pornography attests to the appeal of this kind of presence. Despite the lack of perceptual realism as a result of low quality recording equipment and lack of professional production skills, the ostensibly unscripted content remains exciting as a result of its authenticity.

Social realism is enhanced when the content is advertised as having been created by the person(s) depicted, as in pornography such as *Shot at Home Alone,*[10] an at-home and intimate production featuring a porn star filmed by her husband and apparently created for private use, and *Snatch'd: Stolen Home Videos,*[11] ostensibly genuine, private sex videos. By viewing the private and intimate moments of others, whether celebrities like Pamela Anderson or Paris Hilton, amateur actors, or, especially, just ordinary people, the spectator accesses a level of "real" intimacy that is unattainable in sexual media obviously created for viewing by a mass audience. Sexting and sexcasting (Henderson, 2011; Shaw, 2012) and the phenomenon of mediated exhibitionism (M. T. Jones, 2010), in which amateurs from all walks of life post photographs and videos of themselves or their partners on Websites that offer a public forum for commentary and evaluation, are additional examples of sexual media content that provide presence as social realism.

Note that the two types of realism are distinct but compatible. In fact, the optimum presence experience arguably would combine both perceptually realistic and socially realistic features so that the totality of the unmediated sexual experience can be most accurately duplicated.

Transportation

Beyond realism, or perhaps a precondition of it, is the issue of physical location. In a chapter that discusses the problem of physical location in the context of erotic Internet interaction, Waldby (1998) noted, "The pretext for any computer mediated communication between

participants is separation in space" ("Internet Erotics," para. 1). This, of course, can be extended to include any technologically mediated communication (computer or otherwise). As a result, the experience of presence in the mediated situation is contingent upon the perceived transportation of one, both, or all participants. Lombard and Ditton (1997) describe three ways that location is perceptually altered by presence as transportation: (a) "you are there," (b) "it is here," and (c) "we are together."

"You are There"

"You are there" transportation describes the medium user's perception of traveling into and being a part of a mediated environment. Virtually any pornographic film or video aims to bring the user into the "action." Weaver (1991, p. 231) observed that contemporary pornography typically uses a "'you are there as it happens' documentary style." This is magnified in formats where the camera and spectator (viewer) are acknowledged. In Hollywood style films and television soap operas, the camera is disguised, meaning the actors do not look into the lens and editing style and camera movement work together to deny the existence of the spectator. But in reality and amateur pornography, subjects are seen as aware of both camera and spectator, which sets up the pretext of a first-person experience for the spectator.

"You are there" transportation is also evoked through point-of-view (P.O.V.) pornography, wherein the subjective gaze of the performer becomes the gaze of the viewer. For example, the description of one of the over 40 entries in the DVD series *Peter North's P.O.V.*[12] proclaims, "Shot in first person P.O.V. - Peter brings you so close to the action you'll feel like it's your [d***][13] they're riding." Other series (e.g., *Anal POV*[14]) offer particular sex acts.

Videogames have a "you are there" quality when the player inhabits and controls an onscreen avatar, and this format has been appropriated for sexual content as well. The game *Playboy: The Mansion*[15] entices players to "slip into the slippers of [Playboy founder] Hugh Hefner," and a variety of similar titles are available for Xbox and PlayStation consoles as well as personal computers (see Saltzman, 2004). Even more sexually explicit are some Japanese *bishoujo* (pretty girl) games. In all of these games, the user assumes a persona in another environment and acts in that world (see M. T. Jones, 2005, for a review of the myriad ways these games evoke presence).

"It is Here"

A second form of presence as transportation, termed "it is here," brings the mediated representation into the space of the media user, rather than the other way around. Some sophisticated and realistic sex toys fashioned from casts/molds of the genitalia and other physical features of pornography performers have the potential to transport the anatomical likeness of the particular performer into the user's space. Advertisements for these products emphasize their connection to the flesh and blood performer they represent: The Kobe Tai Ultra Realistic P**** & Ass[16] is "a full size, anatomically correct model cast directly from her hot petite body"; the Blake Riley's Vibrating Ass[17] is a "perfect replica"; the David Anthony Realistic C***[18] was "molded directly from the star himself with attention to every detail"; and the Kimberly Williams Pleasureskin 36DD Breasts[19] are "molded directly from Penthouse Pet Kimberly William's 36DD breasts." One product even goes so far as to

include a video of the cast being made so that the connection between the reproduction and the original human being is especially salient to the user (Cohen, 1995).

These body-part replicas function to bring the performer (at least in fragments) to the consumer, especially when considered in conjunction with other sexual media. For example, a user who has seen many pornographic videos and photographs of Jenna Jameson is more able to appreciate the nuances of the toy because of its likeness to the unique characteristics of her body. This presumably results in a greater feeling that she "is here" from the user's perspective. Kits have also been produced that enable a user to form a mold of his or her own genitals. A description of the Clone-A-Willy kit[20] says it lets you "Keep that special someone home, even when he's far away!" The manufacture of artificial sex organs to stand in the place of an absent lover is apparently not a new phenomenon. Hill and Wallace (2011) present a photograph of an 18th-century Venetian dildo with a husband's portrait painted at the base. Clearly this object was meant to offer a very rudimentary sense of "it is here" transported presence to the wife for whom it was made.

Beyond the reproduction of fragments of performers' bodies, reproduction of the entire body is available in the form of a love doll. The function of the full-sized replica love doll is touted by advertisers of the Jill Kelly Sex Doll,[21] who announce, "You've seen her on the screen. Now see her between your sheets!" Here the advertisers are openly telling the reader that he or she can take Jill Kelly home—a clear reference to presence as "it is here" transportation.

Beyond the tangible replicas in these examples, adult entertainment company Digital Playground is working to develop holographic imagery intended to sexually arouse (Kennedy, 2003). In addition to again demonstrating how sexual media content is a driving force behind innovation in media technology, this would represent another means of transporting mediated people to viewers for sexual purposes.

"We are Together"

The third and final form of presence as transportation specifies a shared space in which mediated communicators experience a sensation of "we are together." This type of presence as transportation is often used to describe such experiences as teleconferencing (see Lichtman, 2006; Muhlbock, Bocker, & Prussog, 1995) and multiuser virtual reality (see Lanier & Biocca, 1992). But even text-based interaction can evoke a sense of interacting together in the same space between people who are actually in different physical locations. What is crucial is the real-time (or apparently real-time) nature of the interaction. In her discussion of erotic online text-based digital communication, Waldby (1998) wrote, "This mutual and simultaneous interaction effectively implicates the bodies of both participants in a particular kind of shared space … produced by the digital assemblage and its embodiment by the user" ("Internet Erotics," para. 3). Beyond real-time, text-based chat are mediated sexual encounters in multiuser online virtual environments, such as Red Light Center[6] (a virtual world for adults only; Lynn, 2006) and Second Life (Wagner, 2007), in which participants interact via avatars in a common virtual space.

In an article for *Wired* magazine titled, "The next best thing to being there," Robert Rossney (1995) attested to the importance of interaction and feedback within a more direct form of mediated erotic encounter. Through an investigation of an online peep show service called Virtual Connections, Ltd., Rossney discovered that he was aroused based on feedback from the woman with whom he was interacting. He wrote, "It's one thing to look at a picture of a scantily

clad woman. It's another thing entirely to ask her to remove an article of clothing and see her respond by whipping off her panties and flinging them aside" (Rossney, 1995, p. 4). Clearly the interactive nature of this sort of experience goes a long way toward reconstituting some of the lost sense of "we are together" transported presence in the mediated erotic encounter.

Taking the erotic possibilities of transportation as shared space further are products that use remote control technology to permit physical stimulation over distance. Products such as the Remote Control Butterfly,[22] the Vibrating Wireless Thong For Him,[23] and the Shots Remote Vibrating Egg[24] permit a person holding the remote control to covertly stimulate a person nearby who is wearing the device receiving the signal. Remote stimulation can also be transmitted via cell phone text messages (Fulbright, 2008; Lynn, 2004b). The Sinulator (Lynn, 2004a) allowed one Internet user to control the sex toy of another user in real time. Live webcam sites such as VSEX[25] charge customers for the opportunity to control mechanical sex machines that stimulate remotely located performers. The site's creator, Allen Stein, said it offers "a new level of intimacy… People come back again and again because they've consummated their relationship with the performers" (Ruberg, 2009, "Deviant Encounters," para. 2; see also Ruberg, 2008). These technologies again illustrate the central role of real-time interaction in the mediated erotic encounter. Although a person at the receiving end of the remote signal is unlikely to mistake the vibration of a remote control egg for direct contact with his or her partner, the knowledge that the partner is controlling the device and determining the level of intensity of the sensations that the receiver feels at that moment creates a sense of physical connection and proximity for both of them.

These remote controlled sexual devices still do not produce the sense of reciprocity so important to the unmediated sex act because they only transmit signals and cannot receive them. In her discussion of online text-based erotic encounters, Waldby (1998) made the observation that the technology used to interact "both substitutes for the face-to-face negotiation of proximate sexuality and simulates certain aspects of that proximate relationship, involving the projection of a limited kind of telepresence through the *simultaneous* and *interactive* production of pleasure in the other's body" ("Introduction," para. 7; emphasis added). Although Waldby referred exclusively to text-based sexual encounters (referring to more elaborate forms as "literal minded and cumbersome"; "The Sexual Relation Does Not Take Place," last para.), the principle importance of reciprocal communication is well illustrated.

Some innovators have devised technology capable of allowing the real-time two-way interaction integral to physical intimacy. The remote sex technology offered (or at least proposed) by F*** You, F*** Me[26] permits users to interact sexually with Windows-compatible genital drives that act as surrogates for their partner's sexual organs. The High Joy Internet-based service enables two-way text, voice, and video communication, along with reciprocal control of sex toys (Jardin, 2004). Mojowijo[27] uses Wii remote attachments and Skype video conferencing to similar effect, and Xcite!Touch[28] provides remote haptic interaction in the virtual world Second Life (see Denning, 2012). Even more complete and elaborate is Dominic Choy's designed and patented computer interfacing sex doll, in which "using signals from the Internet as well as sound and touch sensors… [allows] a user wearing a virtual reality headset to have virtual sex with someone in another part of the world…" (Rohde, 2001, para. 4).

Likely the most sophisticated and comprehensive solution to the problem of creating shared space in the mediated erotic encounter was theorized by Rheingold (1991), who described his notion of teledildonics this way:

> Before you climb into a suitably padded chamber and put on your 3D glasses, you slip into a lightweight bodysuit, something like a body stocking, but with the kind of intimate snugness of a condom. Embedded in the inner surface of the suit, using a technology that does not yet exist, is an array of intelligent sensor-effectors – a mesh of tiny tactile detectors coupled to vibrators of varying degrees of hardness, hundreds of them per square inch, that can receive and transmit a realistic sense of tactile presence, the way the visual and audio displays transmit a realistic sense of visual and auditory presence. (p. 346)

Using this imaginary technology, participants in different locations would be able to interact with each other sexually in a vivid shared virtual space.

Immersion

Another form of presence—presence as immersion—occurs in two varieties: psychological and perceptual. Both are relevant to the context of sexuality.

Psychological Immersion

Drawing from Palmer (1995) and Quarrick (1989), Lombard and Ditton (1997) defined psychological immersion as a feeling of being involved, absorbed, engaged, and engrossed ("Presence as Immersion," para. 3). Cybersex addiction provides a good example of how psychological immersion functions. Despite controversies regarding appropriate labels for phenomenon and its underlying nature (J. E. Grant, 2008; Ley, 2012), millions of Americans are said to be cybersex addicts (Schneider & Weiss, n.d.). Moreover, although much of these addicts' media use involves highly iconic (rather than perceptually rich or immersive) communication via chat rooms and e-mail, they become so deeply involved in the experience that their partners describe it as equivalent to an off-line affair (Hertlein & Piercy, 2006; Schneider, 2000).

Perceptual Immersion

Perceptual immersion refers to the involvement of multiple sensory channels in the mediated encounter. If one can only see or hear a stimulus, the experience is said to be less immersive than if one can see, hear, touch, taste and smell it, in part because the involvement of multiple sensory channels permits cross-validation of experience. The unmediated sex act is extremely sensually immersive because participants experience the sight, sound, feel, smell and taste of each other's bodies. Producers of sexual media content seek to approximate these sensations by creating perceptually immersive presence experiences. For example, the 2009 version of Digital Playground's Website[29] proclaimed that the company's innovative products would stimulate all of the user's senses and thereby bring their fantasies a step closer to reality.

One of the key challenges that face innovators who are attempting to create immersive mediated experiences (sexual or otherwise) is the involvement and coordination of multiple sensory channels. Eric White's Virtual Sex Machine[30] device coordinates haptic stimulation with visuals from CDs and DVDs so that "what happens on the screen, happens to you"; RealTouch[31] does the same thing for films streamed over the Internet. Virtual Sex Sets[32] provide visual, aural, and haptic dimensions of experience by coordinating an interactive DVD of a particular porn performer and a sex toy reproduction of the genitals of that

performer. And the Jessica Drake Talking Love Doll[33] approximates the sight, touch, and sound of a human being by featuring prerecorded sex talk.

Beyond mere involvement of multiple senses, the coordination of those senses is crucial to fostering a perceptually immersive presence experience. If one sensation provides information that contradicts another, the presence experience will be lost.

Social Actor Within Medium

A type of presence labeled social actor within medium (Lombard & Ditton, 1997) or parasocial interaction (Horton & Wohl, 1956) involves a pseudointeraction in which a user of a one-way medium experiences something akin to face-to-face interpersonal interaction with the mediated performer. Because of its ability to sustain a level of feigned intimacy through the gestures of private interaction, parasocial interaction is exploited by media producers seeking to create a sexually arousing experience for consumers. Even as early as the mid-1950s, when Horton and Wohl (1956) first theorized the parasocial encounter, they cited examples of its sexual applications in a discussion of the popular radio program *The Lonesome Gal*, which featured a seductive feminine voice speaking intimately in a first person monologue to an audience of single men at the end of the day. Today, products like Ear Erotica's Audible Arousals[34] provide a similar but more explicit and higher fidelity first person experience.

Adult magazines and Websites frequently feature photographs of models who make direct eye contact with the lens of the camera and, by extension, the viewer of the photograph. This technique, known as direct address, was identified by Horton and Wohl (1956) as key to evoking parasocial interaction. This in and of itself implies a degree of intimacy because the viewer is being acknowledged, on some level, by the gaze of the model. Videos containing scenes of a performer who is masturbating, "dirty talk" videos, and the point-of-view (POV) genre of pornography all permit high levels of parasocial interaction. First person interactive DVDs, with titles such as *Interactive Sex with…*, *Virtual Sex with…*, *Playing with…*, and *Total Interactive Control of…*,[35] carry this parasocial interaction further by permitting the user to have a limited amount of input and feedback in the manufactured encounter. With the DVD remote control, users are able to seem to interact with performers, choosing sexual positions, and other aspects of the parasexual experience.

Some innovative adult software produces parasocial encounters using digitally created characters. VirtuaGuy and VirtuaGirl[36] are freeware programs that feature strippers on the computer desktop. The characters greet users each morning, remind them about their appointments, and dance and strip on demand. The Virtual Valerie series challenges the user to bring a digitally generated woman to orgasm using a computer mouse (Springer, 1996). And, although not available commercially, an infrared-sensitive light projection called INBED, creates the interactive image of a virtual girlfriend in the user's bed: "She's perfectly quiet, but once you sit or lie down, she responds to your every move. Lie on your back, she snuggles up right next to you in a log position. Curl up in the fetal position, she spoons" (Lagorio, 2008, para. 2). More sophisticated are the artificially intelligent programs that allow users to cultivate a relationship with a virtual person. As advertisers of Girlfriend[37] note, "Now you can have your own girlfriend…a sensuous woman living in your computer!... watch her, talk to her, ask her questions, and best of all have sex with her." The ad continues, "Your girlfriend starts with a vocabulary of over 3000 words and will continually learn new words, feelings, and ideas.

This program truly grows the more you use it." By experiencing this change and growth over time, a user of the Girlfriend software, Sergio Virtual Boyfriend/Kari Virtual Girlfriend,[38] Virtual Woman,[39] VirtualFem,[40] or others could conceivably develop a strong sexual and emotional relationship with a person who does not exist. In fact, because these programs are so interactive and adaptable, they may blur the line between parasocial interaction and true interpersonal interaction to the point that a malfunctioning hard drive may constitute the death of a lover and friend.

Medium as Social Actor

This final variation of the presence experience that should be addressed in terms of its role in mediated sexual content "involves social responses of media users not to entities (people or computer characters) within a medium, but to cues provided by the medium itself" (Lombard & Ditton, 1997, "Presence as Medium as Social Actor," para. 1). Novelty products such as the Boyfriend Arm Pillow (Allen, 2004) and the Hizamakura Lap Pillow,[41] which is "shaped just like a beautiful woman's lap, kneeling in Japanese-style" and "gives the best re-creation available," constitute media that function as social actors. So do products with a more directly sexual application, such as dildos, vibrators, masturbation sleeves, penis pumps, sex machines (e.g., see Archibald, 2005), and various other sexual devices that are designed to give pleasure but do not rely upon interaction with other people (real or virtual). Products such as Realdoll and the (hypothetical) amoebot discussed above exemplify the concept of medium as social actor because sexual arousal derives from interaction with the object itself. When a person makes use of any of these sexual media, it is likely that they actively suspend disbelief and generate internal sounds and images to heighten the sense of presence and arousal, a point that may apply to some extent to all of the types of presence discussed and how they function with regard to sexual content (Klimmt & Vorderer, 2003; Retaux, 2003).

THEORY AND RESEARCH IMPLICATIONS OF PRESENCE AND SEXUALITY

We have now reviewed the evolution of technologies related to sexual media content and explored how some of these technologies are used (or likely will be used) to evoke six different types of presence experiences. We turn now to ways we can theorize about and study these presence phenomena to extend our understanding of interpersonal and mediated communication as well as presence itself.

Presence, Sexuality, and Interpersonal Communication

Considering the roles and functions of presence in sexuality can help us understand a variety of interpersonal communication phenomena. Two examples are highlighted here: (a) the positive and negative impacts of presence on the long-distance relationship (LDR), and (b) the role of presence in encouraging and discouraging the formation of intimate human-to-human relationships.

Research with couples involved in LDRs indicates that the separation associated with them has at least some negative consequences for the relationship (Holt & Stone, 1988; Van Horn et al., 1997). Van Horn et al. began with the position that "distance affects a relationship by

restricting opportunities for partners to engage in intimacy processes" (p. 25). Of the LDRs that had dissolved by the second phase of their study, 60% reported distance was the most influential factor in ending the relationship. Based on interviews with LDR couples, Sahlstein (2004) concluded that for successful LDRs, "being 'apart' enables being 'together'" because it "creates a desire in the partners to want to have quality time with one another when they come together" (p. 700). However, for others, "together *constrains* apart" because "time together provides a standard for interaction that cannot be achieved when the partners are apart" (Sahlstein, 2004, p. 699). Meanwhile, some individuals in LDRs employ coping mechanisms to manage the challenges of separation. Holt and Stone (1988) noted that study participants with a visual cognitive style used daydreaming as a coping strategy to deal with separation in LDRs, and Shoup, Streeter, and McBurney (2008) confirmed the finding of McBurney, Shoup, and Streeter (2006) that "men and women commonly smell their partners' clothing during separation to feel close to their partners" (Shoup et al., 2008, p. 2955).

All of this suggests a potentially important role for presence in the degree of success of LDRs. It seems likely that couples in LDRs will increasingly use evolving media technologies during separation to evoke the sense of presence of their partners and thereby provide not just time "together" but also key aspects of intimacy (i.e., descriptive self-disclosure, reliable alliance, and companionship) as identified by Van Horn et al. (1997), as well as versions of mediated physical intimacy discussed earlier. It is reasonable to hypothesize that these couples will experience greater relationship satisfaction and be less subject to both the enabling and constraining effects during the cyclical phases of being apart and being together identified by Sahlstein (2004). Not all types of presence or presence technologies should be equally effective; presence as social richness and as transportation may be most critical.

Presence may have an important role in encouraging or discouraging the formation of physically and emotionally intimate interpersonal relationships in the first place. Human intimacy is a complex phenomenon and a multidimensional concept with sexual, emotional, social, intellectual, and recreational components (see Berscheid, 1985; Dahms, 1972; Heller & Wood, 1998; Hook, Gerstein, Detterich, & Gridley, 2003; L. D. Scanzoni & Scanzoni, 1988; Schaefer & Olson, 1981). Factors that encourage or discourage development of intimate relationships include self-differentiation (Kerr & Bowen, 1988), prior developmental tasks and experiences (Collins & Sroufe, 1999; Erikson, 1959), and media portrayals (Holmes, 2007; see Henline, 2006 for a review).

Presence seems likely to be another increasingly important factor in the process. At least some people who are apprehensive about interacting in person already use media (especially media that do not provide cues that people use to disqualify others, such as physical appearance) to "get to know someone and 'break the ice' before going on dates or engaging [in] other forms of face to face interaction" (Henline, 2006, p. 105) and building intimate relationships (see also McKenna, Green, & Gleason, 2002). New and evolving technologies that allow users to control various aspects of these early and subsequent interactions and the resulting sense of presence experienced by the interactants should make this phenomenon more prevalent.

On the other hand, presence technologies may also discourage the formation of intimate relationships. Although the isolating effect of media is certainly not new—Henline (2006, p. 3) noted the Andy Warhol quotation, "When I got my first television set, I stopped caring so much about having close relationships"—the increasing use of many of the media discussed above could replicate enough of the experience of physical intimacy to discourage media users from

forming rich human-to-human relationships. In particular, media that evoke the type of presence in which the medium is perceived as a social actor are likely to have this effect. This may already be occurring in countries such as Japan, where Sparrow (2008, para. 4) noted that "pornography, masturbation aids, Internet porn sites and social networks that lead to 'virtual relationships', soaplands [a type of brothel featuring nonpenetrative sex] and Japan's widespread prostitution industry all allow men outlets for sexual fulfillment while not fulfilling other needs." Scholars should explore the interactions among the types of presence and the variety of other factors in the literature to determine when presence-evoking media are more likely to encourage and discourage successful intimate human relationships.

Presence, Sexuality, and Mediated Communication

Studying presence and sexuality can also help us better understand important media processes and effects. Two examples are briefly considered here: (a) presence as a moderating variable in the effects of pornography and other sexual media content, and (b) the dynamics of parasocial interaction and relationships.

The effects of pornography have been the focus of media (and other) theory and research for decades (for reviews, see Malamuth, Addison, & Koss, 2000; Malamuth & Billings, 1984, 1986). Although they find support for both indictments and defenses, Malamuth et al. (2000) countered evaluations by others (Fisher & Grenier, 1994) in arguing that the cumulative research shows a consistent relationship between pornography use and sexually aggressive attitudes and behaviors. They favor a multivariate cumulative-conditional-probability model that considers a variety of moderator variables that "previous researchers have often failed to properly examine" (Malamuth et al., 2000, p. 57), including

> the cultural background milieu of the person (e.g., a culture that emphasizes or de-emphasizes equality between the genders), the individual's home background (e.g., open or highly restricted education about sexuality), [the] individual's relatively stable personality characteristics and predispositions (e.g., whether dispositionally hostile or not and one's intelligence level), the particular content of the stimuli (e.g., sexually violent or not), the current temporary emotional state of the person (angered or not), and the environment in which exposure occurs (e.g., permissive vs. nonpermissive for aggression. (p. 55)

Another variable that may help us understand pornography's effects is presence. For instance, E. Kronhausen and Kronhausen (1959, 1964) suggested that pornography may have the positive effect of acting as a catharsis or "safety valve" for the pent-up frustrations of potential sexual offenders. Although there is little supporting evidence for catharsis theory in the context of violence (e.g., Geen & Quanty, 1977; Watt & Krull, 1977) and sparse, contradictory evidence in the context of sexuality (Howard, Liptzin, & Reifler, 1973; Kutchinsky, 1973; McCormack, 1988), researchers have focused on the manifest media content rather than "the mind of the viewer" (Copeland & Slater, 1985, p. 356).

Kutchinsky (1973) begins to take a more psychological approach in the following:

> The abundance of pornographic books could be expected to serve as "safety valves" only for the better educated (or more intelligent) potential sex offenders. Picture pornography, on the other hand, is not affected by this objection; on the contrary, one might expect that these full-color magazines and films with the reputation of "leaving nothing to fantasy"

> would be very well suited as a means of sexual stimulation for persons with poor imagination, persons who need "something more concrete." (p. 177)

This reasoning suggests that media that evoke high levels of presence (especially perceptual realism and immersion) have a greater potential to generate a level of fantasy in the user and would be better suited for providing a cathartic experience.

Many of the claims for pornography's negative effects on attitudes and behaviors (e.g., Check & Malamuth, 1986) are based on Bandura's social cognitive theory, which holds that people learn not only from directly experiencing things that happen to them (including the consequences of their actions) but by observing the experiences of others (Bandura, 1986). It seems reasonable to assume that media that provide a strong sense of presence (particularly perceptual realism, "you are here" transportation, and medium as social actor) that is more equivalent to direct experience than otherwise possible will prompt deeper learning and, depending on the content, more prominent negative effects. Other theories of learning also emphasize the importance of learning by doing, including experiential learning (Kolb, 1984) and embodied cognition (see M. L Anderson, 2003; Rambusch & Ziemke, 2005). Although claims regarding pornography have not been based on these theories, by logical extension they suggest that enhancing presence with sexual content might amplify negative effects.

An examination of presence and sexuality can also contribute to our understanding of parasocial interaction and relationships. Although the degree to which they are functional remains a topic of debate (Jensen, 1992; Turner, 2004), parasocial phenomena have become increasingly common and have been studied in contexts that include celebrity fandom (Giles, 2000, 2002), soap operas (Rubin & Perse, 1987), local news (M. R. Levy, 1979; Rubin, Perse, & Powell, 1985), game shows (Horton & Strauss, 1957), home shopping (A. Grant, Guthrie, & Ball-Rokeach, 1991), and talk radio (Rubin & Step, 2000). Giles (2000) noted that a parasocial relationship has advantages over actual relationships because the user controls the selection of the ideal partner, who can have "all manner of fantasy attributes" (p. 65). He highlighted a familiar context:

> Perhaps the most blatant use of parasocial interaction as a substitute for real relationships is in the use of pornography. Indeed, the phenomenal success of the pornography industry may be all the evidence we need to demonstrate the psychological importance of parasocial interaction. Masturbation with the aid of pornography is an extraordinary psychological phenomenon, far beyond the explanatory scope of evolutionary theory, but the small amount of psychological research into responses to "erotica" largely consists of laboratory-based experiments that tell us little about the real-life *use* of pornography. (p. 65; emphasis in original)

It seems likely that the increasing fragmentation of society (Giles, 2000), the mainstreaming of sexual media, and the current and emerging media technologies described earlier that evoke presence as social actor within medium (and medium as social actor) will combine to increase the prevalence and significance of parasocial relationships, requiring media scholars to expand their models of these phenomena. Research that explores the attributes of media form and content, as well as characteristics and goals of users that lead to different levels of intensity and satisfaction in this most personal type of parasocial interaction and relationship, should lead to insights that apply more broadly as well. The interactive, artificially intelligent sensual and sexual companions discussed above have particular potential to expand our understanding as

they provide a relatively rich form of interaction (e.g., as compared to television viewing) but still provide only a simulacrum of human-to-human social interaction.

Presence, Sexuality, and Presence Theory

Scholarly attention to presence in the context of sexuality holds substantial promise for increasing our understanding of the processes, antecedents, and consequences of presence itself across a variety of contexts. It also can assist researchers in refining several key elements of presence theory.

It is challenging to use technology to create the illusion of the in-person presence of another person, but creating the illusion of physically and/or emotionally intimate interaction with another person arguably represents the ultimate challenge for those who design presence-evoking technology. Whether the evoked experiences represent primarily presence as social richness, immersion, transportation, realism, social actor within medium, or (especially) medium as social actor, producing the complex, subtle, verbal and nonverbal, physical, and emotional elements of human intimacy requires an understanding of which properties and combinations of properties of technology, content, form, and context, and of the technology users, lead to which types of presence experiences. So the ultimate challenge for technology designers is also the ultimate opportunity for presence scholars and researchers to develop and refine their current, relatively primitive understanding of these factors. In short, any comprehensive and useful theory of presence must account for presence in this most rich and personal, and personally important, aspect of life.

Aside from the inevitable but unpredictable heuristic benefits of applying current research paradigms and theories to any new area, examining presence in the context of sexuality should help us refine key elements of our theories about presence. Three of these elements are briefly discussed here, the "uncanny valley," "the book problem," and sex differences.

Masahiro Mori's (1982) concept of an uncanny valley suggests that as an artificial (or mediated) entity looks and moves more like a human, we have increasingly positive responses to it until a certain point when the resemblance becomes eerie and disquieting, and emotional responses become negative. When the resemblance is so close to the real thing and the difference is imperceptible, our responses again become positive (see Thompson, 2004). Current sexual media technology is mostly primitive, and yet at least many people seem willing and able to suspend what should be a strong sense of disbelief and obtain a positive experience. As the technologies evolve—for example, "subsequent generations [of Realdolls] will inevitably acquire increasingly sophisticated animatronics and eventually be wedded to robotics" (Lemons, 2000, para. 44)—it seems likely that responses will reflect Mori's uncanny valley, as it becomes eerily disturbing to have sex with a not-quite-but-almost-real virtual person. A hint of this may be seen in Lemons' report of a visit to the Realdoll factory:

> Far in the back is a bizarre spectacle: eight headless female bodies hanging about a yard or so off the floor, suspended from long chains with hooks affixed to the top of the necks. The bodies are, quite simply, gorgeous -- with the sort of firm, round T-and-A that you only find in gentlemen's mags. It's a disturbing sight, reminiscent of plucked chickens on display in a Chinese restaurant. One is torn between lust and horror. (2000, para. 30)

Presence scholars will be able to evaluate the range of emotional responses to these technologies as they evolve. Further, they will better understand the causes, nature, dynamics, and consequences of the uncanny valley phenomenon in a context that permits an unusually complete consideration of relevant variables.

The context of sexuality also represents a valuable opportunity to explore the book problem (Biocca, 2003; Schubert & Crusius, 2002), the surprising (to some) ability of highly iconic, for example, text-based media to evoke presence. In proposing his capacity limited cognitive construction (CLCC) model of spatial presence, Nunez (2007) evaluated the ability of several models to account for this phenomenon and noted that the successful ones recognize that, even though we refer to high-presence media, presence is a response not to the content and form of a medium but to the technology user's mental representations of that content and form. Little is known about what characteristics of iconic and low-immersion media stimuli lead to the creation of mental representations that evoke presence. Because mediated sexual content that leads to presence, as indicated by physiological arousal, can be found in everything from novels, phone texting (see Layson, 2009), and interactive chat rooms to immersive virtual worlds (and because even without media, humans can create mental representations that evoke the same response), sexuality is an ideal context for identifying those characteristics and testing different models of presence. Key questions concern the roles of automatic and controlled responses and the role of the expectations and unique experiences of media users in evoking different types of presence (see Nunez, 2007).

A final component of presence theory that could be refined by examining presence in the context of sexuality concerns the role of biological sex differences in presence experiences. A growing set of studies (e.g., Lachlan & Krcmar, 2008; Lombard, 1995; Lombard, Reich, Grabe, Bracken, & Ditton, 2000; Maurin et al., 2006) have revealed differences between male and female presence responses to a variety of media, but we understand little about the reasons for the patterns of these differences. There is a more substantial and consistent set of research on sex differences in the area of sexuality. Consistent with assertions by evolutionary psychologists (Bailey, Gaulin, Agyei, & Gladue, 1994; Malamuth, 1996), males seem to be more aroused by visual sexual stimuli (Karama et al., 2002), with females most aroused by tactile stimuli (Herz & Cahill, 1997). J. C. Jones and Barlow (1990, p. 278) reported, based on participant self-monitoring, that "women were equally likely to have externally provoked and internally generated sexual images. Men, on the other hand, were more responsive to external cues." And in their experiment examining gender differences in erotic film preference, Janssen, Carpenter, and Graham (2003, p.243) found that for males, "watching as an observer" and "imagining yourself as a participant" were equally sexually arousing, whereas in females, only "imagining yourself as a participant" was related to sexual arousal. Conclusions such as these might be useful in explaining, for example, a pattern of findings (Lombard, 1995; Lombard et al., 2000) in which only females experience greater presence with larger images when watching television segments from a variety of genres. Although the connection is highly speculative, and it is nearly impossible to separate culture and biology, perhaps larger images are more important for females' ability and/or desire to imagine themselves as participants. In any case, findings and theories regarding sex differences in the context of sexuality are likely to be heuristically valuable not only in helping presence scholars understand interesting and important differences between men and

women in the context of mediated sexual experiences, but also for presence experiences in other contexts.

CONCLUSIONS AND FUTURE RESEARCH

Although scholars have examined presence phenomena in many diverse areas, sexuality has mostly been ignored. In addition to wanting to avoid political and other controversies, it seems likely that this is related to a common tendency in journalists' reports about pornography to maintain "an arm's-length disdain passing for objectivity" (C. Taylor, 2002, para. 4), in which sexual media content is treated "as a sociological phenomenon, just not one that is part of any culture that they—or by implication any cultured [news consumers]—feel part of" (C. Taylor, 2002, para. 5; see also Keilty, 2012). But academics should not hesitate to acknowledge they are part of a culture and species for which sexuality is important, and they should explore interesting, important and common phenomena related to presence in this context.

And these phenomena are worthy of study. As this review has shown, although the people who create sexual media content and technologies to deliver it do not use the term presence, that is exactly what they are pursuing. Perhaps more consistently than in any other context, presence is the most important goal for sexual products, from magazine images to realistic, interactive dolls. And this pursuit has contributed to a fascinating and ongoing evolution of technologies. Moreover, unlike presence in many contexts, these products encompass every type of presence, from realism to medium as social actor (Lombard & Ditton, 1997).

Although current products may be lacking, the technologies will likely evolve quickly: Today's cyberdildonics "products are merely version 1.0" (Baldwin, 2000, "Cybersex Isn't Very Sexy," para. 3), and "given the pace of technological innovation, sexual experiences straight out of science-fiction novels may not be very far away" (Hundley, 2000, p. 60). The technologies and their successes and failures will provide a diverse array of scholars with valuable opportunities to expand their understanding of presence phenomena and the implications.

Based on this review, we suggest several avenues for research and scholarship:

1. Identify key variables. We recommend careful exploration of which variables have the greatest impact on different types of presence; that is, which characteristics of media content, form, user, and environmental setting are most important in evoking presence in the context of sexual arousal (the degree and type of interactivity and the number of senses that are providing input are likely to be among them). Closely related to this, following Short et al. (1976), Rice (1992), and others, we need to better understand which variables most strongly affect how users choose specific media in this context, that is, how people match medium and task to optimize their experience (bandwidth and synchronicity are likely to be key).

2. Investigate theoretical propositions. Although they represent only a starting point, we hope that scholars will investigate the theoretical propositions presented in the Theory and Research Implications section above regarding the role of presence in LDRs, the formation of intimate human relationships, the effects of pornography and other sexual media, parasocial interactions and relationships, the uncanny valley, the book problem, and sex differences. No doubt those and other explorations will lead to additional propositions.

3. Consider issues from diverse perspectives. Scholarship on presence and sexuality will benefit from multiple interdisciplinary perspectives. For example, the embodied or grounded cognition perspective in philosophy (supported by evidence from neuroscience; see Barsalou, 2008) holds that "the environment, situations, the body, and simulations in the brain's modal systems ground the central representations in cognition" (Barsalou, 2010, p. 717), suggesting a rich context for examining mediated sexuality. French sociologist Maffesoli (1993) described ancient erotic instruments (with modern echoes) that created imagery and simulacra and, with their use, provided "symbolic correspondence with other members of the collective" (pp. 102–103), serving as a powerful socializing agent. This suggests intriguing questions about the broader functions of mediated sexuality. Drawing on the work of sociologist Bourdieu (1990), Czaja (2011, p. 4) described a habitus of presence that "involves the habitual and culturally ritualized embodying of technology [and] implies a naturalization of the disembodiment of self implicit within mediated interactions and occurrences of presence"; these notions and the larger cultural perspective on presence (including the posthuman, transhuman, and cyborg, which Czaja discussed) have clear relevance to sexuality. And Harper (2010) examined how, while he and his colleagues invented communication technologies, they focused on replicating the bodily mechanics of human communication (roughly, physical presence) but avoided concern with human intention and expression. This work suggests the need for scholars, as well as designers, to look beyond the physical elements of mediated sex to emotions and identity, and to the complexity of interpersonal relationships. These and other perspectives would enrich scholarship on this topic.

4. Use a wide variety of methods. In addition to diverse perspectives, we encourage scholars in this area to use a wide range of methods in their work. This would include lab and field experiments utilizing self-report questionnaires and psychophysiological measures (see Janssen, Prause, & Geer, 2007; Koukounas & McCabe, 2001), surveys, content analyses, textual analyses, discourse analyses, standardized and qualitative interviews (including Delphi interviewing of experts), case studies, focus groups, ethnography, historical, and any other formal or informal scholarly method or combination of methods.

5. Focus on ethical issues. Finally, among the most important and compelling issues raised by the technologies and phenomena discussed here are the ethical questions they raise. Among these are the (im)morality of having sex with androids and of replacing nonmediated sex and relationships with idealized virtual versions, and the implications of these for our psychological health (e.g., the ability to distinguish acceptable virtual and unacceptable "real" behavior), the social cohesiveness of society, and eventually even changes in the nature of being human (Adams, 2010; Gutiu, 2012; Hayles, 1999; D. Levy, 2007; Rheingold, 1991).

We believe these and related issues should be considered central in the scholarship on presence and sexuality. Despite the cultural and other sensitivities, it is clear that scholars have much to gain by studying and theorizing about presence and sexuality.

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ENDNOTES

1. For information on Realdoll, see http://realdoll.com

2. Information about Leap Motion is available at https://www.leapmotion.com/

3. See http://www.oculusvr.com/ for information on Oculus Rift.

4. Information on Google Glass is available at http://www.google.com/glass/

5. The Vintage Erotica Web site is at http://www.vintageerotica.com/

6. Red Light Utherverse and the Red Light Center are accessible at http://www.redlightutherverse.com/

7. Information on PRO Invention's KissPhone can be found at http://www.gizmag.com/the-kissphone-for-remote-kissing/11532/

8. Encounters Erotica. (1998). *Encounters Erotica* [CD]. [Producer unknown].

9. Private Pleasure Traxxx. (2005). *Premium XXX Pleasures, Volume 1.* [CD]. Boise, ID, USA: LLC Ultimate Innovations

10. Information about *Shot at Home Alone: Selena Silver Volume 1* is available at http://shop.shotathome.com/Merchant2/merchant.mvc?Screen=PROD&Store_Code=SAH&Product_Code=SAHDVD0158

11. Snatch'd: Stolen Home Videos is a series of videos; information is available at http://www.cduniverse.com/sresult.asp?HT_Search=TITLE&HT_Search_Info=snatchd%3A+stolen&style=ice

12. Quote comes from the first paragraph of promotional text for the video. North, P. (Director). (2006). *P.O.V.#5* [DVD]. Retrieved on August 26, 2011, from http://www.cduniverse.com/productinfo.asp?pid=6836598&style=ice

13. In order to protect *Human Technology* from association with sexually explicit keywords in search engines, asterisks are inserted in certain words. In direct quotes, such as this, the edited word(s) are placed within square brackets.

14. POV (point of view) videos include a wide variety of titles. Examples can be found at http://www.simplyporndvd.com/genres-pov_point-of-view/

15. Information on *Playboy: The Mansion* is available at http://www.mobygames.com/game/ps2/playboy-the-mansion/adblurbs

16. The quote appears in the advertising description of the Kobe Tai UR3 Ultra Realistic P**** & Ass, with information at http://www.xmeg.com/store/detail/Kobe-Tai-Ultra-Realistic-Ass-Pussy-2514.html

17. The quote comes from the first paragraph of the promotional material for the Blake Riley Vibrating Ass product, available at http://www.tlavideo.com/gay-blake-riley-vibrating-ass/p-270264-3

18. The quote can be found in the advertising blurb for the David Anthony Realistic C***; information is available at http://www.docjohnson.com/index.php/dj-superstars/collections/titanmen/titanmen-signature-cocks-david-anthony-realistic-cock.html

19. The quote appears in the advertising blurb for the Penthouse Pet Collection Kimberly Williams PleasureSkin 36DD Breasts product; information at http://www.topco-sales.com/products/penthouse-pet-collection-kimberly-williams-pleasureskin-36dd-breasts

20. The quote can be found in the third paragraph of the Clone-A-Willy product description at http://www.extremerestraints.com/realistic-dildos_40/clone-a-willy-kit_757.html; more information on that product, and the Clone-A-P**** product, can be found at http://www.empirelabs.com/

21. The quote comes from the promotional text for the Jill Kelly sex doll, with information at http://www.xtoyszone.com/322-sex-doll.htm

22. Information on the Remote Control Butterfly can be found at http://www.xandria.com/index.php?getpage=store&getsec=catalog&page=item&xpage=category&itemid=92&theme=7

23. Additional information on The Vibrating Wireless Thong for Him can be found at the Adam & Eve site, at http://www.adameve.com/lingerie/mens-wear/sp-vibrating-wireless-thong-for-him-5559.aspx

24. The Shots Remote Vibrating Egg is available at http://www.amazon.com/Shots-Remote-Vibrating-Egg-Green/dp/B0039TAPEK/

25. Information about the VSEX service is available at http://vsex.com/

26. For information regarding F*** You, F*** Me, see http://web.archive.org/web/20070321013931/http://www.fu-fme.com/

27. Information on Mojowijo is available at http://www.mojowijo.com/

28. Haptic interaction tools for Second Life can be viewed at the Xcite!Touch Web site at http://www.getxcite.com/index_v2.php

29. The current Web site of Digital Playground can be found at www.digitalplayground.com

30. The quote, and more information, can be found on the Virtual Sex Machine Web site: http://vrinnovations.com/index2.htm

31. The Real Touch Web site is at http://www.realtouch.com/

32. Virtual Sex Sets were widely available from adult product catalogs (e.g., Spice TV's) in the mid-2000s.

33. Information about the Wicked Lover Jessica Drake Talking Love Doll is available at http://www.69pleasuretoys.com/wicked-lover-jessica-drake-talking-love-doll-p-3808.html

34. Audible Arousals are described at http://earerotica.com/audible-arousals/ (see especially "Audible Arousals vs. Erotica").

35. See descriptions of interactive adult DVDs at Adult DVD Marketplace, at http://www.adultdvdmarketplace.com/search_cat_0_5_1_popular.html

36. The official Web sites for VirtuaGuy and VirtualGirl are http://www.virtuaguy.com and http://www.virtuagirl.com, respectively.

37. The advertisement appeared in the online version of Sexxy Software's adult product catalog, which is available from http://secure.netreach.net/starbyte/sexxy/Sent%20to%20Dennis/page12.html

38. For more information about Sergio Virtual Boyfriend/Kari Virtual Girlfriend see the Web site of Lhandslide Studios: http://lhandslide.com/

39. For information about Virtual Woman, see http://virtualwoman.net/index.htm

40. For information about VirtualFem, see http://www.virtualfem.com/

41. The Hizamakura Lap Pillow is described at http://www.japantrendshop.com/hizamakura-lap-pillow-p-64.html; a short video is available from CBS News at http://www.cbsnews.com/video/watch/?id=660986n

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EVIDENCE AGAINST A CORRELATION BETWEEN EASE OF USE AND ACTUAL USE OF A DEVICE IN A WALK-IN VIRTUAL ENVIRONMENT

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Abstract: *Technology acceptance and its use are assumed to be based on the perceived usefulness and ease of use of the technology. We studied one aspect of that by focusing on a possible correlation between the actual use of a device and its perceived ease of use. For studying technology that is new to users, we investigated the use of a locomotion control device in a walk-in virtual environment. We organized a user test in which participants browsed virtual shopping items by walking or by controlling locomotion with a device. Data were gathered in two ways: First, we observed their actual device use, and second, we asked users to evaluate the ease of use of the device. The analysis illustrates that there is no correlation between the actual use and ease of use of the device.*

Keywords: *virtual environment, virtual reality, technology acceptance, ease of use, empirical study.*

INTRODUCTION

Nowadays, people anticipate that technology will be user friendly and employable with little or no special training. In addition, users often are expected to adopt new technological devices immediately. This also applies to visits to a cave-like, walk-in virtual environment (VE), where users are expected to be active. Activeness in this context refers to active manipulation of technical devices by the user, as is assumed in many VE studies (e.g., Plancher, Nicolas, & Piolino, 2008; Pugnetti et al., 1998; Särkelä, Takatalo, May, Laakso, & Nyman, 2009). However, we contend that rapid adoption of new technical devices by the users happens only if they accept the device.

Technology acceptance in information system (IS) research also underscores ease of use as a significant factor. When inexperienced users are taken to a VE and given unfamiliar tools, the most important feature of the ease of use in this situation is learnability; in other words, the ease in which users are able to accomplish basic tasks the first time they encounter the device (Nielsen, 1993). Learnability can be supported by making things (i.e., objects, actions, and options) visible; exploiting the powers of constraint; and designing for error (Norman, 1988). In the case of VEs, this means making it easy to perceive how to operate the device and what can be done with it, as well as supporting intuitive application in circumstances where the operation will be successful, since some tasks can be carried out only in certain situations. Furthermore, when a user learns by trial and error, they make many errors from which recovery must be simple.

IS researchers commonly study the adoption of a novel technological artifact using the technology acceptance model (TAM; Benbasat & Barki, 2007; Lee, Kozar, & Larsen, 2003). TAM states that IS and/or information technology adoption depends on users' attitudes towards these technologies and on the perceived usefulness and ease of use (F. D. Davis, 1989). More recently, the unified theory of acceptance and use of technology (UTAUT; Venkatesh, Morris, G. B. Davis, & Davis, 2003) was developed based on several existing models. Both TAM and UTAUT include an abundance of elements because many variables affect technology acceptance. These kinds of details make the theories credible, but they also cause complications in seeing the whole entity, as well as in applying the theories to practical design cases.

The TAM model was developed in the 1990s (see F. D. Davis, 1989, for the first related publication), when computers were mostly in organizational use. At the time when IS user acceptance was in the early stages of study, the subject of investigation included also a new technological device: the home computer. In later studies, once users had domesticated the computer, the objective was to find out whether they accept new applications. In our study, we return to the original quest by studying a case in which the technological environment is somehow new for its users. We chose to study users in a walk-in VE, a technological environment of which most people know something, but very few have actually experienced. In this VE, we study whether there is a correlation between users' evaluation of the ease of use of technology and their actual use of the device.

We begin this paper by outlining the ideas of TAM and UTAUT and connect both to our study. Then we describe how we conducted our empirical study involving a small walk-in virtual shopping center, with data gathered by way of observation of participants' use of both their body and a device to manage locomotion within the virtual space and a completed questionnaire on their perceptions of ease of use of the device. Finally, we discuss our contribution to TAM and UTAUT research and to technology acceptance theories in general.

TECHNOLOGY ACCEPTANCE IN INFORMATION SYSTEM STUDIES

Many IS studies employ two well-known theories about user acceptance of IT: TAM (F. D. Davis, 1989; F. D. Davis, Bagozzi, & Warshaw, 1989) and UTAUT (Venkatesh et al., 2003). One element these models share is ease of technology use. In this section, we outline briefly TAM and UTAUT and their approach to ease of use.

TAM (Figure 1) describes the properties that affect users' technology acceptance. According to TAM, individuals' IS acceptance, as well as their IS use, is determined by two major variables: perceived usefulness and perceived ease of use (Venkatesh & F. D. Davis, 1996). During the last two decades, TAM has been applied to various technologies (e.g., word processors, e-mail, and hospital information systems) in multiple contexts (e.g., in historical situations involving the novelty of IT and in organizational culture). Furthermore, according to Lee et al. (2003), studies have involved various types of participants (e.g., undergraduate students, business graduate students, and knowledge workers) with different control factors (e.g., gender, organizational type, and organizational size).

Several studies question the overall effects of perceived ease of use in TAM (Gefen & Straub, 2000; Keil, Beranek, & Konsynski, 1995; Lee et al., 2003). The contradictory findings have been explained by gender differences in user behavior. Men's technology use was strongly influenced by their perceptions of usefulness. Women were more strongly influenced by perceptions of ease of use and other subjective norms, although the effect of subjective norms has diminished over time (Gefen & Straub, 1997; Venkatesh & Morris, 2000).

The other acknowledged technology acceptance theory, UTAUT, aims to reach a unified understanding of user acceptance of technology by combining the results of other theories about technology acceptance. In addition to TAM, UTAUT encompasses the model of PC utilization (Thompson, Higgins, & Howell, 1991) and the innovation diffusion theory (Moore & Benbasat, 1991; Rogers, 1995). UTAUT (Figure 2) holds four key constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) that are direct determinants of usage intention and behavior. Gender, age, experience, and the voluntariness of use are indicated as mediating the impact of the four key constructs on usage intention and behavior (Venkatesh et al., 2003).

The elements connected to the ease of technology use represent part of the effort expectancy. This construct draws together ease of use from TAM (F. D. Davis, 1989; F. D. Davis et al., 1989), the innovation diffusion theory within the IS field (Moore & Benbasat, 1991), and complexity—as the opposite of ease of use—from the model of PC utilization (Thompson et al., 1991). UTAUT also includes gender differences, indicating that the effect of ease of use on technology adoption is stronger for women than for men. Even stronger than gender, however, are the differences associated with increased age and limited technical experience (Venkatesh et al., 2003).

A common view states that users easily accept user-friendly technology. Theories of user acceptance give some support to this view, at least when the users are female. We focus on this issue by investigating whether a relationship exists between perceived ease of use and the
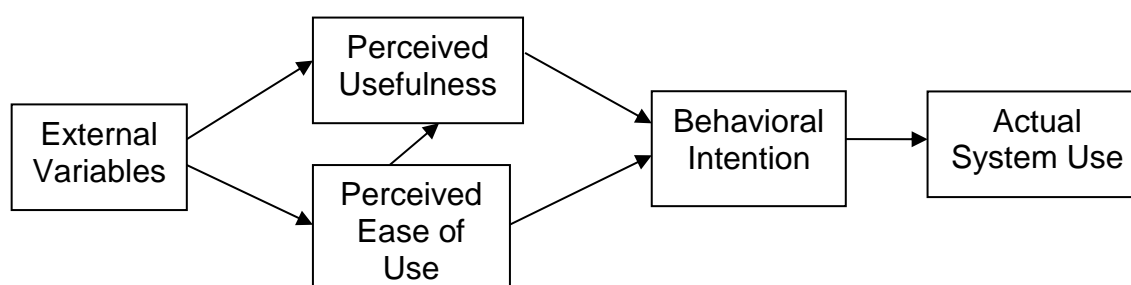

Figure 1. TAM (Venkatesh & F. D. Davis, 1996, p. 453).
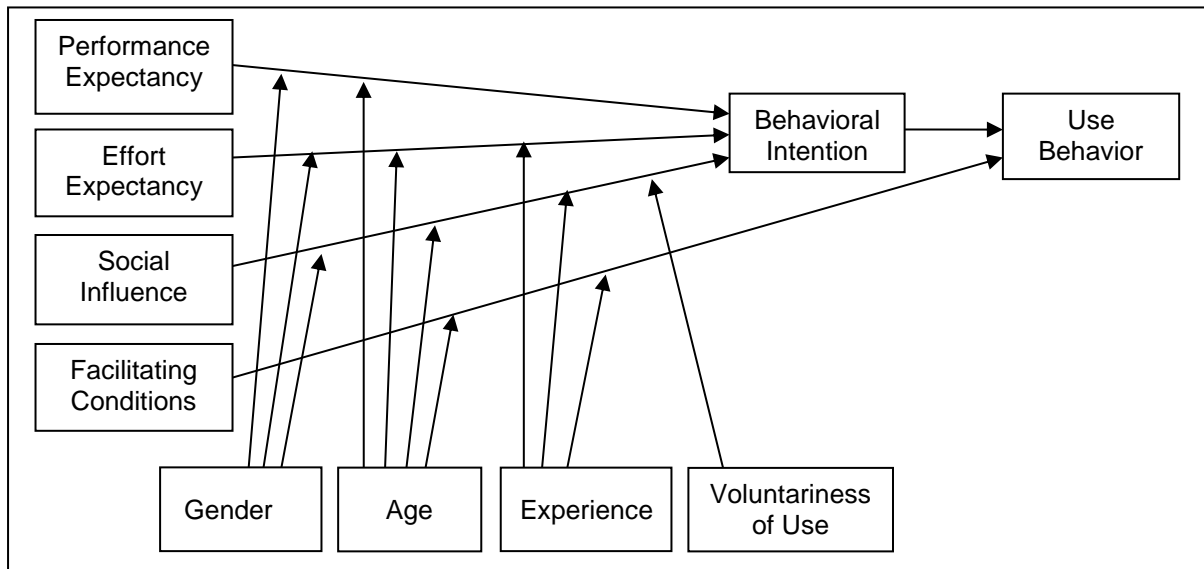Copyright © 2007, John Wiley and Sons; reprinted with permission.

Figure 2. UTAUT.
From V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly* (27:3), p. 447.
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actual use of a technical device. We concentrate on the first use of a new device. For that, we selected a locomotion control device in a walk-in VE, and, for participants, we selected persons who had never been in a VE. The only other technology that somewhat resembles VE is the 3D computer game. Nevertheless, previous studies prove that playing computer games does not affect the VE experience (Alsina-Jurnet & Gutiérrez-Maldonado, 2010; Kuusisto, Ellman, Kaapu, & Tiainen, 2011).

EXPERIMENTAL METHODOLOGY

Our aim was to discover whether individuals who find a technical device easy to use will use it more often than those who find it difficult. In other words, we analyzed whether a correlation exists between perceived ease of use and actual use. Our venue was a walk-in VE and our test involved user movements that could be accomplished either by use of Wanda, a technical device, or by the actual body movements of the participant.

We conducted a laboratory test in a VE with 40 participants from various backgrounds. The test included a guided tour of the VE, followed by the participants completing a navigational task within the environment. In this section, we describe the participants first, and then the test situation in more detail by focusing on the VE (its physical and technical elements, the application used, and the virtual shopping center), and continue with describing the testing process and data analysis.

Participants

The user test comprised 40 voluntary participants' visits to a virtual shopping center. Such a large number of subjects is rare in VE user studies because each VE test takes a long time. The participants need to be taken through the test individually, and a person new to VEs often needs some guidance and practice.

Volunteers were sought by sending an invitation to several e-mail distribution lists, such as a local academic information list that reaches individuals within a local university (students, faculty, and staff), businesses, and the community. One common attribute of all participants was that they were familiar enough with ICTs to read the e-mail invitation and fill in an Internet form to show their willingness to participate in the test. The other common attribute was that they had never before visited any VE.

The average age of the participants was 36, ranging from 18 to 72 years, and the group consisted of more males (26) than females (14). All were native speakers of Finnish, the language used in data gathering. Table 1 shows the detailed demographic information on the test subjects.

The participants were healthy adults who participated in the test voluntarily and were aware that they could, at any time, drop out of the experiment. Furthermore, the participants knew that data were gathered for research purposes. Therefore, for example, a written consent for videotaping during the experiment and interview was obtained. In the analysis and results presentation, the participants remained anonymous. Finally, the data used in the research process will not be available for use by other researchers.

Table 1. Demographic Information of Participants.

Participants' age	Males	Females	Total
Between 18 – 25	10	2	**12**
Between 26 – 39	9	6	**15**
40 and over	7	6	**13**
Total	**26**	**14**	**40**

Test Environment: Small Shopping Center in VE

The technical environment of our test was an immersive walk-in VE, in which an artificial, visual 3D world is generated by a computer through five rear-projection surfaces: three walls, a floor, and a ceiling (see Figure 3). The VE had a floor space of 3 x 3 m and was 2.4 m high. The user wore a pair of liquid crystal glasses that transformed the projected images into active stereo images. The user's view was rendered according to his/her position, with orientation determined by a magnetic tracking system via a wired sensor located within the user's glasses. For the virtual movements, we used an ordinary Wanda input device (Figure 4) that we programmed so that the on/off button toggled between simulating walking at a normal pace and standing still. The user controlled the direction of movement by pointing Wanda in the desired direction.

For this test, we created a model of a small shopping center (Figure 5) using 3D Studio Max software, and we brought it to life with the VR4Max application running on Windows XP. The model included a corridor and three rooms: (a) a product presentation room that provided a table
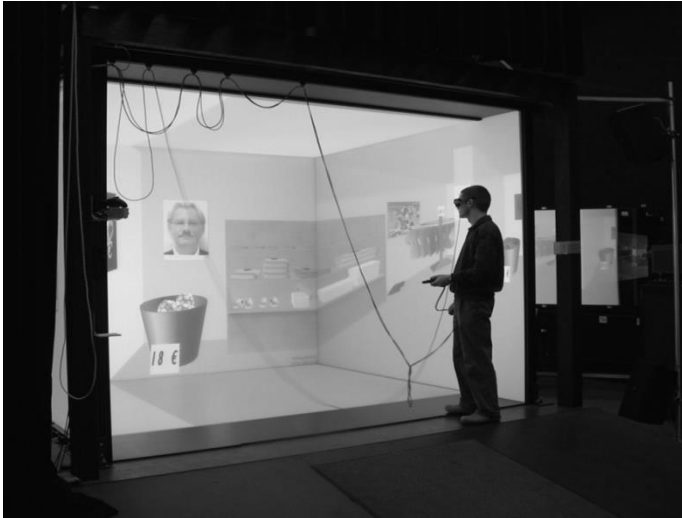
Figure 3. Virtual environment displaying a shop in the virtual shopping mall.

Figure 4. Wanda input device.

with products on it; (b) a sports shop with racks, shelves, and bins of sportswear and equipment; and (c) a clothing shop with wall posters, two mannequins, and racks and shelves of clothing.

The perceived spaces of the virtual shops were larger than the VE physical space (3 x 3 m): The dimensions of the sports shop were 4.3 x 4 m and those of the clothing shop were 4 x 3 m. Because our aim was to study the use of a locomotion control device, we ensured that the users needed to change their position during the testing in the VE. This was achieved by placing virtual walls in the shops to prevent the user from seeing everything from any one position, thereby making the user's movement essential. However, this solution made locomotion more cumbersome. Simple collision detection made it impossible to walk through the virtual walls, although it was possible to walk through other items within the shops (e.g., clothing racks).

Figures 3 and 5 illustrate the test situation. Figure 3 shows the physical test environment, set with the VE sports store, and the tools (i.e., Wanda, the glasses, and cables). Figure 5 provides an overhead view of the virtual shop premises: the corridor and the three rooms.

Test Process

Three members of the research group conducted the actual user tests: an operator responsible for the VE equipment, a research assistant to guide the participants, and a researcher who observed the participants' behaviors. Prior to initiating the user tests, in order to ensure a smooth and well-managed test environment, the three research group members practiced the test procedure by performing two pilot tests. Two doctoral students with no experience in a VE served as the pilot participants.

The participants were taken individually into the VE. At first, the assistant led each participant to the product presentation room, a small virtual room in which the participant could practice taking some steps to adjust their field of view. After some minutes of practice, the assistant supported the participant, as needed, in navigating to the first shop, which was randomly assigned to be either the clothing or sports shop. The assistant asked the participant to
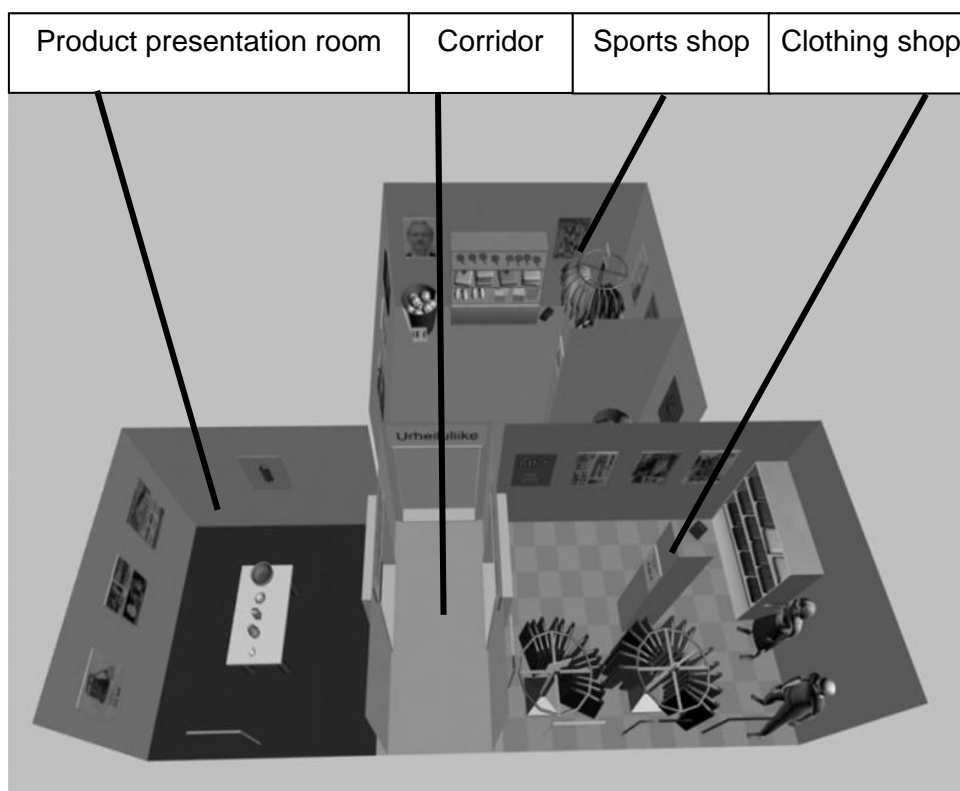
| Product presentation room | Corridor | Sports shop | Clothing shop |

Figure 5. The 3D floor plan of the small virtual shopping center used in the test.

think aloud about whether there would be something interesting available. The participant was asked to focus on the virtual products. Although we guided the participants' focus for their verbal commentary, some of them commented on the VE technology or their own feelings, as well as challenges and concerns.

Before proceeding to the second shop, the research assistant provided additional practical advice on how to use the Wanda device to navigate in the VE. The assistant then encouraged the participants to explore the entire shop. If the participants encountered thwarting problems (e.g., if the participant found themselves "inside" a virtual prop), the assistant aided in solving the challenge. However, the participant could choose how to move within the second shop—either by using Wanda for changing their position and field of view or by taking physical steps and/or using body movements. While in the second virtual shop, participants were again encouraged to think aloud.

In summary, visits to the presentation room and the first shop were for demonstrating to participants the possible ways of locomotion. Physical movements were used in the product presentation room. When the participants were taken to the first shop, the assistant presented how locomotion was controlled with the Wanda device, and the participant practiced. Finally, the second shop experience focused on the participants' own actions for controlling their locomotion.

The participants had 3 minutes to move around each shop unassisted. A short visit was deemed sufficient because the virtual shop resembled a traditional "bricks-and-mortar" shop.

Data Gathering

We gathered data in two ways. First, data related to actual use were captured on video during each test; as such, the data consisted of the actual locomotion by participants. However, only the video recordings of the second shop visits, when participants made their own decisions on how to navigate, were used in the analysis.

Second, because determining the VE users' perceived ease of use requires asking the participants, we used a written questionnaire following the VE visit. The questionnaire focused on the participants' own evaluation of the locomotion control (see the Appendix), which corresponds to perceived ease of use in the terminology of TAM. Based on VE literature and our prior VE research projects, we formulated eight statements. They dealt with the participants' experience of using Wanda and of the virtual space and products. Because prior VE studies have focused on VE technology use, we followed that technology centricity in formulating the statements.

We observed that many participants moved their own body actively for controlling locomotion (i.e., moving forward and/or turning). Therefore, for this study, we selected only the three statements connected to the ease of use of the locomotion control device for analysis. The selected statements, translated to English by the research team, were

> S1: It was easy to learn how to use Wanda for locomotion.
>
> S2: I found the locomotion control unit easy [to use].
>
> S3: When I was controlling locomotion [via Wanda], it was sometimes hard to achieve the direction I wanted.

The participants were asked whether they agreed or disagreed with the statements. We employed an evaluation scale of five units (totally agree, partly agree, cannot say, partly disagree, and totally disagree). The researchers coded the answers to numeric values ranging from 0 to 4. The positive statements, S1 and S2, were coded so that the answer totally agree was given a 4, partly agree a 3, and so forth. For the negative statement, S3, the coding was reversed, with a 4 for totally disagree and a 0 for totally agree.

Analysis of the Data

Of the 40 participants, four males, 22, 23, 43, and 47 years of age, were eliminated from the analysis due to technical problems during in the VE testing or videotaping. Two of these males belonged to the youngest group and two to the oldest (see Table 1).

For the analysis, the data sets (actual Wanda use via video and perceived ease of use via the questionnaire) were first analyzed separately. The combined sets then underwent an additional analysis.

The actual Wanda use data (hereafter *Wanda use*) were extracted by viewing the VE sessions videotapes. We counted how often each participant moved by use of Wanda, the locomotion control device. The participants used Wanda to turn on a few occasions, but, by far, Wanda was used for zooming in and out (i.e., moving the virtual products closer or further away). In addition, the participants used Wanda in very distinct ways. For example, to arrive at the desired location, some participants moved in one continuous motion, while others did so in small increments until

reaching their destination. The latter method resulted in a much higher Wanda-use count for those participants. Nevertheless, all those assessed as actively using Wanda for locomotion exhibited a greater amount of Wanda use than those who were assessed not active.

Perceived-ease-of-use data were calculated from the participants' own evaluation of the three selected statements from the questionnaire. The expression used for the calculation was

Ease of use = Answer to S1 + answer to S2 + answer to S3.

As described in the previous section, statements S1 (i.e., easy to learn) and S2 (i.e., easy to use) depict participants' positive experiences, while statement S3 outlines the opposite feeling (i.e., hard to control). Statement S3 was reverse coded, thus all 3 statements yield a high result for a favorable experience.

RESULTS OF WANDA USE AND EASE OF USE

The participants' Wanda use varied from 1 to 93 times, with a median of 25. Also dramatic was their opinions of Wanda's ease of use, which varied from 0 to 12 with a median of 6. We analyzed the relationship between the actual use of Wanda and its perceived ease of use in three ways. First, we calculated the correlation between them to be 0.22, which is rather low to be significant. By removing the outlier values of 93 (24 higher than the second highest of 69), and 1 (the second lowest was 5), the adjusted correlation was only 0.17, which expresses no significant correlation. Therefore, our first analysis of the data does not support a relationship between the actual use of Wanda and its perceived ease of use.

In a second attempt to expose a possible relationship between Wanda use and perceived ease of use, we drew a two-dimensional figure with these two data sets. Figure 6 presents all users plotted against these two dimensions. The figure reveals that most of those who found it hard to use Wanda (ease of use value from 0 to 2) used Wanda the average number of times or fewer. Those who found the use of Wanda easy (value 10 or more) were evenly split above and below the median in regard to frequency of use. Among those users whose Wanda use exceeded the median value (i.e., 25 times), slightly more found the use of Wanda easy. Moreover, considerable variation existed within the perceived ease of use, ranging across the entire scale from 0 to 11.

Our third analysis of a potential relationship was by comparing opposite groups. For this, we created two separate categorizations. The first was based on the frequency of Wanda use.

Group A contained those users whose Wanda usage exceeded the median and Group B those with usage below the median (Table 2). The separation of the two groups was verified with two-tailed t-tests. The two groups did not differ significantly on their evaluation of the ease of use, $t(10) = 0.87$, $p = 0.2$. The result was the same from the opposite perspective, in which the categorization was based on the perceived ease of use of Wanda. Group C comprised users who found Wanda easy to use and Group D those who did not (Table 2). These groups did not differ significantly in respect to the frequency of Wanda use, $t(91) = 1.2$, $p = 0.1$.

Because both TAM and UTAUT point to gender differences, we analyzed and found in both of our categories a gender bias. Of the 14 women in the study, only four were in the High Use group, as compared to 10 in the Low Use group, while five were in the Easy to Use group as compared to nine in the Not Easy to Use group (Table 2). However, statistical analysis gives
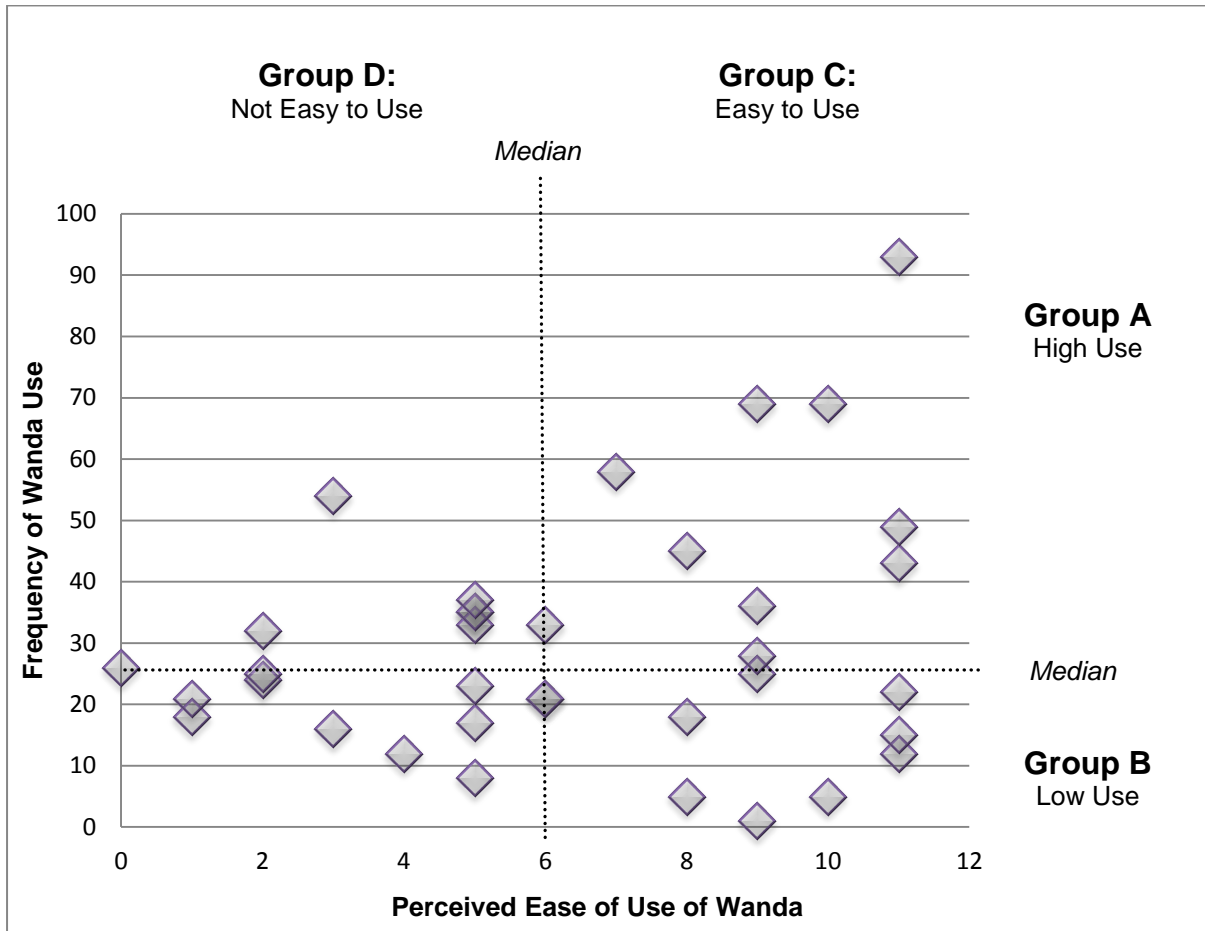
Figure 6. A graph of the perceived ease of use plotted against actual use of Wanda.

Table 2. User Characteristics within Categorizations of Wanda Frequency of Use and Ease of Use.

	Categorization based on frequency of Wanda use		Categorization based on perceived ease of use	
	Group A High Use	Group B Low Use	Group C Easy to Use	Group D Not Easy to Use
Ease of use				
Average	6.9	6.0	9.3	3.6
Range	0 – 11	1 – 11	7 – 11	0 – 6
Frequency of use				
Average	45	16	34	26
Range	26 – 93	1 – 25	1 – 93	8 – 37
Users' age				
Average	34	39	30	42
Range	22 – 72	21 – 63	21 – 51	23 – 72
Gender				
Male	15	7	12	10
Female	4	10	5	9

some support to gender difference within the ease-of-use categories, $t(1) = 3.8$, $p = 0.1$, but no support within the Wanda use categories, $t(1) = 11.6$, $p = 0.4$ (see Table 3). The female participants used Wanda fewer times than the males and found it a bit more difficult. Although both Wanda use groups and both perceived ease of use groups exhibit gender separation, there is negligible connection between Wanda use and perceived ease of use. Among the male participants, the correlation was low ($r = 0.23$; moderate correlation limit is 0.2 and strong correlation 0.6), and was even lower among the females ($r = 0.10$).

Additionally, UTAUT indicates that age is a factor, in that the ease of use of technology is more important for older users. In our study, the older participants found Wanda more difficult to use than did the younger ones, but they used Wanda as frequently as their younger counterparts. This finding is shown by the users' average ages in Table 2. Similar findings are reached with the t-test. The values indicate that the two groups of Wanda use are not separated by users' age, $t(50) = 0.98$, $p = 0.2$. However, a statistically significant difference, $t(50) = 2.7$, $p < 0.005$, is found in users' age between the two perceived ease of use groups (Table 3). Although our test confirms that older participants found the use of Wanda more difficult than did younger participants, the age-related statement of UTAUT (i.e., ease of use has a greater effect on technology adoption by older users; Venkastesh et al., 2003), does not receive support from our data. In other words, if participants found the device easy to use, they were almost equally likely to use it regardless of their age.

Table 3. T-test Values for the Categorizations.

Groups' separation in	Groups A & B Categorization based on frequency of Wanda use:	Groups C & D Categorization based on Wanda's ease of use:
Wanda's ease of use	$t(10) = 0.87$, $p = 0.2$	-
Frequency of Wanda use	-	$t(91) = 1.2$, $p = 0.1$
User Age	$t(50) = 0.98$, $p = 0.2$	$t(50) = 2.7$, $p < 0.005$
User Gender	$t(1) = 11.6$, $p = 0.4$	$t(1) = 3.8$, $p = 0.1$

DISCUSSION

We studied whether a relationship exists between users' perceived ease of use and actual use in the case of controlling users' locomotion in a VE with the device called Wanda. To determine their actual device use, we observed how the participants navigated through the VE test situation and then surveyed them regarding their perceived ease of use of the device. Our study indicates a low correlation between users' evaluation of the ease of use and their frequency of use of the device. TAM and UTAUT state that gender and age are variables that explain the correlation; our study does not give support for that.

In our VE case, the participants' task was to move around a virtual shop. To determine whether the participants wanted to use the technical device, the test situation was set up so that Wanda's use was not compulsory in the final shop. The participants had two alternative ways of carrying out that task: They could either control locomotion with Wanda or move physically by taking steps. Before the participants became engaged in their task, both of the alternatives were presented to them. That optional use of the technology increases the

contribution of our findings. However, this line of research needs to be extended to discover how voluntarily use in technology is shaped. For example, we assumed that participants understood that they had alternatives for locomotion controlling in the final virtual shop because two ways were introduced to them. But it is not known how fully the participants understood the test use situation.

One possible explanation for our results is a phenomenon known as the negative cycle of technology adoption, in which similar prior technology use experiences negatively affect the use of a new technology (Lippert & Forman, 2005; Straub, 2009). In other words, more knowledge about technology is actually a detriment to learning a new technology. In our VE case, the individuals we selected as participants had used IT but had no prior experience in a VE. Nevertheless, it is conceivable that some might connect their earlier experiences of some other technology to the test use situation. A walk-in VE is a technology-oriented environment: In addition to the locomotion control device, the testing environment contained wall-size screens, crystal glasses, and a magnetic tracking system. Those technical elements also might have had some negative effect on the VE test use. The minimal age differences in our results indicate that although the younger participants evaluated Wanda easier to use, they did not use it more frequently than the older ones. This result can be explained with the negative cycle: The younger participants who likely had more IT experience were also more likely to have prior experience that complicated their learning a new technology.

Another possible explanation for the difference in testing behavior could be social influence, which is used in UTAUT. It is defined as the degree to which an individual perceives that others assume he or she should use the new system (Venkatesh et al., 2003). In an empirical study of UTAUT, the participants were asked to evaluate several explicit statements such as "people who are important to me think that I should use the system" (Venkatesh et al., 2003).

In some cases, other people's expectations are known. For example, work situations typically explicitly state what IS and technical tools the staff members will use. In other situations, the expectations are not explicitly stated but exist as norms that are assumed to be known and followed by all community members. One such example provided by Rogers (1995) as a failure of technology diffusion was a campaign in Los Molinas, Peru, encouraging water boiling as a means toward improved health and overall wellness. The campaign did not succeed because the local population linked boiled water to something that only the "sick" or "unwell" consume, and thus the idea of healthy residents boiling their water prior to consumption was frowned upon (Rogers, 1995). So the norms or predispositions of the community can prevent the acceptance of even low-tech innovations.

Sometimes, identification as a community member is seen in a negative light and, as a consequence, technology and other artifacts linked to that community are avoided. For example, Hartmann & Klimmt (2006) found that many girls regarded playing video games unfeminine behavior. However, sometimes norms work in the opposite way, that is, promoting innovation diffusion. One extreme example is that of seeing hackers as heroes who pioneer the use and learning of computer technology (Levy, 1984). However, that works only for those who value hackers highly, so much so that they may join that technology-oriented, innovative community, although some parts of it focus on criminal actions.

When innovations and technology use are linked to a particular community, a person's decisions concerning the use of the product or technology are not just based on usefulness and ease of use but on social issues as well. The effect can be positive or negative. In addition to the

social issues described above, users' personal characteristics also have been found to influence their acceptance of innovations and technical artifacts. One such characteristic, attitude, is defined as a person's predisposition to think, feel, or behave in certain ways towards certain defined targets (Arnold, Cooper, & Robertson, 1998). The defined targets of attitudes may be anything that exists for the individual: tangible objects (e.g., a Wanda device), virtual objects (e.g., a virtual football), people (e.g., an operator), and/or the environment (e.g., a dark room and a virtual shop). In regard to our study, we could surmise that it was not just a question about how participants accept a technical device, but also a larger question regarding the test situation and the participants' attitude toward any or all of its elements.

Predispositions are like a window that allows us to see alternatives but that, at the same time, restricts our view (Kuosa & Basden, 2000). When pondering the reasons for differences among people in accepting or starting to use new technical devices, both social features and personal characteristics need to be analyzed. UTAUT includes both elements, but within a narrow perspective: Social influence involves only other people's expectations on user behavior, and personal characteristics encompass only gender, age, experience, and voluntariness of use (Venkatesh et al., 2003). However, those features do not explain the differences in our case. Instead, we propose that to identify reasons for the differences, participants' predispositions need to be analyzed. That can be done by focusing on the social norms of the participants' communities and the participants' attitudes towards all the elements of the use situation.

CONCLUSION

We studied correlation between the ease of use and the actual use of a device. The idea for studying this correlation is based on TAM, which states that individuals' IS acceptance is determined by perceived usefulness and perceived ease of use (F. D. Davis, 1989). We studied the use of a locomotion control device in a VE. This context was chosen because the technology involved in a VE is as unfamiliar for non-ICT-professional users today as computer technology was at the time of TAM creation. We gathered the data in two ways: participants' were asked via a questionnaire for their evaluation of the ease of use, and the actual use of the device was determined through viewing video recordings of the participants' test use. The analysis indicates no correlation between perceived ease of use and the actual use of the device by the users.

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Appendix

This survey was provided to participants following their experiment within the virtual environment. The instrument was conducted in Finnish for native Finnish-speaking participants and has been translated into English here by the researchers.

Please, evaluate the following statements
(totally agree, partly agree, cannot say, partly disagree, totally disagree)

S1: It was easy to learn how to use Wanda for locomotion.

S2: I found the locomotion control unit easy [to use].

S3: When I was controlling locomotion [via Wanda], it was sometimes hard to achieve the direction I wanted.

S4: In the first shop, when the assistant used Wanda, I was able to get a good look at the products.

S5: When I used Wanda, I could concentrate on the products that I found most interesting.

S6: I found the virtual space felt more like a real shop when I controlled the locomotion using Wanda.

S7: With the help of the assistant I could focus just on those products that I wanted to look at.

S8: I was not taught well enough how to use Wanda.

DESIGNING A MULTICHANNEL MAP SERVICE CONCEPT

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Abstract: *This paper introduces a user-centered design process for developing a multichannel map service. The aim of the service is to provide hikers with interactive maps through several channels. In a multichannel map service, the same spatial information is available through various channels, such as printed maps, Web maps, mobile maps, and other interactive media. When properly networked, the channels share a uniform identity so that the user experiences the different channels as a part of a single map service. The traditional methods of user-centered design, such as design probes, personas, and scenarios, proved useful even in the emerging field of developing multichannel map services. The findings emphasize the need to involve users and multidisciplinary teams in the conceptual phases of designing complex services aimed at serving various kinds of users.*

Keywords: *map services, multichannel services, user-centered design, multidisciplinary.*

INTRODUCTION

Interactive map services have been a topic of growing interest for more than a decade (Lehto & T. Sarjakoski, 2005), and new opportunities for such services in different use contexts are at hand. A map service may be used for finding information about interesting places or for planning routes to unfamiliar locations. Along with the development of wireless and mobile technologies, the number of people who use interactive maps in everyday life has grown rapidly worldwide (L.T. Sarjakoski, Sarjakoski, Koskinen, & Ylirisku, 2009). According to Cartwright and Hunter (2001), users are increasingly demanding more from map services. As a

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result, the usefulness of a map service can no longer be viewed in a traditional manner only, that is, as a guide in an unfamiliar environment. Instead, the service also must be enjoyable, entertaining, and aesthetically pleasing (L.T. Sarjakoski, Sarjakoski et al., 2009).

A multichannel map service allows the user to access the same spatial information contents through various channels (T. Sarjakoski, Kovanen, Rönneberg, Kähkönen, & Sarjakoski, 2010), and such a service allows the user to acquire information through the most suitable channel for each situation. Recently, there has been a strong growth of services provided through multiple channels (Sousa & Voss, 2006). The multichannel map service in our case study features the following channels: a Web map (see Kettunen, L. T. Sarjakoski, Ylirisku, & Sarjakoski, 2012), a mobile map through iPhone (see Kovanen, L. T. Sarjakoski, & Sarjakoski, 2009), a large multitouch map (see Rönneberg, Halkosaari, T. Sarjakoski, & Sarjakoski, in press), and printed maps (see Oksanen, Schwarzbach, L. T. Sarjakoski, & Sarjakoski, 2011). The digitally interactive channels are shown in Figure 1.

The present study explores opportunities to utilize a multichannel map service within a hiking context. Hiking and spending time in nature is becoming a popular trend (Antikainen et al., 2006; Johansson, 2009; Puhakka, 2007). Hiking involves more than simply navigating through nature: Activities such as planning and reflecting are essential parts of the hiking experience (Nivala, L. T. Sarjakoski, Laakso, Itäranta, & Kettunen, 2009). Existing services to support hikers are mainly printed items or on the Web (Nivala et al., 2009). When planning an excursion, hikers may seek information from several media sources. They may, for example, find details about hiking trails from one Website, the experiences of other hikers from another Website, additional information about the general area from books, and a detailed description of

Figure 1. The three interactive channels (a mobile map, a Web map, and a map on a large multitouch screen) of a multichannel map service.

the terrain from a traditional printed map. In addition to excursion-specific details, hikers may seek a variety of information, such as local weather forecasts, public transportation routes, or locations of parking lots, as well as diverse thematic information for related outdoor activities, such as backpacking, cycling, or skiing.

As a key contribution, we present a design framework (as defined by Cooper, Reimann, & Cronin, 2007) of a multichannel map service, which was created through a user-centered design (UCD) process. We present the design opportunities and design drivers that guided the subsequent process of designing a functional multichannel service for hikers. The presented design opportunities are intended to be useful beyond the immediate case presented here. A functioning prototype of a multichannel map service for hikers is currently being finalized according to the principles, or design drivers, expressed in the design framework. This paper describes the early phases of the development of the multichannel map service concept.

Designing a multichannel map service is a complex task because each channel contributes to the overall experience of the service. One key challenge is the design of a unified identity for the service, so that a user may understand using a single service, rather than multiple services on different channels. Defining potential users and understanding their needs by utilizing qualitative research techniques is essential for a successful design, as stated by Cooper et al. (2007). The UCD methods are useful for studying various potential user groups. The UCD approach promotes a constant focus on users' needs and limitations throughout the process.

We explored opportunities to address hikers' needs facilitated by new technologies and concretized these through UCD methods, such as design probes, personas, and scenarios. In the design process of our multichannel map service, we relied upon fields of expertise such as usability, user research, concept and interaction design, cartography, geographic information science, and computer science.

In this paper, we begin with a review of both map and multichannel services, and continue by presenting our case study. We then conclude by discussing the value of the conducted work with regards to the design of multichannel map services more generally.

BACKGROUND

A multichannel map service consists of different channels that, in their entirety, form an interface for the user to acquire spatial information. The increasing spread of multichannel map services, such as Google Maps including channels such as a Web map and a mobile map, is setting urgent pressure for the study of the design of multichannel map services. However, only a few studies on the process of designing such services are presented in the existing literature.

Interactive Maps and Location-Based Services

Traditionally, maps were static representations and abstractions of the surrounding world. Today, maps increasingly provide interactive interfaces to our environment. The interactive maps, referred to as multimedia cartography by Cartwright and Peterson (2007) or cybercartography in Taylor's formulation (2005), evolved from the need to present geographical information in an intuitive manner. While the visual design of maps still remains a fundamental

issue, the focus in cartography now also extends to usability issues regarding interaction, enabling dynamic maps and map object functionality (MacEachren & Kraak, 2001). Utilizing UCD methods in designing map services is still a new approach (Nivala et al., 2009), although employing UCD methods in the field of geoinformatics is becoming more common, as can be noticed, for instance, in the studies of Flink, Oksanen, Pyysalo, Rönneberg, and L. T. Sarjakoski (2011), L. T. Sarjakoski, Ylirisku, Flink, and Weckman (2009), Schobesberger (2012), and Magnusson, Tollmar, Rassmuss-Gröhn et al. (2009).

Interactive maps in a location-based service (LBS) include an important parameter: the location of the user. An LBS answers such questions as, "Where am I?", "What is nearby?", and "How do I get there from here?" (Steiniger, Neun, & Edwardes, 2006). When an LBS also delivers maps to the users' devices, it can be called a map service (T. Sarjakoski & Sarjakoski, 2007). Several research projects have studied LBSs from the user's point of view. For example, Van Elzakker and Wealands (2007) presented a case study of a UCD approach for mobile tourism applications; Zipf (2002) studied LBS maps for tourism that were adapted according to a range of variables, such as users' preferences and interests and the given task or location; and Kramers (2007) presented an example of a UCD process by introducing the development of the online atlas of Canada.

Because of the nature of interactive maps, the map can function as an interface or index to additional information (Kraak, 2001). The user can alter the scale of interactive maps, and the locations and points of interest on the map may include links to text, photographs, videos, animations, and so forth. Existing commercial Web maps include, for instance, Google Maps[1] and Bing Maps,[2] which offer functionalities such as route planning and map sharing, and OpenStreetMap,[3] which offers free user-editable maps. In addition to maps, Via Michelin,[4] for example, provides additional information on traveling and tourism in its map service.

Existing map services that specialize in supporting hikers in their outdoor activities are mainly print- or Web-based services, although several research projects on mobile maps for hikers have been conducted. Studies on LBS for hikers include the GiMoDig -project (T. Sarjakoski & Sarjakoski, 2007), in which a prototype was developed for delivering real-time adaptive maps to mobile users in a national park context. Also in a national park context, the WebPark project (Krug, Mountain, & Phan, 2003) developed an LBS for recreational use in coastal, rural, and mountainous areas. This service offers adaptive information filtered by relevance to the user's location, temporal cycles (daily, annually, or other), and user profile settings. The information could be about weather, flora, fauna, routes, trails, restaurants, hotels, one's current location, unexpected dangers, and so forth. A prototype of mobile maps for hikers in mountainous areas (e.g., the Alps or the Pyrenees) was developed in the PARAMOUNT project (Sayda, Wittmann, Kandawasvika, & Wang, 2005), in which the objective was to provide hikers with navigation and guidance tools that include safety functions, such as sending an emergency call with position reference.

Multichannel Services

A multichannel service involves various channels, which together form an overall interface to access and manipulate the service-related content. It allows for the users to dynamically employ the preferred channel according to a situation. For example, a hiker could plan the hike using a Web map, but refer to a mobile version of the map during the hike. The use of a

multichannel approach is popular, for example, in the newspaper business. Newspapers have multichannel (or cross-media) strategies, in which the news content is supplied not only in print, but also via radio, digital television, the Web, and mobile devices (Quinn, 2003). Banks often offer multiple channels in providing access to their services via the Web, mobile devices, ATMs, in addition to face-to-face interaction in the bank. Also some multichannel map services already exist, for example, Ovi maps[5] by Nokia and Google Maps.[6]

According to, for example, Pasman (2011), Paternó and Santoro (2012), and Segersthål (2011), people are becoming familiar with different kinds of multichannel services, and this sets increasing pressure on the design of this type of services. Designing a multichannel service is a complex task. Central to this challenge is the establishment of an experience of a unified service, in which the user feels as though he or she is using one multichannel service rather than a number of disparate services. The KANA White Paper (KANA Software, Inc., 2012) describes three key elements in a multichannel service: (a) full integration of channels, which creates a seamless service experience; (b) a consistent user experience across all channels, which requires unified functionalities from every channel; and (c) a reliable user experience that takes place without interruption or slowdown. In a multichannel service, the user's experience of the service builds upon the use of the channels. Therefore, developing a multichannel service requires a broader range of aspects in its design than would be required in a single-channel service. Understanding the integration of the channels is crucial (Parker & Heapy, 2006), as interactions with the service across all the channels must be considered.

CASE STUDY

Our case study explores a UCD effort to develop a multichannel map service for hikers. The study is based on three research projects conducted in the Department of Geoinformatics and Cartography at the Finnish Geodetic Institute (FGI). Two of these projects, MenoMaps (2008–2010) and MenoMaps II (2010–2013) are joint ventures of the FGI's Department of Geoinformatics and Cartography and Aalto University's Department of Design. They involve 13 additional partners, consisting of authorities of various municipalities and public organizations and private companies in Finland. The MenoMaps projects aim at conducting research on and developing a prototype of a multichannel map service for supporting outdoor leisure activities. The third research project, the HaptiMap (2008–2012),[7] was coordinated by the Department of Design Sciences at Lund University, with a total of 14 partners. The aim of the HaptiMap project is to develop multimodal LBSs that are accessible also by special user groups, such as elderly and visually impaired people and that support their use of spatial information. The FGI's expertise in the projects focused on geoinformatics in geoservices, on map accessibility, and on LBS contents guidelines. The projects shared joint technical development platforms, which provided a synergy for prototype creation and offered a common environment for user studies and usability evaluations.

The focus of the present study is the design of a multichannel map service within these three related projects by applying a combination of UCD methods. In the following sections, we present the methods used and describe how we have applied the methods in our case study.

Design Process

A user-centered approach has been recognized as one of the key factors in the successful design of products and services (e.g., Cagan & Vogel, 2002; Miettinen, 2012). Understanding the user's point of view can be valuable especially in the early phases of the design process, where all design options are still open and changes to the design are easier to make (Koskinen & Battarbee, 2003).

We followed the UCD process as defined by Cooper et al. (2007). The goal-directed design process by Cooper et al. is divided into six phases: research, modeling, requirements definition, framework definition, refinement, and support. Although, as the development of our multichannel map service is still in progress, the last phases of refinement and support have not been yet conducted (see Figure 2). Despite that the phases are usually presented in a sequential manner, in the real process the phases were often overlapping, and thus were informing each other. For example, the modeling of personas was informed by the kinds of activities envisioned to be supported by the service. To reflect that the phases did not happen in a strictly sequential manner, we have named the working units "activities." The activities that took place in our case study are as follows:

1. The *research activity* involved a background study of technologies and existing services. It also included a user study that employed techniques such as observations, interviews, and design probes.

2. In the *modeling activity*, we utilized the material gathered during research to design the personas, which expressed groups of users through archetypal characters. The chosen personas became the main characters in scenarios that the requirements phase focused on.

3. The *requirements definition activity* created a much-needed link between the users and the design framework. We utilized a scenario-based approach to keep the focus of the scenarios on the goals and needs of the selected personas.

4. During the *framework definition activity* the overall concept was designed. This phase involved defining the basic frameworks for interactivity and visual design.
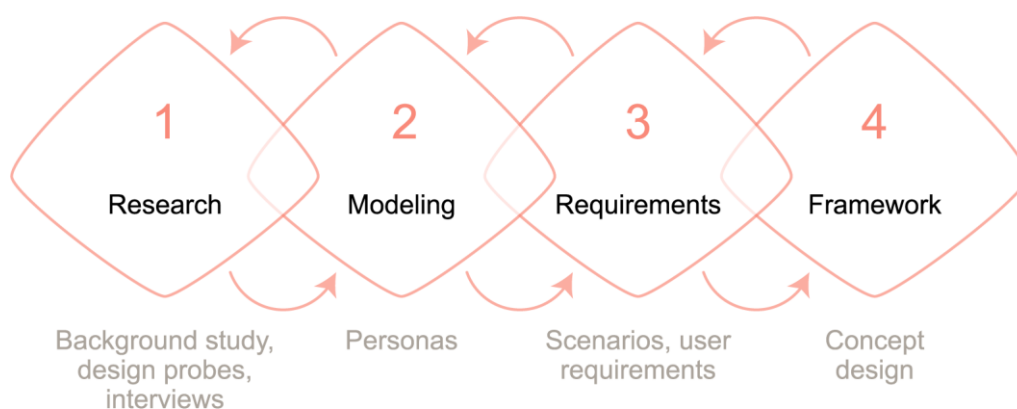

Figure 2. In our design process, we implemented four phases of the goal-directed design process (Cooper et al., 2007). Our interpretation of the phases as "activities" better reflects their true parallel and dynamic character.

The design process did not follow Cooper et al.'s (2007) process phase-by-phase in the order they are present, but rather involved the respective activities (research, modeling, requirements definition, and framework construction) that occurred in parallel and informed each other. The process featured numerous phases, typically in the form of codesign workshops, where multiple activities were advanced in parallel. The original phasing of the activities as a sequence nevertheless resembles in its overall character the progress in our development regardless of it failing to convey the actual dynamics of the real process.

User Groups

We included three user groups in the case study: experienced hikers, boy scouts, and visually impaired persons. Five or more participants represented each group. According to Koskinen (2003), three types of user groups are needed for a successful user study: primary, secondary, and deviant. The experienced hikers formed the primary user group; we expected them to be able to readily describe their specific needs for hiking. The secondary user group consisted of boy scouts, who we expected to complement our understanding of various needs related to outdoor activities of future generations. Finally, we chose to focus on visually impaired people as our deviant user group in order to learn about concrete issues related to accessibility and about particular needs that relate to their outdoors activities. The accessibility view was complemented by also including aging hikers in both our experienced hiker and visually impaired hiker groups.

The experienced hikers group consisted of five participants from 30 to 57 years of age. The three male and two female hikers were members of a Finnish hiking association and were all active hikers and experienced trekking guides. They possessed wide-ranging expertise in organizing different types of hikes for various groups. The boy scouts group consisted of a scout leader and four patrol leaders whose patrols had varying numbers of scouts participating in the studied activities. The four patrol leaders were from 14 to 17 years of age, and the patrol members were from 12 to 15 years of age. The user group of visually impaired people consisted of three male and two female participants from 21 to 78 years of age. Most of the visually impaired participants hiked daily in urban nature; some had participated in long hikes as well. These participants, all having residual sight, used both white canes and guide dogs.

The experienced hikers were contacted through the local hiking association, the scouts were contacted through the participating scout leader, and the visually impaired through an association of visually impaired. The user study was initiated by the introduction of the overall idea of the study: a 10-day design-probes-based documentation activity complemented by interviews. The process began with a meeting in which the design probes approach was explained to the users, and assignments were given. The users were informed that the project was focused on outdoor leisure activities.

Research Activity

Design Probes Study

The design probes study method is based on empowering users to articulate their personal insights, expectations, and goals with self-reflection materials (Mattelmäki, 2006). The

method was originally invented at the Royal College of Art by Gaver, Dunne, and Pacenti (1999) to provoke design teams to think more creatively about their users. The method has since transformed into a less artistic direction and now supports more informative and collaborative purposes (see Mattelmäki, 2006). Typically a user study conducted with the design probes method involves a set of assignments—a probes kit—given to the users. Diary keeping and photographing tasks are among the most common assignments in a probes kit. After users document their practice over an agreed period of time, usually around 1 week, they are interviewed on the basis of what they have documented with the probes kit. The number of participants tends to be limited to fewer than 10 due to the resource-intensiveness of the method. Along with helping researchers to construct a more elaborate empathic understanding of a participant, the stories behind the probes artifacts may also contain readily articulated user requirements.

In our study the probes kits were created based on an initial internal team negotiation of themes related to each user group. We designed distinct probes kits for the experienced hikers, the boy scouts, and the visually impaired persons (L. T. Sarjakoski, Yhirisku et al., 2009). The probes kit for experienced hikers included a diary that they were asked to keep for 10 days. It featured questions related to themes such as hiking habits, hiking gear, and hiking safety. They were also asked to photograph their hiking tools and practices. The kit included a map-drawing task to gain insights on what kind of hikes they plan and what they think when considering a hiking trip as a whole. Within two weeks of finishing the self-documentation two researchers interviewed the hikers individually.

The diary for the boy scouts included questions on topics such as how they plan a hike to a known or unknown place and what was the most memorable trip for them. During the 1-week study they were asked to photograph topics such as scout gear, essential gadgets, nice places, and so forth. The kit also included additional tasks related to the meaning of seasons, people related to the patrol, and the planning of a map-based game. The scouts divided their responsibilities to document their practice with the probes kits so that the scout leader was overseeing the activity, the patrol leaders filled in the diaries, and the other tasks were completed together by the respective patrols. After the self-documentation, which included a weekend hiking trip, one researcher interviewed the scouts in a session where all scouts participated collaboratively.

The probes kit for the visually impaired hikers was adapted to enable documentation even while having severely reduced vision. The questions were handled in digital form, which enabled them to listen to the instructions with a screen reader. The kits included haptic signifiers to allow the participants to feel their way through the materials. We asked the visually impaired participants to keep a diary for 10 days. The kit included tasks on topics such as the use of one's senses on a hike, the use of route maps, and the use of assistive devices and services. Also, they were asked who or what they prefer to have with them on a hike. Two researchers interviewed the participants individually within 2 weeks following the documentation period.

Interpretation of the Design Probes Materials

After the probes study, we gathered as a team to work with the material in order to translate it into a more meaningful and relevant form for further use in the project. This work is often conducted by using an affinity diagramming technique, where individual observations, written on individual slips of paper, are grouped into broad themes in a bottom-up fashion (see, e.g., Beyer &

Holtzblatt, 1998). During the initial phase of the interpretation, we recorded on various-colored sticky notes all observations and impression about the individual participants' experiences of hiking, and placed these notes within bounded columns (see Figure 3). In order to accelerate the process, we chose to categorize initial observations into four broad categories: Characteristics and Thoughts; Events Before, During, and After a Hike; Important Locations and Mobility; and New Ideas for Map Applications. The color-coded sticky notes distinguished observations (yellow) from category headings and places (pink) and new ideas (green). We utilized the same overall strategy and categories for the interpretation of the materials from each participant group.

The initial arrangement of observations according to the broader categories supported our team to work towards a synthesis of the observations because it enabled us to see how the participants were related in their characteristics. The structured organization of observations about participants formed the basis for starting to discuss how the participants were similar to, or different from, each other in regard to their relationship with hiking.

Modeling Activity

Personas are design tools that provide a means to articulate users for design purposes. A persona description typically contains an overview of a particular persona, such as name, age, and profession, in addition to personal goals, fears, and typical activities (Pruitt & Grudin, 2003). Personas are not representations of real people as such, but are based on the real behaviors and motivations of the studied users (Cooper et al., 2007). One of the benefits of using personas is that they communicate information about the users in an engaging and concise manner and allow for designers to address also sensitive issues about users without compromising their identity. Personas are grounded in field study findings and may contain concrete features adopted directly from the participants. The use of visual material is encouraged in order to support effective communication of the descriptions. Careful attention needs to be paid when making the visual parts of the description so that anonymity of the participants will be maintained.
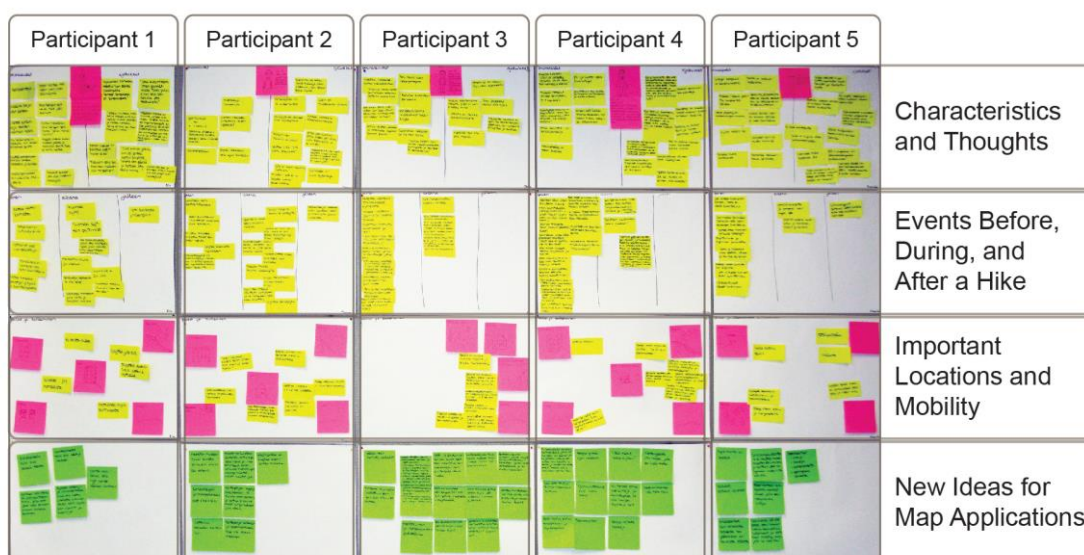

Figure 3. A structured affinity diagram for one participant group.

After we had categorized the observations from the probes study material with the aid of the structured affinity diagram, we began to synthesize the material in order to produce a set of personas fewer than the original number of studied participants. The observations showed that the many participants shared similarities in, for example, their way of hiking and goals related to it, or in their attitude towards technology, while some participants had little in common with the others. The overall intention was to reduce the amount of material while teasing out project-relevant details on a sufficient level of concreteness.

We began the construction of the personas by setting up blank paper backgrounds and discussing how the observations presented differences in, for example, how the participants within that group plan hikes. Then we transferred the notes onto the blank surfaces. Figure 4 presents one example of the new structures that emerged during this negotiation. In order to produce coherent results, we established common themes that were described for all personas: Background, Accessibility Issues, Hiking Style, Hiking related Issues, and Attitude towards Technology. The observations were marked with yellow notes, the themes with orange notes, and the scenarios with pink ones.

The main purpose of the personas in our study was to fuel and inspire designing, rather than to serve as the objective truth derived from field data that could be used to justify all design decisions. This allowed for some freedom in the articulation of the personas. The aim was to attain descriptions with an organic connection to the empirical material, while at the same time achieving a coherent, understandable, and well-rounded presentation. This was challenging because personas amalgamated only a few real people into even fewer descriptions. The process took place as a qualitative negotiation, where designers also utilized their own knowledge and expectations in dialogue with the materials at hand. Each persona became aligned around one
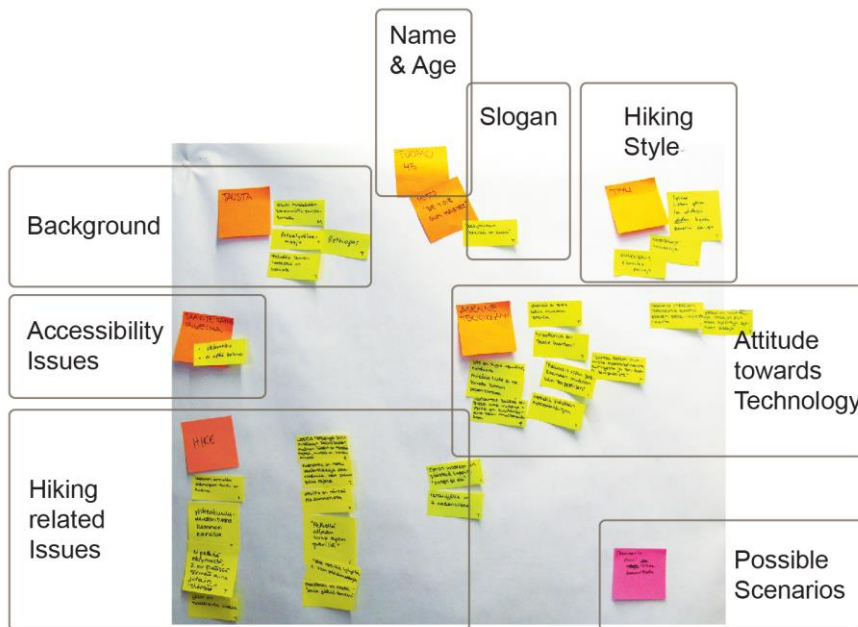

Figure 4. The persona "Tuomo" was first expressed as a collection of sticky notes.

core motivation that related to hiking. This was expressed in a slogan such as "The best hikes are the ones without any plans" (see Figure 5).

The persona construction resulted in three experienced hiker personas (Figure 5), two boy scout personas, and four visually impaired personas. Each persona was assigned a name, for easy reference, and factors such as the role of hiking in the persona's "life" and its preferred style of hiking. Each persona featured distinct preferences and needs. In a subsequent workshop, the personas were used as the substitute for actual-user participants. Hence, they were talked about as if they were real people. For example, it was convenient to talk about what "Tuomo" wanted, what "Irma" would think about safety or accessibility in a particular situation, or what "Esko" would think of a mobile-only application that would be available only through a small screen. This kind of use of personas encouraged designers to empathize with the potential users.

Requirements Definition Activity

Scenarios

Scenarios are useful for expressing what happens in a particular situation without committing to details of precisely how things happen (Rosson & Carroll, 2002). Scenarios are like stories and tend to be easily understood by the various collaborators in design projects. Scenarios also function as a means for designers to make sense of the potential value of novel technologies for users in concrete situations. Scenarios force designers to think from the point of view of the users when imagining the progress of interaction with the envisioned technologies.

We organized a scenario-building workshop with attendees not involved in the design probes activity from multiple countries (e.g., Spain, Sweden, France, Germany, UK, and Finland) that aimed at identifying generic user requirements for a multichannel map service. Priming, or the sensitization to the theme of a project, is an important aspect to foster the fast-paced development of a shared focus in workshops (Ylirisku, Halttunen, Nuojua, & Juustila, 2009). To

"I want to see the whole route at once. That's why I'm not fond of car navigation systems." *Esko, 52, engineer.*

"I always carry a map and a compass with me. Quite often a GPS, too." *Irma, 57, pharmacist.*

"The best hikes are the ones without any plans." *Tuomo, 43, salesman for trekking goods.*

Figure 5. The experienced hiker personas with name, age, profession, and slogan. Their key characteristics were visually expressed to convey their style.

support priming, workshop participants were assigned a particular persona to become familiar with prior to the workshop. In order to ensure the workshop participants would actually invest their time in reading the persona descriptions, we asked them to present their assigned personas to their workshop colleagues at the beginning of the session. The overall intent with priming was to enable the participants to ground their imagination more readily on the empirically founded personas, and thus presumably contribute to the emergence of more realistic scenarios where relevant user needs for a multichannel map service could be discovered.

The scenarios were created by employing the improvised video scenario method (Ylirisku & Buur, 2007). We briefly introduced the participants to the method of improvised video scenarios through an actual example that we had created. The participants first had to decide a rough plot for the scenario: a situation where the main character would encounter problems and novel technology would assist in to solve the issues. We also encouraged the participants to address potential issues, especially social and health related challenges that new technologies could introduce. The participants then planned and acted out short scenes, each embodying the persona that they were assigned (Figure 6).

Requirements for Design

Requirements reveal answers as to what the service should be and what it should do (Cooper et al., 2007). We employed the video scenarios for generating user requirements for the design of the multichannel map service. The video scenarios were collaboratively reviewed by the multinational working group, the same participants who created the video scenarios. After screening all the scenarios, the participants were asked to fine-tune and translate their observations into requirements, if possible. For example, the observation "the appearance of the device causes unwanted attention" was translated into a requirement "the appearance of the device must not attract unwanted attention."

To serve as canvases for collecting notes into affinity diagrams, four white boards contained one of the following titles: Technical, Social, Adaptation, and Functions. The labels functioned also to foster the articulation of the requirements as well as to enable sorting the requirements under broader topics. When articulating the requirements, the participants were
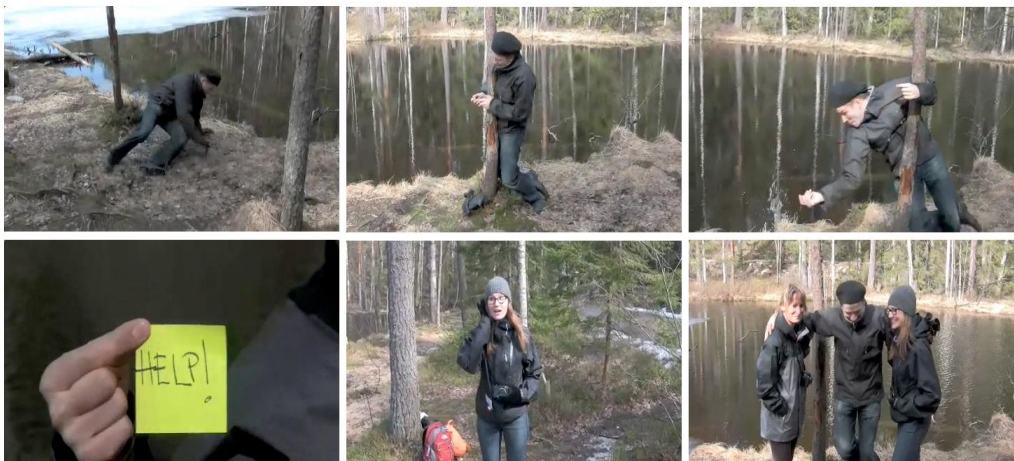

Figure 6. Screenshots from an improvised video scenario (created by the participants of the workshop), where a person falls and drops his assisting device into a lake and gets helped through traditional means.

encouraged to extend and elaborate the requirements according to their knowledge because many of the participants were experts in the field of personal outdoors technology development and have conducted user studies in related contexts.

Once the individual notes about requirements had been placed on the white boards (see Figure 7), the notes were grouped into themes and labeled. Then all requirements labels from the four affinity diagrams were collected on a shared computer screen and grouped to form overall categories of user requirements for design of multichannel map services. The requirements were treated as being prospective, that is, not all the proposed requirements were treated as something that all multichannel map services should implement, but rather as potentially important, depending on which functionalities and characteristics would be selected for implementation later. The overall categories of the user requirements were as follows:

- *Adaptability.* The group addressed requirements such as the possibility to choose what information is shown on the screen. In addition, for the visually impaired, adjustable features are important, such as volume, magnification, type of tactile feedback (e.g., vibration), colors, and level of detail.
- *Usability.* Requirements concerning usability included, for instance, that the application should be designed to fit the intended purpose, hiking.
- *Safety.* The safety issues included requirements such as the mobile application informing the user when he or she is not on the right track and of obstacles (e.g., a fallen tree) on the route.
- *Functionality.* This group included detailed functions, such as the requirement that the mobile application should include a "Where am I?" function with the latest known position or path.

Figure 7. The user requirements were developed collectively in a workshop on the basis of making observations from the video scenarios.

- *Content.* Requirements about the content included the need for additional information concerning points of interest, and important details, such as major roads or rivers, to be emphasized on the map.
- *Technical.* These included requirements such as a water resistant, portable, and durable device; for the visually impaired, the device must be as hands-free as possible.
- *Experience.* The applications should be attractive and include fun elements, such as the possibility for games.
- *Social.* The user requirements concerning social issues included reducing the likelihood to inconvenience bystanders with sounds or other loud noises, and enabling the easy switch to a nonintrusive mode.

Framework Construction Activity

The multichannel map service framework, or design concept, was generated in a session with the core design team responsible for the whole process. The initial development of the channels (the Web map, the mobile map, the large multitouch map, and the printed maps) had started even before the video scenario workshop in order to attain more sophisticated results within the given time constraints for the development. The user requirements were considered in the development of the technical implementation of each of the channels, where appropriate. For example, the tactile feedback was not relevant for a Web map.

The framework construction session was facilitated by a design researcher specializing in concept design. The other members specialized in various aspects of geospatial information systems, such as path optimization algorithms, visualizations, and technical implementation. Similarly as with the video scenario workshop, the session employed priming to foster relevant planning. Each participant was asked to present the state of art in his/her respective area of work on the different channels of the multichannel map service. The aim was to generate a simplified framework of what the multichannel map service and the principles for its implementation were, grounded in the latest technology presented by the workshop participants. One of the presentations recapitulated the identified design opportunities for the multichannel service targeted for hiking.

The Design Opportunities

The design opportunities are expressed in terms of a few key insights:

- Hiking is becoming increasingly popular. Consequently, need is growing for new map services to support it. Tourism has increased everywhere in the world; in Finland, it can be seen especially in terms of an increased interest in spending time outdoors, experiencing nature and hiking (Antikainen et al., 2006; Johansson, 2009; Puhakka, 2007).
- Social media and social sharing have become megatrends. Social aspects could be better exploited in map services because current map services seldom provide ways for social networking or sharing, such as the possibility to create groups and events.
- Making the maps accessible for all could significantly increase their use potential. The design-for-all perspective is not yet well recognized in existing map services (Magnusson, Tollmar, Brewster et al., 2009). The increasingly aging population

potentially could become future frequent users of multichannel map services. The interactivity of maps already allows users to adapt the map presentations to such an extent that the maps remain readable even for those with reduced vision. However, the adaptation of map presentations to suit specific needs has not yet been exploited to its full potential.

The Design Drivers for a Multichannel Map Service

As part of the design framework, we generated principles, or "design drivers," for the implementation of the multichannel map service. Design drivers are high-level objectives that guide and fuel designing (Keinonen, 2006). Design drivers express briefly the distinguishing characteristics of a particular design, that is, they are the key principles that enable the creation of a coherent and distinct identity for a designed service. Our design drivers were as follows:

- Maximize the Map Experience. The map itself is the most important part of a map service, and it should play the central role at all times in all the channels. Designing the map and the overall user experience are very much intertwined: The user interface and the map itself cannot be separated due to the nature of interactive maps (Nivala, 2007).
- Begin with User's Situation. The service should be created with a good understanding of the possible situations the user may get into with the new service. Any feature included in the final service should be justified by referring to a potential situation relevant for the users. The possible situations may be explored, for instance, with the aid of scenarios.
- Network the Channels. The channels in a multichannel service should be networked so that plans made on one channel should be available on any other. The channels should also be designed so that they share appearances, functionalities, and resources whenever possible to maintain a common identity and enhance the consistency of the service.

One of the major technical challenges in a multichannel map service is adapting the same geospatial data and similar functions to the different channels. For example, the multichannel map service on a small touchscreen creates different requirements for the user interface than the large multitouch map. The differences influence what can be conveyed to the user and how the interactivity may be facilitated. Therefore, some alterations to content, functioning, and presentation are needed in order to provide smooth and reliable experience across the channels. In addition, the networking of the paper-based maps can be achieved through data matrix technologies, which allows for the opening of associated content through mobile devices.

A truly user-centered process requires recognizing possible future user groups. Designers must gain insights about them and understand their relationships with map services within a hiking context.

CONCLUSIONS

This paper reported on the early phases of a pioneering concept development of a multichannel map service. The study provided a concrete example of the combined use of a wide array of

existing UCD methods in the emerging field of map services. It also illustrated how users' insights could be incorporated into a generative design process where these were not treated as objective facts, but rather as design material establishing relevant conceptual ground for the construction of the multichannel map service framework. The process was informed by the work of Cooper et al. (2007), although, it was shown that the actual UCD process introduced a much less straightforward and more complex and dynamic structuring than the process model suggests.

Our aim was to develop a multichannel map service that is easy to use, effective, and enjoyable. From the design probes study with three different user groups (experienced hikers, boy scouts, and visually impaired people), we learned about the differences between hikers in terms of their needs; for instance, some needed to know precisely their position on the map, while others claim to be happy with a rough overview map. The process of generating personas, that is, archetypal concretizations of the potential users of the service on the basis of the design probes materials, was illustrated. These were employed to ground collaborative authoring of improvised video scenarios, and they served as sources for further extraction of potential user requirements for the multichannel map service. A multichannel map service concept was then designed.

The concluding design concept expresses some characteristics that have been promoted earlier to be valuable for designing multichannel services, for example by Parker and Heapy (2006). They underlined the importance of creating a consistent experience across the channels, and this characteristic of multichannel services is also expressed in the KANA White Paper (KANA Software, Inc., 2012). Our process relied on the close appreciation of the potential users of the multichannel service. The UCD process that was applied produced an understanding of the users' needs beyond the rather superficial treatment in the earlier sources, such as in the KANA White Paper. In further contrast to these earlier works, our concept emphasized the value of the map itself and gave it a pivotal role.

The centrality of the map also created a new challenge. It is not at all a trivial problem to establish a map in multichannel map services. The design of a map becomes intertwined with the design of other aspects of the service, such as user controls and the presentation of additional map-connected data, for example, links to Web sites and photographs. This raises implications for the design of such services and underscores the need for integrative practices that bring together development across the channels. Also designers of multichannel map services need to develop frameworks, such as the presented design concept, that guide design beyond individual maps and comprise also the other aspects of the service. The findings also emphasize the need to involve users and multidisciplinary teams in the conceptual phases of designing complex services aimed at serving various kinds of users.

The presented study is part of an ongoing research project. A prototype of the multichannel map service was exhibited in the Finnish Nature Centre Haltia[8] in May 2013. The prototype of the multichannel service will be developed further, and usability evaluations will be conducted in an iterative process to ensure the convenience of the service for a large audience.

ENDNOTES

1. Google Maps is reachable at http://maps.google.com

2. Bing Maps is reachable at http://www.bing.com/maps

3. Open Street Maps is reachable at http://www.openstreetmap.org/

4. Via Michelin is reachable at http://www.viamichelin.com/

5. Ovi Maps is reachable at http://maps.ovi.com

6. The mobile version of Google Maps is reachable at http://m.google.com/maps

7. Information on the Haptimap project is available at www.haptimap.org

8. Haltia is an event and exhibition center situated in Southern Finland within the Helsinki Metropolitan area and functions as a "door" to Finnish nature. Its grand opening was in May 2013.

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EFFECTS OF POSITIONING AIDS ON UNDERSTANDING THE RELATIONSHIP BETWEEN A MOBILE MAP AND THE ENVIRONMENT

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Abstract: *Positioning technologies such as GPS enable mobile map applications to display a symbol representing an estimation of a user's location on a mobile map, therefore acting as a positioning aid. Previous research on the cognitive processes involved in map reading suggests that map readers need at least two map–environment points (objects that are visualized on the map and perceived in the environment) for determining their location on a map. Hence, the positioning aid alone does not provide enough information for self-location. Using a field experiment, we assessed the effect of representing the user's location on a map on the cognitive processes involved in self-location. The results show that positioning aids guide the search for map–environment points and narrow the area on the map that must be scanned for self-location.*

Keywords: *mobile, landmark, spatial cognition, hiking, navigation, GPS.*

INTRODUCTION

Imagine yourself strolling in a forest with only a mobile map to guide your navigation. You notice a small pond and boulders on your right. You look at your mobile map and search for the cartographic symbols representing the pond and the boulders. After finding the symbols, you locate yourself on the map.

Recently, topographic maps, the type of map typically used by hikers, have been integrated into mobile applications. Topographic maps symbolically depict landforms and other physical

objects that can be recognized in the terrain. Today, most mobile devices include integrated positioning devices, such as GPS (Global Positioning System) receivers, that enable applications to plot the user's location on the map (Raper, Gartner, Karimi, & Rizos, 2007). In the present study, any technologies that enable the plotting of a user's estimated location on a mobile map are referred to as *positioning aids*.

Self-location on a map is a process by which a map reader determines his or her own location in relation to the symbols on a map (Blades & Spencer, 1987). Orientation is an important part of self-location on a map because organisms necessarily have a location and an orientation in space (see Klatzky, 1998). In the present study, the concept of self-location on a map refers to the process by which the user determines both his or her location and orientation on a map.

Further, self-location on a map requires the map reader to recognize at least two objects in the environment and their corresponding referring symbols on the map (Aretz & Wickens, 1992; Levine, Jankovic, & Palij, 1982; Levine, Marchon, & Hanley, 1984; Liben & Downs, 1993; Oulasvirta, Estlander, & Nurminen, 2009). However, map applications typically only present one symbol indicating the user's location on the map. The symbol has a single relation to the environment; hence, representing the approximate location of the user on the map does not provide a sufficient amount of information for self-location.

The nature of landmarks used in map reading and navigation has been studied mainly in urban environments (Denis, Pazzaglia, Cornoldi, & Bertolo, 1999; May, Ross, Bayer, & Tarkiainen, 2003). A study by Brosset, Claramunt, and Saux (2008) showed that the ability to read topographic maps and city maps are based on the recognition of different kinds of objects in the environment. According to Lynch (1960), the uniformity of urban environments affects map legibility and ease of navigation. Conversely, in nature environments, users often must rely on recognizing ambiguous landmarks (L. T. Sarjakoski et al., 2012). The search for map–environment points on topographic maps of rural areas, as compared to on maps of densely built-up environments, may be more demanding because the density of distinctive map objects is lower. Pick et al. (1995) stated that topographic maps are useful when the environment is not artificially structured with routes connecting locations.

The research presented in this paper studies the effect of positioning aids (which enable the representation of the user's location on a mobile map) on the process of self-location. The paper, based on Kässi's previous work (2011), presents an experiment employing a combination of the pointing paradigm (Oulasvirta et al., 2009; Thorndyke & Hayes-Roth, 1982) and protocol analysis (Boren & Ramey, 2000; Ericsson & Simon, 1984, 1993).

PREVIOUS STUDIES

Several studies have recognized that determining one's location on a map is a prerequisite for other map-based tasks (Bluestein & Acredolo, 1979; Ishikawa, Fujiwara, Imai, & Okabe, 2008; Liben & Downs, 1993; Lobben, 2004). Only after the map reader has a conception of his or her own location on the map may he or she proceed to other tasks, such as planning a route to a destination, monitoring whether or not he or she is lost, and deducing the directions to locations displayed on the map (Blades & Spencer, 1987; Board, 1978).

In order to determine one's location and orientation on a map, the user has to determine the relationship between objects in the environment and the symbols on the map (Liben & Downs,

1993; Oulasvirta et al., 2009). According to Oulasvirta et al., solving the *mapping problem* is a prerequisite for self-location on a map. The mapping problem refers to the process whereby the user has to recognize the correspondence between a symbol on the map (e.g., symbol referring to a rock) and its referent in the environment (e.g., a rock in the environment). In the present study, the objects that are recognizable in the environment and on the map are called *map–environment points*.

However, one map–environment point alone does not provide enough information for self-location. According to the two-point theorem, the map reader needs at least two map–environment points for self-location (Levine et al., 1982; Levine et al., 1984) and for being able to determine the direction towards any third point. Bluestein and Acredolo (1979) have stated that a directional symbol along with one map–environment point may provide the minimal amount of information needed for self-location. The two-point theorem suggests that although a satellite navigation system makes it possible to add a symbol on the map that indicates the user's location, the symbol alone does not provide enough information for self-location. Even if the user is able to treat the point given by the positioning aid as a map–environment point, additional information is needed for self-location.

The process of recognizing map–environment points consists of two elements: the visual search (Wolfe, 1994) for symbols on the map and the evaluation of their relevance for the self-location process. In map reading, the visual search on the map refers to the ability to identify relevant symbols on the map. The relevance of a symbol is defined either by the user's ability to recognize the symbol's referent objects in the environment from a certain position or by the user's memory of landmarks that he or she has recognized earlier. Because the map reader's position and memory of the environment influence how the symbol's relevance for map reading is determined, the map reader's location in the space affects the problem input (Newell & Simon, 1972) for the self-location task. Figure 1 represents an abstraction of the process of searching relevant map–environment points for the purpose of self-location.

The three-component model of self-location proposed by Liben and Downs (1993) allows for analyzing the prerequisites for solving the mapping problem (Oulasvirta et al., 2009). Liben and Downs (1993) determined that self-location on a map requires understanding three kinds of relations. First, the map reader has to understand the person–space relation (i.e., the map reader's
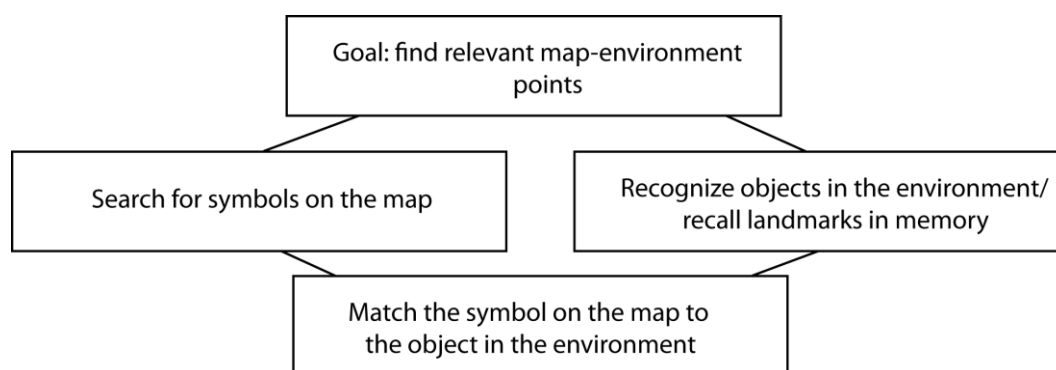

Figure 1. An abstraction of the process of finding the relevant map–environment points for self-location, where the user searches the symbols on the map and identifies corresponding landmarks in the environment. The relevance of the symbols on the map is determined by the map reader's ability to match them to the environment.

own location in the environment and in relation to objects in the environment). Second, the map reader has to establish the map–space relation (i.e., understand the correspondences between the map and the environment represented on it). Only after the map reader has a conception of the person–space relation and the map–space relation may the map reader proceed to the person–map relation (i.e., understanding the map reader's location on a map). The person–map relation includes processes called projection (Bluestein & Acredolo, 1979) and structure matching (Levine et al., 1982). In the process of projection, the map reader has to transform the vertical view of the map into the horizontal view from which he or she is looking at the environment. In structure matching, the map reader connects objects in the environment to the corresponding symbols on the map (Levine et al., 1982; Oulasvirta et al., 2009). As a result of structure matching, the map reader has a set of map–environment points.

The three relations (i.e., person–space, map–space, and person–map) allow for analyzing the possible effects of the use of a positioning aid on the map-reading process (see Table 1 for a summary of the possible effects). The person–space relation covers only the cognitive processes involved in searching and recognizing the objects and landmarks in the environment. Because representing the user's location on the map only adds information to the map (and no information to the environment), the person–space component of the self-location process remains uninfluenced by use of a positioning aid. Furthermore, the map–space relation refers only to the semantic content of the cartographic symbols on the map and their relation to the objects and landmarks in the environment. By plotting the user's approximate location on the map, the user receives only one additional symbol that has a relation to the surrounding environment. The most significant effect of the use of a positioning aid may be on the third component of the map reading process, the person–map relation. Because representing the user's location adds information to the mobile map, it may influence the search for map–environment points. More specifically, the user's location may either improve or impair two of the elements involved in searching for map– environment points: the visual search for symbols on the map and determining their relevance for self-location.

Table 1. Effects of Plotting User's Location on a Map on Self-location.

	Person–space relation	Map–space relation	Person–map relation
Essential features of the components of the self-location process	Map-reader's location in relation to the objects in the environment.	Semantic interpretation: Understanding the referential relation of the map and environment.	Mapping problem: Understanding the relation between an object in the environment (point X) and a symbol on the map (point X').
Effect of representing the map-readers location on the map on the component of the self-location process	No effect.	Representing the location of the map reader adds one symbol to the mobile map that has a relation to the environment.	Representing the location of the map reader may improve or impair the search for symbols on the map and the evaluation of their relevance for self-location.

Note. The table summarizes the three-component model of self-location on a map (Liben & Downs, 1993) and the possible effects of representing the map reader's location on the map on the different components of the model.

GOAL OF THE RESEARCH AND RESEARCH QUESTIONS

This study is part of an ongoing research project. The goal of the UbiMap project is to develop new knowledge and research methodology related to ubiquitous spatial communication. The focus is the interactive map that is explored as a user interface through which the user is able to interact with the surrounding environment. The case studies of the project focus on hiking in the wild.

The aim of the present study is to assess the effect of representing the user's location on the map on the cognitive processes involved in self-location. Earlier research found that searching for map–environment points is an essential element of the process of determining one's location on a mobile map (Liben & Downs, 1993; Oulasvirta et al., 2009). To investigate whether representing the user's location on the map impairs or improves the search for map–environment points, three research questions were formulated:

- Does representing the user's location influence the time needed to locate oneself on a map? If plotting the user's approximate location on the map impairs the search for map–environment points, the time needed to determine one's location on a map will be increased. However, if representing the user's location improves the search for map–environment points, the time needed for self-location will be reduced.

- Does representing the user's location on the map influence the number of map–environment points needed for self-location? If the user is unable to exploit the information provided by the positioning aid, representing the user's location with a symbol will not influence the number of map–environment points needed in self-location. On the contrary, if a user benefits from the positioning aid, the number of map–environment points needed in self-location will be reduced.

- Does representing the user's location on the map change the way map–environment points are identified? The search process involved in finding the relevant map–environment points for self-location may be either improved or impaired by use of the positioning aid.

It may be concluded that the information provided by the positioning aid does not influence the search for map–environment points if the time needed to perform self-location and the number of map–environment points needed for self-location is unaffected. However, if the positioning aid use decreases the time needed for self-location and affects the number of map–environment points being sought, it may be concluded that knowing one's approximate current location on the map guides the search for map–environment points.

METHODS

We modified the pointing paradigm, originally developed for studying the memory for maps (Thorndyke & Hayes-Roth, 1982), and combined it with analysis of the subject's verbal protocols (Ericsson & Simon, 1984, 1993). Because our aim was to study the effect of plotting user's location on map on self-location, we asked our participants to indicate the direction to targets shown on mobile map, which either had positioning turned on or off. The participants were asked to think aloud while performing the tasks. The verbal think aloud

protocols obtained from the participants were used to analyze the mental processes involved in the self-location process.

We organized the present study in a nature environment and used a mobile map application to display topographic maps covering the experimentation area. In half of the tasks, we configured the application to give a location estimate and, in the other half, the positioning aid was not used.

Experiment Site and Participants

Twelve individuals participated in the study. The subjects were, on average, 24 years old, and eight of them were female. Most subjects estimated that their map-reading skill was good (i.e., on scale of 1 to 5, where 4 indicated good map-reading skills). Three individuals reported that they use a smart phone daily, eight reported that they have never used a smart phone, and one reported that she uses a smart phone only rarely. All subjects spoke Finnish as their native language, and the verbal data recorded in the experiment was in Finnish.

The subjects were recruited from the e-mail list of a university student scouting organization. Because the map application used in the study lacked a legend that would have explained the meaning of the symbols and features on the map, only hikers who had experience in reading topographic maps were recruited.

The experiment was conducted near Lake Halkolampi in Nuuksio National Park, located within the capital region of Finland. The park is approximately 30 kilometers northwest of the center of Helsinki.

Map Application and Navigational Aids

We used an early prototype version of the Terrain Navigation mobile map application as a research platform in the study. The application was developed at the Finnish Geodetic Institute as part of the UbiMap project. The Terrain Navigator runs on Apple iPhone mobile devices (Kovanen, L. T. Sarjakoski, & Sarjakoski, 2009).

The map views are manipulated by using the touchscreen. For instance, the map is scrolled by moving a finger along the screen and rotated by placing two fingers on the screen and making a rotating movement with the fingers. Double tapping the screen with one finger zooms the map in, and touching the screen with two fingers at the same time zooms the map out. The application can display maps at six different design scale levels. The scales at the latitude of the test area were 1:2362 (where one centimeter on the map corresponds to approximately 23.62 meters in the environments), 1:4724, 1:9449, 1:18898, 1:37795, and 1:75591.

The Terrain Navigator application utilizes the positioning capabilities of the mobile phone. The positioning method in the test was Assisted GPS (A-GPS). The position estimate from the A-GPS unit was overlaid on the map with a red symbol surrounded by a circle. Because the circle was transparent, the map's symbols located under the circle were recognizable. The diameter of the circle corresponded to the accuracy estimate of the map reader's location. The more accurate the positioning was, the smaller the circle was. The accuracy of the A-GPS mode of the iPhone 3G has been studied to have a horizontal median error of 7.7 meters with a root mean square error of approximation of 9.0 meters (Zandbergen, 2009). However, the accuracy benchmarking was performed under ideal circumstances that significantly deviated from our

test circumstances. Our test area was more challenging because the satellite geometry was poorer as a result of the surrounding terrain.

Because some hikers typically use a compass as an important navigational aid while hiking, the subjects were also provided with a Suunto A30 scout compass. However, the subjects were not instructed to use the compass.

Pointing Tasks

In the pointing tasks, subjects were shown a target on a map and asked to indicate the direction to the target. They then were instructed to think aloud while performing the task. In all the pointing tasks, the target was marked on the map with a green symbol. To be sure that the subjects had recognized the target and located themselves accurately on the map, they were asked to report the cardinal direction (north, east, south, west) or intercardinal direction (northeast, southeast, southwest, northwest) to the target. The experiment was a 2×2 within-subject design, with the following conditions:

- Distance to the target. Half of the pointing tasks were proximate and half remote. In the proximate pointing tasks, the target was visible from the site where the task was performed. In the remote pointing tasks, the target was not visible from the task site.
- Positioning aid usage condition. Half of the pointing tasks used a positioning aid, and half did not. In the task with positioning on, the map reader's location was displayed on the map. Otherwise, the location was not plotted.

In Figure 2, the circles represent the actual sites where the pointing tasks were performed within the experiment area. The arrowheads indicate the locations of the targets that were shown to the subjects on the mobile map.

To control the order of the tasks, the pointing tasks were divided into four pairs (pairs A, B, C, and D; Figure 2). Each pair contained one proximate pointing task and one remote pointing task. In pairs A and C, the subjects performed the proximate pointing tasks before the remote pointing tasks, and in pairs B and D, subjects performed the remote pointing tasks before the proximate pointing tasks.

The order of the pairs was balanced using the following manipulations:

- Five subjects performed pairs A and B with the positioning aid on and pairs C and D without positioning aid; seven subjects performed pairs A and B without the positioning aid and pairs C and D with the positioning aid. Our initial goal was to recruit eight participants to both conditions, but we settled for five and seven after several cancellations.
- Six subjects performed the pointing tasks in Pair A before those in Pair B; and six performed the pointing tasks in Pair B before those in Pair A.
- Six subjects performed the pointing tasks in Pair C before those in Pair D; and six performed the pointing tasks in Pair D before those in Pair C.

These manipulations of the execution order and of the conditions for the experiment resulted in eight different configurations (configurations in which the positioning was used only in pairs A and B: AB-CD, AB-DC, BA-CD, BA-DC; configurations in which the positioning aid was used only in pairs C and D: AB-CD, AB-DC, BA-CD, BA-DC). With only 12 subjects, balancing the number of subjects in each configuration was impossible.
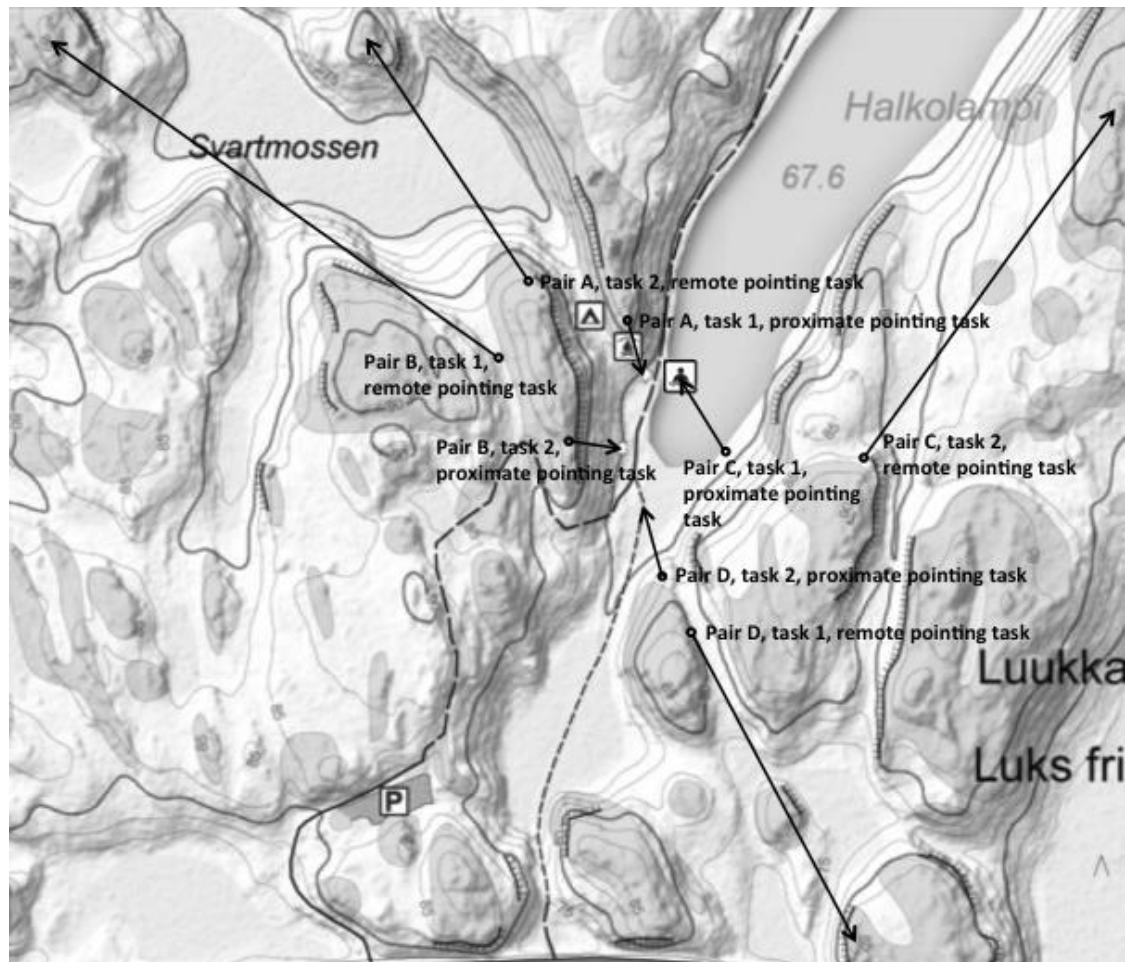
Figure 2. The actual sites where the pointing tasks were performed are marked with circles. The arrows point to the targets' locations. The pointing tasks were divided into four pairs.

Procedure

Subjects carried out the tasks individually with one experimenter guiding them. Before the actual pointing tasks, the subjects performed two practice tasks: one proximate pointing task with the positioning aid switched on and one remote pointing task without the positioning aid. The aim of these tasks was to familiarize the subjects with the Terrain Navigator and to allow them to practice the thinking aloud method described by Boren and Ramey (2000) and Ericsson and Simon (1984, 1993). During the actual test, data were recorded using a digital voice recorder and a video camera. A microphone connected to the recorder was placed close to the subject's mouth to capture the think-aloud data. The experimenter video recorded the subject's movements during the pointing tasks.

After completing the practice tasks, the subjects were escorted to the first pointing task site. The pointing task started when the mobile device was handed to the subject and stopped when the mobile device was returned to the experimenter. After the completion of each pointing task, the subjects were escorted to the next site. During the pointing tasks, subjects were allowed to

manipulate the map view by zooming and scrolling. However, before each pointing task was started, the map on the mobile application was reset to the scale 1:37795, centered over Lake Halkolampi, and oriented so that north was displayed on the top of the screen.

Because the experiment focused on analyzing the subjects' mental representations, subjects were instructed to focus their thoughts on verbalizing rather than on completing the tasks as quickly as possible. If subjects were silent for longer than 20 seconds, the experimenter reminded them to start thinking aloud again. No feedback on how well the subjects performed was given during the experiment. During the trials, the experimenter only answered questions concerning the pointing task instructions and how the map view could be manipulated.

Preprocessing the Data

We transcribed the subjects' audio recordings verbatim. As is often the case in field experiments, loss of data occurred. Specifically, the first three subjects were not recorded on the digital voice recorder due to technical problems. However, in these cases, we transcribed the think-aloud audio from the video recordings. Moreover, after viewing the video recording, we eliminated the audio scripts of 11 tasks (seven no-positioning; four positioning on) from our data, due to the subject having moved significantly away from the chosen site for the pointing task.

We compared the direction from the actual site to the target with the directions reported by the subjects. If subjects reported the direction ambiguously (e.g., "somewhere southeast or south") the reported direction was deemed correct if either direction was correct. We excluded tasks (three no-positioning) in which the reported direction was deemed incorrect.

With the above eliminations, we analyzed 82 tasks (38 positioning on; 44 no-positioning). The compass was used in just 28 tasks (16 positioning on; 12 no-positioning).

DATA ANALYSIS

Data from the pointing tasks consisted of two measures: the time needed to perform the task and the number of map–environment points mentioned while completing the task. We calculated the time needed to perform each task as the time from the subject's first word (after the experimenter gave the mobile device to the subject) until the subject's last word. In addition, we used the qualitative data from the think-aloud recordings to analyze how use of the positioning aid changed the strategies used to solve the pointing tasks. We further analyzed the qualitative data by counting the number of map–environment points mentioned by the subjects while they performed each pointing task. This approach follows the quantifying qualitative data technique introduced by Chi (1997).

The map–environment points mentioned by the subjects corresponded to the features displayed in topographic maps (roads, building, water, elevation, vegetation). We treated references to the use of the positioning aid and/or the compass as similar to landmarks because both can be used as points connecting the map to the environment. (This can be done, for example, by using the compass to align the map to the direction the subject is facing.) The map–environment points, identified in Finnish and later translated to English by the researchers, are summarized and categorized in Table 2.

Table 2. Summary of the Map–Environment Points Identified from the Protocols.

Category	Terms used by subjects
Roads and paths	Road, parking lot, path, trail, intersection, and fork in the road
Buildings and related features	Cooking shelter, shelter, shed, hut, building, woodhouse, outhouse, table, tent site, and fireplace
Lakes and related concepts	Lake, pond, bay, shore, shoreline, beach, opposite shore, water, and pier, or the proper names for these features
Hills and elevation	Boulder, ridge, crag, cliff top, cliff, hill, mound, valley, slope, hillside, wall, and mountain
Vegetation	Rock, forest, swamps, or the proper names for these features
Other concepts	GPS and compass

Note. The table summarizes the map–environment points identified from the think-aloud data. The categories correspond to the features plotted on topographic maps. Terms were spoken by the native Finnish subjects in Finnish and translated into English here by the researchers.

In addressing a quantitative aspect of the data analysis, we looked at the effect of two factors and one covariate on the time needed to perform the pointing task and on the number of map–environment points mentioned. The three factors explored involved

- positioning condition, referring to the experimental conditions in which the user's location was either plotted on the map (positioning on) or not (no positioning);
- distance to the target, referring to the experimental conditions in which the target is either visible (proximate pointing task) or out of sight (remote pointing task) from the actual site where the pointing task is performed; and
- verbosity, referring to the total number of words uttered by the subject while completing the task. Because the subjects might vary regarding how much they tend to speak during the tasks, the verbosity was used as a covariate in the analyses.

The data from the experiment involved several trials from each subject, and, thus, the trials from each subject cannot be considered to be independent from each other. To treat the correlation between the observations, statistical analyses were performed using a linear mixed model (LMM), which includes a fixed effect part and random effects part. The fixed effect part of the LMM accounts for the influence of the independent variable data (positioning condition, distance to target, verbosity), whereas the random effects part of the LMM accounts for subject-to-subject variation. The LMM permits the inclusion of multiple measurements from one subject and for missing data, thereby increasing statistical power while controlling for within-individual variation.

The dependent variable data, the time needed to perform the tasks and the number of map–environment points mentioned during the tasks, were entered into an LMM. In these analyses, the factors positioning condition (two levels: no-positioning and positioning on), distance to the target (two levels: proximate pointing and remote pointing), and the covariate verbosity were assessed.

To analyze how the positioning influenced the time needed to perform the pointing tasks, the following LMM analysis was computed: the effect of the positioning condition (two levels), distance to the target (two levels), verbosity, and the interactions between these variables on the time needed to perform the pointing tasks. To assess the qualitative effect of the positioning on

the way the pointing tasks were performed, the following statistical analysis was computed: the effect of the positioning condition (two levels), distance to the target (two levels), verbosity, and the interactions between these variables on the number of used map–environment points.

RESULTS

The analysis indicated that the positioning aid reduced the time needed to perform the tasks. The analysis of the number of map–environment points showed that there were qualitative differences in the process between the positioning conditions.

There is a positive, and statistically significant, association between verbosity and the time needed to perform the pointing task, $F(1, 39) = 11.377$, $p = .002$. This result shows that the more subjects spoke during a task, the more time they needed to perform the task. Furthermore, the main effect for the factor positioning condition on the time needed to perform the task almost reached the level of statistical significance, $F(1, 65) = 3.470$, $p = .067$. The mean time needed to perform the pointing task was shorter in the positioning on condition ($M = 69.7$ s) than in the no-positioning condition ($M = 80.5$ s). No other main effects or interactions reached the level of statistical significance on the time needed to perform the task. The statistical tests of the effects of verbosity, positioning condition, distance to the target, and their interactions to the time needed to perform the tasks are summarized in Table 3.

Further, the main effect in the LMM for the factor verbosity reached the level of statistical significance on the number of map–environment points mentioned, $F(1, 75) = 55.484$, $p < .001$. The result shows that the more subjects spoke during a trial, the more points they mentioned. The factor distance to the target had a statistically significant effect on the number of map–environment points mentioned, $F(1, 75) = 4.845$, $p = .031$. The subjects mentioned, on average, fewer landmarks in the remote pointing tasks ($M = 4.8$) than in the proximate pointing tasks ($M = 5.9$). The interaction between the factor positioning condition and the covariate verbosity reached the level of statistical significance on the number of map–environment points mentioned, $F(1, 75) = 5.806$, $p = .018$. The statistical tests of the effects of verbosity, positioning condition, distance to the target, and their interactions to the number of map–environment points mentioned during the tasks are summarized in Table 4.

Table 3. Linear Mixed Model of the Main Effects and their Interactions on the Time Needed to Perform the Pointing Tasks.

	df	*F*	*p*
Verbosity	1, 39	11.377	0.002
Positioning conditioning	1, 65	3.470	0.067
Distance to target	1, 70	1.208	0.276
Verbosity × Positioning condition	1, 66	1.419	0.238
Verbosity × Distance to target	1, 69	0.970	0.328
Positioning condition × Distance to target	1, 63	0.434	0.512

Note. Significance levels in the linear mixed models were .1%, 1%, 5%, and 10% (i.e., $p <.001$, $<.01$, $<.05$, and <0.1).

Table 4. Linear Mixed Model of the Main Effects and their Interactions on the Number of Map–Environment Points Mentioned in the Pointing Tasks.

	df	F	p
Verbosity	1, 75	55.484	0.000
Positioning conditioning	1, 75	1.205	0.276
Distance to target	1, 75	4.845	0.031
Verbosity × Positioning condition	1, 75	5.807	0.018
Verbosity × Distance to target	1, 75	2.103	0.151
Positioning condition × Distance to target	1, 75	0.780	0.780

Note. Significance levels in the linear mixed models were .1%, 1%, 5%, and 10% (i.e., $p < .001$, $< .01$, $< .05$, and < 0.1).

Figure 3 displays the linear dependency between the number of points mentioned in the task and the verbosity in the conditions with and without the positioning aid. In addition to the linear model, Figure 3 depicts the mean number of map–environment points in the no-positioning and positioning on conditions at four points of the verbosity data (61, 81, 102, 404). These data points correspond to the 25th, 50th, 75th, and 100th percentiles of the verbosity values. No other main effect or interactions reached the level of statistical significance on the number of map–environment points mentioned during the tasks.

DISCUSSION

The present study was conducted to assess the effect of GPS-supported plotting of a user's location on a digital map on the cognitive processes of self-location in a mobile map context. The study is based on the view that determining one's location on a map requires the user to recognize points in the environment with respect to the map.

The results indicate that the positioning aid decreases the time needed to perform the pointing tasks. If the pointing task is considered to consist of two phases (self-location and deducing the direction), the positioning aid affects only the self-locating phase of the task.

The interaction between verbosity and the positioning condition has a significant effect on the number of map–environment points accessed. In most cases (more than 75% of the usable data), the number of map–environment points mentioned was lower in the positioning on conditions than in the no-positioning conditions. This difference suggests that the positioning aid reduces the number of points needed for self-location.

The results also show that the positioning aid reduces the time needed to perform the pointing tasks in nature environments. Furthermore, the results show that the number of map–environment points accessed increases as a function of the verbosity more steeply when the positioning aid is not available. Even though verbosity has a significant effect on the number of map–environment points mentioned, their number is also dependent on the positioning condition. In general, the number of map–environment points mentioned is lower when the positioning aid is used than without the positioning aid. These findings suggest that in nature environments the positioning aid helps users to find other relevant map–environment points for self-location.
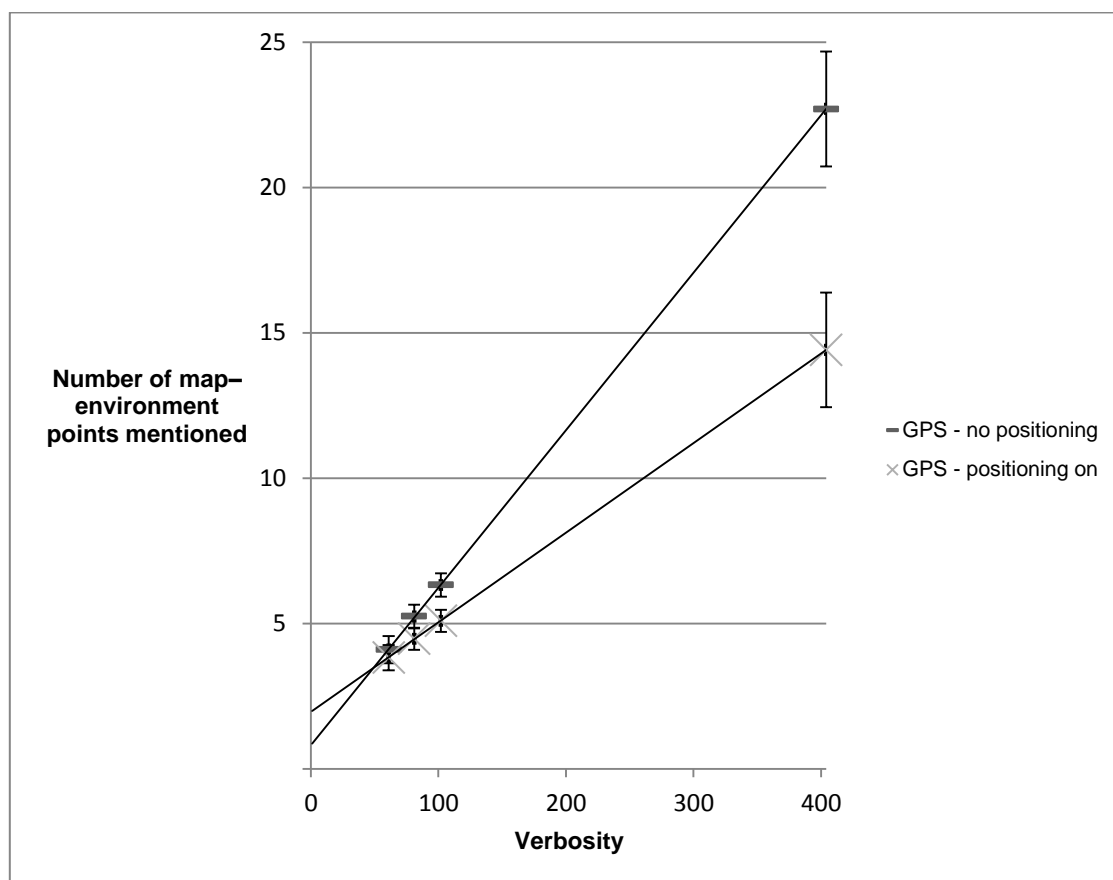
Figure 3. A linear model of the number of map–environment points mentioned (y-axis 0 - 25) as a function of the verbosity data and positioning conditions. The error bars display the standard error in the mean of the data points. The regression line is based on the linear mixed model (LMM). The standard errors of the means are computed by comparing the estimations derived from the LMM to the data from the experiment.

The present study indicates that adding a symbol showing the user's location on a map improves performance in the self-location tasks in nature environments and reduces the number of map–environment points accessed. These findings confirm that the positioning aid helps the user in solving the mapping problem (Oulasvirta et al., 2009) and in understanding the person–map relation (Liben & Downs, 1993). The effects may be mediated by the positioning aid improving the search for additional map–environment points and the evaluation of their relevance.

More specifically, the results from the present study suggest that the positioning aid guides the search for map–environment points and narrows the search area on the map. This theory is in line with the study by Schofield and Kirby (1994). In their study, subjects were shown a location on a miniature model of a landscape, and they were asked to show the location of a target on a topographic map. The reaction time was reduced when the search area on the map was reduced. According to a study by Willis, Hölscher, Wilbertz, and Li (2009), mobile map reading leads to a more fragmented and regionalized knowledge of the space than what can be achieved by reading a traditional paper map. Willis et al. suggested that the small screens of mobile devices might be one of the factors causing the "local" focus

of attention during mobile map reading. The present study also suggests that the use of the positioning aid might strengthen the local focus of attention in mobile map reading.

Furthermore, in the present study, subjects mentioned on average more than two landmarks while performing a pointing task. This finding, together with the findings by Aretz and Wickens (1992), signify that the two-point theorem should be considered as expressing the minimal computational principles that govern the process of self-location on a map rather than be a psychologically realistic description of how self-location is carried out. In their study, subjects were shown pseudo-maps displaying arbitrary symbols instead of landmarks and a view of an artificial environment. Subjects were able to connect the view to the pseudo-map fastest when only a few symbols were displayed on the map. As the number of displayed symbols increased, the more the reaction time increased.

The idea that the positioning aid narrows the search area on a map has implications for the design of mobile map applications. According to the present study, self-location on a map requires the user to search cartographic symbols located near the symbol plotting the subject's location on the map and relate them to the corresponding objects in the environment. However, in real-world map reading tasks, the user may need to switch quickly between multiple tasks (e.g., self-location and route planning). When the information requirements for the different tasks change, the user has to zoom and scroll the map to find the relevant information for each task. The manipulation of the map may cause an increased cognitive load to the user, especially when the maps are displayed on the small screen of a mobile device. Extrapolating, then, the present study suggests that combining large-scale and small-scale maps may help to reduce the cognitive load caused by the different map-based tasks. These kinds of approaches for mobile map applications have been implemented, for example, in the wired fisheye-lens map interface (Carswell et al., 2009) and in the variable-scale approach for small-display cartography (Harrie, L. T. Sarjakoski, & Lehto, 2002).

Even though the present study allows for drawing conclusions about the effects of the positioning aid on the cognitive processes involved in self-location on a mobile map, future research should take certain considerations into account. First, the results of the present study showed that the positioning aid had an almost significant effect ($p < .10$) on the time needed to perform self-location. Recruiting more subjects and gathering more data might increase the power of the statistical analyses. Second, the present study did not employ methods to record how the subjects manipulated the map view. Because the positioning aid might influence how users zoom and scroll the map, methods for recording these interactions with the mobile device are needed. Third, in the present study, the subjects' orientation in the environment was not controlled. Controlling the effects of orientation would ensure that a misalignment of maps with the environment does not influence the experimental data (Levine et al., 1982; Levine et al., 1984; Shepard & Hurwitz, 1984). Fourth, the present study showed that subjects' verbosity influenced the time needed to perform the pointing tasks. In future studies, it may be beneficial to control the effect of thinking aloud on subjects' performance. This may be done, for example, by using the retrospective think-aloud method instead of the concurrent think-aloud method. In retrospective think-aloud, the subjects are asked to verbalize their thoughts after they have performed the task. Using this kind of method would ensure that the time needed to perform the task is not dependent on the subject's verbosity.

CONCLUSIONS

The paper showed that even with the additional information provided by the positioning aid, the self-location process is governed by the search for map–environment points. The present study disproved the assumptions that the positioning aid either would not affect or would impair the map reading process. Furthermore, the study suggested that the positioning aid might guide the search for map–environment points and help users to determine their relevance for self-location. This effect may be especially significant in nature environments, where self-location is based on recognizing ambiguous landmarks (L. T. Sarjakoski et al., 2012).

The narrowed-search theory can be seen to have implications for the design of mobile map applications. For instance, because users concentrate more on the area displayed around the symbol representing the user's location, this area should be plotted in more detail than the remaining map area. However, because the field of human–computer interaction research on mobile map reading is still emerging, the present study and the implications drawn from it may serve merely as an initial step towards integrating cognitive research concerning map reading and the design of mobile map applications.

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