Balancing Human Agency and Object Agency: An End-User Interview Study of the Internet of Things

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ABSTRACT
Advances in the field of the Internet of Things (IoT) have made it possible for everyday objects to attain agency. However, it is unclear how laypersons perceive the increasingly active artifacts. These perceptions are likely to foreground their future responses to IoT objects as they become relevant actors in the physical world and begin to influence everyday user experience. We conducted an in-depth interview study to investigate individuals' knowledge, attitudes, expectations and concerns relating to IoT technologies. Findings show that affordances such as interactivity and modality can be reconceptualized in order to enhance user perceptions of relatedness with the objects. Different from technology-centric and user-centric approaches, the paper suggests a balance between human agency and object agency by adopting a need-oriented design paradigm when building an integral, self-adjusting, user-relevant archetype of IoT.

Author Keywords
Internet of Things, digital memories, object agency, user agency, customization.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human factors, theory.

INTRODUCTION
Over the last decade, IoT-enabled objects have steadily progressed from being passive to becoming agentic—actively capturing and storing data, communicating information among objects or with users, and offering suggestions to users. Given that they are equipped with digital memories, objects are able to react to communication scenarios within an environment [6], and complete daily routines [12]. While the objects start to possess increasing levels of agency, the question of coordinating the agency of both objects and human users becomes important. However, neither user agency nor object agency has yet been clearly defined in the field of IoT. More importantly, little knowledge exists about how individuals react to agentic objects. We respond to this by exploring end users' perceptions and attitudes toward IoT with a focus on user and object agency. In order to understand the coordination between technology-centric and user-centric approaches, we suggest several theoretical propositions. As an exploratory study, the current study attempts to offer a framework for balancing user agency and object agency in an IoT context, geared toward inspiring future studies and designs. We first define the two types of agency based on previous research on agency in human-computer interaction (HCI) and communication fields, then draw on the existing literature to discuss the relationship between the two, and finally support our argument with data from a series of interviews with end users.

Previous literature on agency mainly focuses on discussing human agency in terms of the capacity to exercise control over processes, motivation, action, and environment [1]. Scholars of communication technology have contrasted machine agency to personal agency. Personal agency or user agency is defined as "the extent to which the self serves as the source of communication" [10], which can be exemplified through information-filtering processes such as customization [7]. On the other hand, systems, interfaces or objects can be perceived as information sources that automatically communicate and perform tasks, hence possessing a certain level of machine agency. The former has shown significant impact on user experience with communication technology in a number of studies, whereas the effect of the latter has not been fully understood.

User perceptions of machine/object agency are closely associated with the innate human tendency of anthropomorphism [8]. Scholars [4] suggest that, over time, inanimate things, even those that do not have an information function (i.e., furniture), start to seem like social actors, and serve as mediators between individuals and the world surrounding them. According to the Computers as Social Actors (CASA) model [9] and the associated tendency of source orientation [11], an IoT-enabled object is likely to be perceived as a social actor and as the source of the information that it transmits, which leads to perceived machine agency as well as evoke the schema of human interaction.

On the face of it, the two types of agency seem conflicting: Object agency, operationalized in terms of information

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filtering and system suggestions, might hinder individual freedom and voluntarism. However, given that objects may be perceived as social actors, if designed wisely, an emotionally intelligent object can provide the individual with a sense of warmth and caring, leading to a heightened sense of relatedness between oneself and the object, which, according to the Self-determination Theory [3], can serve to increase the user's intrinsic motivation to interact with the object. Social Cognition Theory also proposes one mode of human agency, called "proxy agency," which can be exercised by getting others with resources or expertise to achieve one's own goal [1]. That is to say, as long as the internal locus of causality is secured (e.g., through cueing a sense of self), object agency can be internalized as part of the individual's own power.

Therefore, we propose that, by including human input in the process, or even by highlighting self-related cues, IoT designers could balance human agency and object agency, as well as enhance both of them at the same time. As shown in one of the previous studies [3], the increase in both types of agency can result in improved interactions as well as user experience. To examine this proposition, we conducted an interview study that asked individuals their perceptions of IoT technologies, with a hope of understanding the perceived conflicts between user agency and object agency.

METHOD

An in-depth interview study was conducted in Fall, 2011 to investigate 1) users' familiarity and experience with IoT, 2) evaluations of existing IoT applications, 3) concerns and issues, and 4) expectations of future innovations in IoT technologies. A total of nine participants were recruited through a University research website. They all identified themselves as "tech-savvy" and showed an interest in keeping up with new technologies. Specifically, eight participants reported having at least one mobile device (e.g., a smartphone and/or tablet computer), and three participants identified themselves as power users who constantly upgrade their technological devices. At the beginning of each interview session, the concept of IoT and a sample of IoT technologies (e.g., real-time bus location tracker, supply chain management, etc.) were briefly introduced by the interviewer in order to give participants a general idea. Participants were asked to talk about their experience and opinions regarding these technologies or similar ones. After that, the participants were showed a 2-minute video clip excerpted from *The Internet of Things* (downloadable at http://www.youtube.com/watch?v=sfEbMV295Kk; from 0'40" to 2'40") envisioning the future of IoT. Participants' reactions to the video clip were gathered with follow-up questions such as: "For technology that enables objects to communicate without human interference, what are some of the things that researchers and designers should think about?"; "Do you have any concerns about these technologies?"; etc. Interview notes and transcripts were later analyzed to identify patterns in users' perceptions towards IoT.

RESULTS

The results from the interview sessions revealed that all participants had heard of smart objects or IoT applications of some kind, and many had direct experience with the technologies. In general, their attitudes were positive towards IoT conceptualizations, but they expressed some discontent and concerns especially towards current models, especially regarding the limited opportunities of exercising agency. According to our participants, addressing human needs and their daily problems as the ultimate goal is a way of highlighting human agency in the course of developing and designing IoT technologies. We are reporting in this section the key findings regarding the perceived advantages and flaws of IoT as well as design suggestions.

Our interviewees shared an anthropocentric understanding of IoT technology as a novel means to monitor and record the surrounding environment for humans to examine and analyze. They thought that such technologies should be integrated into the devices that they already use daily, such as smartphones. They strongly opposed the current conduct of replacing existing objects with new ones equipped with IoT technologies for the sake of accessing data and enabling interconnectivity. One participant used her Nike Plus shoes as an example: "It would be nice to have some type of technology (that) you can put into whatever type of shoes you have, so that *these* shoes can automatically track your running on the road." A uniform preference of embedding the IoT technology to existing platforms or interfaces shows people's tendency to both stick to familiar products and decide on the exact object with which that they would like to interact.

The need for an integrated interface for all sorts of IoT technologies resonated as a theme across our participants. It is not simply related to the user dictating their choice of object or interface, but also related to usability concerns. Most interviewees expressed doubts about the extent to which the IoT innovations from various developers could all be integrated into a cohesive entity or a comprehensive interface. The lack of integrability or interoperability in IoT applications may severely harm the usability of these applications and result in negative effects on user's self-efficacy, a fundamental factor for feeling agentic.

More importantly, these integrability viewpoints reflected the users' perception of IoT technology as a sort of add-on functionality to an existing interface rather than developing separate interfaces for each object. In other words, they do not yet see the potential in IoT objects to act as independent interactants with their own level of agency. However, this kind of consensus was found detrimental to user experience with IoT technologies--one interviewee specifically expressed frustration at the developers' tendency of "adding everything to everything" without a semantically meaningful purpose. Some participants described IoT as a technical overlay, and thought of the IoT-enabled objects as "gimmicky toys" if the additional function is inconsistent

with the objects' inherent capabilities. This worry of "adding everything to everything" perhaps underlies participants' call to adopt a problem-solving and need-gratification approach: "Designers should think about what things should be connected as well as what things should not (be connected)… (The rule is that) they should think about the problems that *we* face in our daily lives, and how they (the IoT technologies) could make it easier."

On the other hand, the interviewees noticed that IoT-enabled objects and things showed some level of agency, and were generally concerned over the thought of objects and things being "agentic" or even "dominant." The major issues that they brought up included potential privacy breaches and security risks. Given that the information transactions would be wireless, automatic, and hardly noticeable, our interviewees felt incapable and vulnerable when it comes to control or maintenance of their personally identifiable data in the data collection and data transaction process. The distrust lies in the automaticity of the technology as well as the relative invisibility of its manufacturer or developer. Participants were also wary of system failure as more and more objects become connected. They expressed their worries that humans might become highly dependent on the assistance of the IoT-enabled objects, and therefore, whenever there is a malfunction, it could lead to a far-reaching collapse.

Is there a solution to the conflicts between user agency and object agency, as well as the accompanying concerns over privacy and security? If we adopt a need-gratification approach, how should we identify the existing or foreseeable needs, and how do we design IoT technologies to meet these needs? The interviewees pointed out the possibilities of personalization and customization. One participant suggested that to better serve human needs, future IoT technologies should be "customizable, depending on personal needs or wants." Another interviewee hoped that IoT technologies "can be designed (with elaborate customization features) so anyone can create anything they need out of it." Interviewees largely supported the idea of customizable features that can afford user control. For example, one participant said that she would like to have "more control (of the technology)"; the controllability discussed here can be understood as a psychological outcome of customization.

While most of the interviewees called for a "user-centered" approach to IoT design and expressed their desire for exercising their own agency by using customizable features, the following two caveats were noted: Firstly, participants deemed it important to have some default set-up to start with. Personalization, therefore, would be a desirable feature for novice users. In other words, the IoT-enabled objects should by default be set up to meet general demands of users before offering advanced customization features for experienced users. Secondly, too much effort in specifying preferences can be undesirable. Instead, participants were hoping that objects and things could be *intelligent* enough that they would memorize user preferences from mundane interactions and self-adapt rather than depend on user's purposeful customization. One analogy that some participants suggested was the E-ZPass system that can automatically complete a transaction fulfilling the needs of the customers and requires minimal input from the user.

Though doubtful and worried, all of the interviewees showed a great level of anthropomorphic tendency, describing the perceived intelligent objects as "assistants" or "helpers" to human beings. They also demonstrated a high level of excitement at the futuristic notions of IoT; one said that he cannot wait for the "gamified world" where the visual and the physical are seamlessly combined.

DISCUSSION

Our findings reflect the overall concern over object agency competing with or replacing human agency ("machines taking over the world"), thus signaling a subconscious desire for exerting their own agency. At the same time, participants expressed their desire for IoT objects to be helping assistants with self-learning capabilities. It seems that, as long as the IoT technologies serve human needs, interviewees showed consistently positive reactions to popularly available examples or conceptualizations of IoT.

Our interview data are not necessarily conclusive or representative, but they showed a tendency among individuals perceiving themselves as agentic as long as the agentic objects satisfy their needs, as we predicted. Our interviewees envisioned a symbiosis of agentic humans and agentic objects with shared goals. This is consistent with the notion of proxy agency: the degree of relatedness that one perceives in agentic others (in this case, the objects) is likely to result in heightened personal agency, and hence, a more positive user experience.

In order to enhance the perceived relatedness in a human-object interaction, interfaces affordances can be devised to imbue a sense of care and warmth. For instance, interactivity has been shown in previous literature as well as in our interviews as a fundamentally important affordance. Different from the notion of interactivity in traditional HCI literature, an interaction between an individual and a network of objects is comparatively more invisible and ambiguous. A self-managing, -adapting and -maintaining system needs to provide visual cues of interactivity--that it "learns" from, adapts upon, and coordinates with user actions.

This conceptualization of interactivity also leads to a rethinking of interaction modalities. Users seem to favor an existing interface with which they are already familiar (i.e., a smartphone). However, IoT can adopt much more intuitive modalities such as body movements and other natural actions. The E-ZPass example illustrates their preference of minimal user input. In this case, the routine

behavior, driving through the toll booth, is taken as an input to the system. Similarly, any everyday movement can be considered as an input modality, while the meanings are analyzed and processed semantically in order to trigger information transactions.

In sum, the development and the design of IoT need to address highly idiosyncratic user needs, both habitual and at-the-moment ones, through affordances such as interactivity, customization and modality. Most importantly, object agency needs to be congruent with human agency by making the invisible and unconscious user input more visible to the users and more relevant to the interactions.

LIMITATION

Admittedly, a major limitation of the current study is the relatively small sample size, which might limit the extent of generalizability and predictability. However, these empirical findings can serve as groundwork for future user research and experimental studies (e.g., experimentally examining user and object agency on a specific IoT technology). We expect to see IoT research testing the prototypes that balance the emerging object agency and the long-existent human agency. Meanwhile, it has to be noted that IoT is still a highly conceptual notion to our "tech-savvy" interviewees. As more IoT technology becomes available for consumer use, we expect better-informed opinions from the end users in interviews like this and to reveal more challenges such as designing IoT technologies that cater all levels of user skillsets.

IMPLICATIONS AND FUTURE WORK

Our study has drawn from communication, cognitive psychology, HCI, and IoT literature, to define the core concepts of human agency and object agency in the IoT context. The findings from the end-user interviews have supported our preliminary expectations and suggest broad design guidelines for developing highly proactive objects with affordances that highlight user involvement and user control. Future research in this area should take into consideration the two types of agency and empirically test the propositions from this study, either by conducting interviews or surveys with a significantly larger sample, or preferably, by conducting an experimental study. More work needs to be done before a full understanding of the effects of agentic objects can be achieved. Researchers may consider the redefined notion of customization and personalization as well as the psychological variables emerging as important factors in this study, including self-efficacy, user control, and relatedness. Individual characteristics and contextual differences also need to be considered in the discussion of agency. Developers and designers would be well advised to reconceptualize and redesign affordances relating to interactivity and modality with an eye toward assuring or reinforcing human agency, even as they make greater strides toward building object agency into IoT applications.

REFERENCES

1. Bandura, A. Social cognitive theory: An argentic perspective. *Annual Review of Psychology 52* (2001), 1-26.
2. Criel, J., Vanderhulst, G., Kawsar, F., and Trappeniers. L. A co-creation platform for creative engagement of end-users in a connected object space. In *Proc. NoME-IoT '11*, ACM Press (2011), 9-14.
3. Deci, E.L. and Ryan, R.M. The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry 11* (2000), 227-268.
4. Gulati, V. *Thingbook:* A user created Internet of Things. https://webfiles.uci.edu/vgulati/ThingBook_GulatiVrishti.pdf
5. International Telecommunication Union. *Internet report: The Internet of things*. http://www.itu.int/osg/spu/publications/internetofthings.
6. Kröner, A., Brandherm, B., and Schneider, M. Investigating communication needs of digital object memories for user interaction. In *Proc. NoME-IoT '11*, ACM Press (2011), 15-16.
7. Marathe, S. Control and agency customization video games: A theoretical approach to learning outcomes. *International Communication Association* (2008).
8. Nass, C., Lombard, M., Henriksen, L., and Steuer, J. Anthropocentrism and computers. *Behaviour and Information Technology 14*, 4(1995), 229–238.
9. Nass, C., Steuer, J., and Tauber, E.R. Computers are social actors. In *Proc. CHI '94*, ACM Press (1994), 72-78.
10. Sundar, S.S. Self as source: Agency and customization in interactive media. *International Communication Association* (2006).
11. Sundar, S.S., and Nass, C. Conceptualizing sources in online news. *Journal of Communication 51*, 1(2001), 52–72.
12. Tollmar, K. Dual media design: Sharing memories through digital object. In *Proc. DOME-IoT 2010*, ACM Press (2010).