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# Ethical and normative issues in shared augmented reality.

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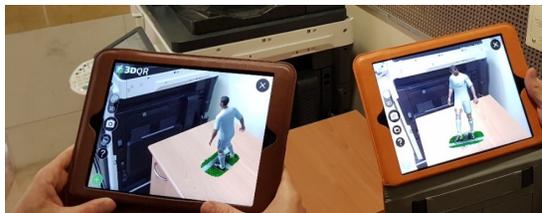
## ABSTRACT

Novel technologies enable new forms of human interaction, often challenging existing norms of social behavior. We describe our initial findings on normative tensions and ambiguities emerging when the participants interact in shared augmented reality social spaces and propose future research directions. In particular, our analysis revealed users' concerns over the preservation of their self- and social identity, as well as concerns related to personal space and the sense of psychological ownership over one's body and belongings when interacting in social augmented reality environments. In addition, we demonstrate that users develop increased feeling of relatedness and psychological ownership to the virtual artefacts in an AR environment compared to a conventional virtual environment. This finding highlights the importance of the "real" physical layer in shaping users' perceptions and outlines possible ethical issues that may arise in the design of AR experiences. Our findings point to the need for regulation and design of control mechanisms of shared AR technology and spaces.

**Keywords:** ACM proceedings; shared augmented reality; psychological ownership; relatedness; social norms; ethical issues

CHI'19 Extended Abstracts, May 4-9, 2019, Glasgow, Scotland UK

Proceedings of the 1st Workshop on Challenges Using Head-Mounted Displays in Shared and Social Spaces.



**Figure 1: an example of shared AR**

## 1 INTRODUCTION

Shared AR applications (e.g. Figure 1) involve social interaction between users, thus making social norms of behavior a critical factor to consider. For example, the shared AR based social network WallaMe allows its users to superimpose images and graffiti on the physical surfaces. These virtual elements then become visible to all users of the application looking at these places. In the popular AR game of Pokémon Go, users can interact with each other, competing or collaborating in augmented reality battles in a collocated physical environment.

Durham University's Robert Seddon writes in his piece in *The Conversation*: "The design of physical environment carries intent, from statues telling us about notable people to walls obliging us to keep out – but AR adds an extra, optional, transformational layer, and it makes changing the meaning of that layer merely a matter of switching between apps" [14]. Previous research discovered that AR environments have power to elicit affective reactions, both positive such as empowerment and inspiration [8], and negative, such as unfairness [10], shame [1,16], or loneliness [9].

We posit that the unique ability of AR to interfere with the physical environment, as described by Seddon, could potentially lead to social tensions when AR becomes shared among multiple users, who will be able to see and engage with virtual artifacts created and/or left by others. What may seem rude or tactless in traditional social environments may be perceived by some as normal and acceptable [3]. We are concerned that the effortless creation and attachment of virtual augmentations in public spaces may produce an unwarranted environment that can lead to tensions over acceptability, responsibility, and control. Moreover, attaching socially unacceptable or simply unwanted virtual elements to one's private belongings (or even body) may cause personal distress and interaction avoidance.

Because in AR the virtual object is represented as if it exists in the physical world, the users may perceive it as if it possesses some degree of "physicality" or "materiality." Consequently, they may relate to it as more physical than virtual, assigning it a social or personal emotional value that they would never attribute to the virtual object that is represented on top of a "conventional" virtual background. These effects will probably be enhanced, considering that future AR interactions will likely occur in the context of always-on head mounted displays.

Even in today's online environments (such as online MMO games, virtual communities, and immersive VR environments), users engage with their virtual possessions [5,7,11,15] and (mostly) interact with them in accordance to their understanding of what is acceptable and unacceptable in the real world [17]. In AR, the users may develop even stronger emotional relatedness and feeling of ownership over the virtual objects and relate to social normative acceptability much more acutely.

This increased intensity of relationships between the user and her virtual possessions in AR spaces calls for the considerations of ethical design and incorporation of existing socio-normative platforms into



**Figure 2.** The three scenarios used in the experiment. (a) **Body:** a virtual mask was aligned with the space-proprietor’s face; (b) **Home:** virtual dogs were released in the living room of the space-proprietor ;(c) **Possessions:** a virtual item was placed on top of the space-proprietor’s possession (bag).

Scenarios	BODY	HOME	POSESS
Concerns			
Personal Identity	Med (13)	Low (6)	Med (11)
Social Identity	High (27)	Low (2)	Med (19)
Personal Space	High (39)	High (37)	Med (14)
Ownership	Low (6)	Low (2)	Med (16)
Requirements			
Design for Control	High (54)	High (40)	High (40)
Regulation	Med (15)	Med (13)	Med (10)

**Table 1: Extent of participants’ concerns and requirements (and number of comments) for each of the three scenarios as extracted from the qualitative analysis. 2-10 comments were interpreted as “low,” 11-20 as “medium,” and over 21 comments as “high.” The darker color of cells is associated with higher levels of**

future AR experiences. For example, the increased psychological ownership that the users may experience toward their virtual possessions in AR will potentially cause some existing design choices to become unacceptable. As the first step, we call for identifying the normative "points of tension" where the violation of the social conduct is especially at danger.

## 2 PRELIMINARY WORK

In an initial study [13], we began to explore what social norms are threatened within a shared AR space. We conducted a user study simulating several possible social interactions between pairs of participants around AR artifacts whereby one participant (object creator) created a virtual object and placed it over another participant’s (space proprietor) body, physical space, or belonging. Figure 2 presents the three scenarios that we used in the experiment. Participants’ perceptions were measured through surveys and interviews. Our findings indicate that creating, seeing, and interacting with virtual objects that are attached to physical anchors, such as one’s body, objects, and environment, may disrupt users’ feeling of identity, as well as potentially threaten people’s feeling of personal space and ownership towards the physical objects. Table 1 presents the level of participants concerns in each of the scenarios (BODY, HOME, POSSESSIONS) ranging from *low* to *high* for each of the identified social norms.

Asking the study participants how they think the identified normative ambiguities and tensions should be addressed on practice produced several commendations. Most participants expected that substantial ownership rights should be assigned to the proprietor of the physical space, rather than to the creator of the virtual object. In addition, The participants required the existence of clear authorization and control mechanisms and regulation of what is permitted to perform/create in shared AR environments. In a second study [12] we aimed to increase our understanding of the psychological mechanisms that govern interactions in augmented reality settings. In particular, we were interested in the way in which users develop relationships with their virtual possessions. This study adopted the theoretical lens of material culture and the psychology of possessions [2,4,6] and sought to develop a conceptualization of meaning and ownership over virtual objects in AR. To that end, we conducted an explorative study in which participants cared for a virtual dog over a three-week period. Half of the participants interacted with a virtual dog superimposed onto the physical reality in AR using the camera of their mobile device, while the other half had the dog displayed on the screen of their phone, lacking the grounding of a physical background (what we called VE - virtual environment - mode). Apart from viewing the dog in AR or screen-based mode, the functionality of the app was identical. Figure 3 demonstrates the main screen of the application, in which the participant interacts with the dog first in VE and then in AR mode.



**Figure 3a and 3b. The view of the application with the virtual dog represented in VE mode (left) and AR mode (right).**

We used questionnaires and semi-structured interviews to capture participants' perceptions of the experience, employing thematic analysis to analyze the interviews. Our findings indicate key differences in perception of the virtual dog between those who interacted with it in AR mode and those in a traditional fully-virtual 2D mode. Specifically, we found that raising a virtual pet in AR mode caused the participants to perceive the dog as an "authentic" or "real" being [12]. These participants also developed stronger feelings of relatedness and psychological ownership than the participants in a non-augmented environment demonstrating the power of AR to induce an emotional connection and foster the relationships between users and their virtual possessions.

### 3 FUTURE RESEARCH DIRECTIONS

We plan to build on our preliminary work and extend it in several important directions. First and foremost, our studies so far are done in the mobile AR setting. This fact presents a serious limitation to the generalizability of our findings. The participants have to hold the mobile device in their hand and thus are restricted from more natural interaction techniques using as two-hand manipulation of the object. Moreover, the virtual layer is not persistent - it is visible only when the user points the camera toward the object. Using a HMD as the primary driver of the AR experience will not only enable us to address these limitations, but also to compare these two modes of interaction.

In addition, we would like to:

- examine other social norms such as sharing, public use of artefacts and exposure.
- Improve the experimental designs to make scenarios more realistic (for example, in the ownership study, introduce a pre-study intended to allow the creator of virtual objects to develop a deeper sense of ownership over that object).
- Employ a multi-method research methodology, measuring participants' reactions through a variety of approaches (questionnaires, diaries, interviews, and log analysis).
- Perform more targeted experiments, with prototypes specifically developed for the purpose of the studies.
- Loop back the findings into design modifications, involving industry and ethics experts.

As AR technology advances, more and more applications apply AR settings. Furthermore, social interactions are increasingly possible in and around AR. Understanding how social norms play out in an AR-rich social environment will lead to more informed designers, as well as potentially more aware and considerate designs.

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