Impact of Location-based Augmented Reality Games on People's Information Behavior: A Case Study of *Pokémon GO*.

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Abstract
Location-based augmented reality games, blending the reality and virtual world, are becoming increasingly popular. We aim to improve our understanding on how these new types of games will impact people's information behaviors in both physical and virtual places, specifically investigating the case of *Pokémon GO*. We conducted over 100 hours of field observation of *Pokémon GO* players in numerous public places and also monitored over 200 online communities related to the game, in addition to conducting interviews of 30 players. Our key findings include observation of the emergence of ad-hoc information grounds in physical spaces where much of the information sharing occurred, as well as a crowdsourced data-driven approach in problem solving and information sharing in online environments. We discuss the common types of information sharing that occur in both of these environments in detail, and identify areas for future research.
Keywords: Location-based mobile games; Augmented reality games; *Pokémon GO*; Information behavior; Information ground
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1 Introduction

Pokémon GO, a location-based mobile game launched in July 2016, became the most downloaded app in the history in its first week (Dillet, 2016). *Pokémon GO* is the first widely popular mainstream augmented reality game (ARG), which blends reality and virtual world through its gameplay. With the growing popularity of ARGs, there is an increased urgency to understand the types of actions people will take to meet the goals of the game. Since the launch of *Pokémon GO*, numerous issues regarding safety, privacy, ownership of virtual space, and tension between players and non-players have emerged. However, many of these questions regarding the implications of the increased prevalence of ARGs are yet to be answered. In our work, we seek to understand how these new kinds of games impact our behavior in real life. We specifically aim to answer the following research question: *How does ARG gameplay affect people's information behavior in both physical and virtual places?* To answer this question, we conducted user interviews and observed *Pokémon GO* players in various public places and online communities. This work reports the preliminary results obtained.

2 Relevant Work

2.1 Augmented Reality Games (ARGs)

Pokémon GO is usually called an ARG, a term which has become intertwined with mixed reality (or hybrid) game (a game with digital and real-world components) and location-based mobile game (LBMG: a game dependent on player location) (de Souza e Silva, 2008). ARGs can also use GPS satellites to afford highly accurate positioning information. Some argue that *Pokémon GO*, with no precise 3D representations of its hybrid reality, fails to exhibit all characteristics of augmented reality (Azuma, 1997); nonetheless, the ARG label has taken hold within the gaming community. *Pokémon GO* is also a massively multiplayer online (MMO) game, as all players are simultaneously participating in one global game environment, and network access is required for play (Yahyavi & Kemme, 2013). In *Pokémon GO*, players locate and catch Pokémon (virtual creatures) that appear in real-world locations. Three player factions use captured Pokémon to battle for control of virtual Gyms, which are mapped onto real-world locations. PokéStops are locations that allow collection of game resources. While Gyms and PokéStops are permanent virtual features, "wild" virtual creatures are subject to game mechanics that govern the location and frequency of their availability.

2.2 Information Sharing in Location-based ARGs

While ARGs provide some level of game data and often afford basic player communication, systems for sharing game information arise in communities of players. Participation in game-centered virtual communities grants access to persistent, pervasive game support (Hampton, 2016) and allows knowledgeable experts to build social capital among community members (Faraj, 2005). Software developed by players can use game API and crowdsourced data to surface new game information. Message boards, email lists, Facebook communities, and mobile apps allow players to communicate and coordinate future play. Location-based play affords opportunities for real-world communication, accidental or intentional, as players are drawn to important game locations or form organized groups.

One vital type of information sharing concerns player safety. These games encourage players to move around in the real world, and some players will explore unfamiliar and potentially unsafe environments. Play can even lead to travel with practical strangers. In addition, location-based game servers track and can reveal player positions to others (Hulsey & Reeves, 2014). Player actions, such as controlling Gyms, can inadvertently expose player location and behavior. Player communities thus often share information on safe play and threats (Blasiola, Feng, & Massanari, 2016).

3 Study Design and Methods

We employed field observations and interviews as our primary research methods. In addition, all authors downloaded and played *Pokémon GO* since its launch to fully understand the gameplay mechanics and features. We tried to fully experience the gameplay by visiting "hotspots" for playing *Pokémon GO* and setting lures at PokéStops to attract Pokémon in local neighborhoods and observe its impact.

We conducted field observations of *Pokémon GO* players across multiple public contexts, both physically and virtually: public places[i] such as university campus, local area parks, urban parks (e.g., Central Park in NYC), stadiums, and shopping centers, *Pokémon GO* specific events (e.g., CenturyLink Summer Nights), small towns with populations less than 20,000 (e.g. Brawley, CA; Sandpoint, ID; Bozeman, MT), and game-related events (e.g., San Diego ComicCon, PAX). One of the authors visited Sokcho, one specific city where *Pokémon GO* could be played in South Korea (Hancocks & Kwon, 2016). We recorded audio memos of the observations for at least 3-4 hours at each site. Altogether, over 100 hours were spent observing *Pokémon GO* players from July 6, 2016 (date of game release) to September 5, 2016. We also joined over 200 different local *Pokémon GO* online communities in order to observe interactions among community members and understand their communication and information behavior.

Additionally, we interviewed 30 *Pokémon GO* players, recruited at game-related events and via various *Pokémon GO* Facebook groups. Participants had to be at least 18 years old and have played *Pokémon GO*. We employed a semi-structured interview; the interview protocol[ii] contained 27 key yes/no and open-ended questions asking about the player's gameplay experience and perception of the game, opinions on safety and privacy issues related to the game, their identity inside and outside of the game, their connection with local community and other players, and use of information tools and technologies, in addition to seven demographics questions. Most interviews lasted approximately 20 minutes and participants received no financial compensation.

4 Findings and Discussion

4.1 Emergence of Ad-Hoc Information Grounds for Information Sharing in Physical World

While it is possible to play *Pokémon GO* anywhere around the world where it was released, we observed specific public places emerging as "hotspots". We use the term "Information Ground" to describe this phenomenon. Pettigrew (1999) observed how multiple contextual factors including the physical environment, individual's situations, and activities led to the conceptualization of "information ground," defined as "an environment temporarily created by the behaviour of people who have come together to perform a given task, but from which emerges a social atmosphere that fosters the spontaneous and serendipitous sharing of information" (p. 811). Pettigrew (Fisher) (2005) states that information grounds can emerge anywhere at any time, but people are gathered for a primary purpose other than information sharing. Various social types attend and their interactions are a primary activity from which information flow occurs.

4.1.1 Characteristics of information grounds in *Pokémon GO*

Safe space. A wide variety of players of all demographics in all relationships (e.g., solo, family, friends, co-workers) gathered to play in a safe space. One such space was Bellevue Downtown Park (Figure 1,

left). These places resemble the characteristics of the "third place", a publicly accessible place without membership or exclusion that is lively, engaging, inviting, and has a persistent playful mood (Oldenburg, 1999). As one of our interviewees (P17) stated:

> *"There is [sic] all different age groups, all different races, all different backgrounds. I went to the beach at midnight to 1:30 in the morning once, and I have never seen so many people at the beach at that time before. And they were all friendly to each other and they were all playing together. It reminded me of what Woodstock must have been like."*

Figure 1. *Pokémon GO* players at Bellevue Downtown Park (7/23, 8:44pm) [Left] and University Campus (7/15, 1:43pm) [Right]

These hotspots also had enough active players to preserve their anonymity; when everyone is yelling and running to catch a rare Pokémon, it is easier to blend in. Some of the places had very social, festive atmospheres with people carrying Pokémon toys, playing Pokémon music, wearing Pikachu outfits, and cosplaying. This safe space seemed important, as some of the authors experienced firsthand some negative and aggressive behavior from non-players mocking and condemning *Pokémon GO* players. The original purpose of the place also seemed important. Even though the University of [hidden for blind review] has a similar physical setup as Bellevue Downtown Park (round fountain, flat layout of space, lack of obstacles) we did not observe the same festive atmosphere as the local downtown park (Figure 1), most likely due to the university campus serving academic purposes. Safe spaces also meant family and friends socializing. In the small town of Sandpoint, ID (pop. 7,365), players expressed positive sentiment about City Beach, a PokéStop-dense park location not far from the center of town. Interviewee P20 noted:

> *"Everyone comes here to play, because this is where the most PokéStops are, plus there are a lot of water Pokémon. If you're going somewhere to play with friends or meet up with people, this is it".*

Ad-hoc in nature. What is unique about these *Pokémon GO* information grounds is that they are established based on the number and concentration of PokéStops and people in any public places. Some would be possibly dissolved until the next occurrence of the relevant event (e.g., ComiCon).

Game design elements. Game design certainly has an impact. For instance, the concentration of PokéStops and Gyms in specific places increases player numbers. The types of Pokémon spawning at the venues also matter; venues close to water would often attract water-type Pokémon, such as Dratini or Magikarp (which evolve to some of the strongest Pokémon in the game).

Layout of the physical space. Physical environmental factors had an impact on players. For instance, the circular, flat layout of the space and a lack of obstacles facilitated the movements of hundreds of people in Bellevue Downtown Park (Figure 2, day and night time), in addition to external factors like access to public parking, dense urban location, lights at nights, and access to noise free ordinances.

Figure 2. Bellevue Downtown Park Daytime (8/20 2:36pm) [Left] and Nighttime (7/23 8:37pm) [Right]

Climate and weather dependent. In the small town of Brawley, CA, daytime temperatures reached 120F, and the town plaza was mostly empty at this time. However, after the sun set and temperatures dropped, hundreds of people converged on the plaza. Many groups of people, including families with children, stayed for hours. Up to 200 players came between 8:00 pm and midnight.

4.1.2 Information sharing in the physical space

Much of the shared information focused on gameplay; players discussed rumors about future updates, tips for effective play, regional differences in Pokémon availability, personal gameplay experiences, and on-the-fly "theorycrafting" to experiment with the underlying game mechanics. We also observed people gathering around specific players, paying attention to the information shared. These players also reached out to other players, eager to share helpful information. Players also socialized about a particular sentiment about catching or losing certain Pokémon, sharing Pokémon locations, and acknowledging Pokémon-related gear. Interestingly, random children also approached the authors asking about the game, despite being complete strangers.

Another type of common information sharing was calling out rare Pokémon appearances. This resulted in a massive crowd of people running and gathering at the particular spot to catch the Pokémon. Players also "trolled" and deceived other players by making false calls. Karlova and Lee (2011) discussed three different types of cues for recognizing disinformation: physical, verbal, and textual cues. For *Pokémon GO* players, a mix of physical and verbal cues became important. Cues used to identify a legitimate call included a bigger group of people gathering at a faster pace, multiple voices calling out the same Pokémon from different groups, and drones hovering over one particular location. Fake calls were immediately discounted and accurate information was shared to prevent people from gathering. Of the

many trolling attempts we observed, the most successful ones were when no Pokémon was identified and a group of people just started running to a particular location. Lack of information (rather than false information) could not be disputed by other players, resulting in larger numbers of deceived players.

4.2 Distributed and Data-driven Approach in Online Information Sharing

4.2.1 Collaborative efforts for collecting, sharing, and verifying information

Cheating was one of the most frequently observed negative behaviors. Numerous posts showed players bragging about their “spoofing” (digitally falsifying player location) or “botting” (automating game play) based on multiple reasons (Figure 3). However, community policing efforts also emerged through these local online communities. Within two weeks of game launch, players began organizing and reporting such suspected activity, typically including screenshots of suspicious circumstances. A common pattern we observed were players posting screenshots of Gym full of similarly named players with very high level Pokémon. This sharing motivated local players to specifically target that Gym and remove the suspected cheaters.

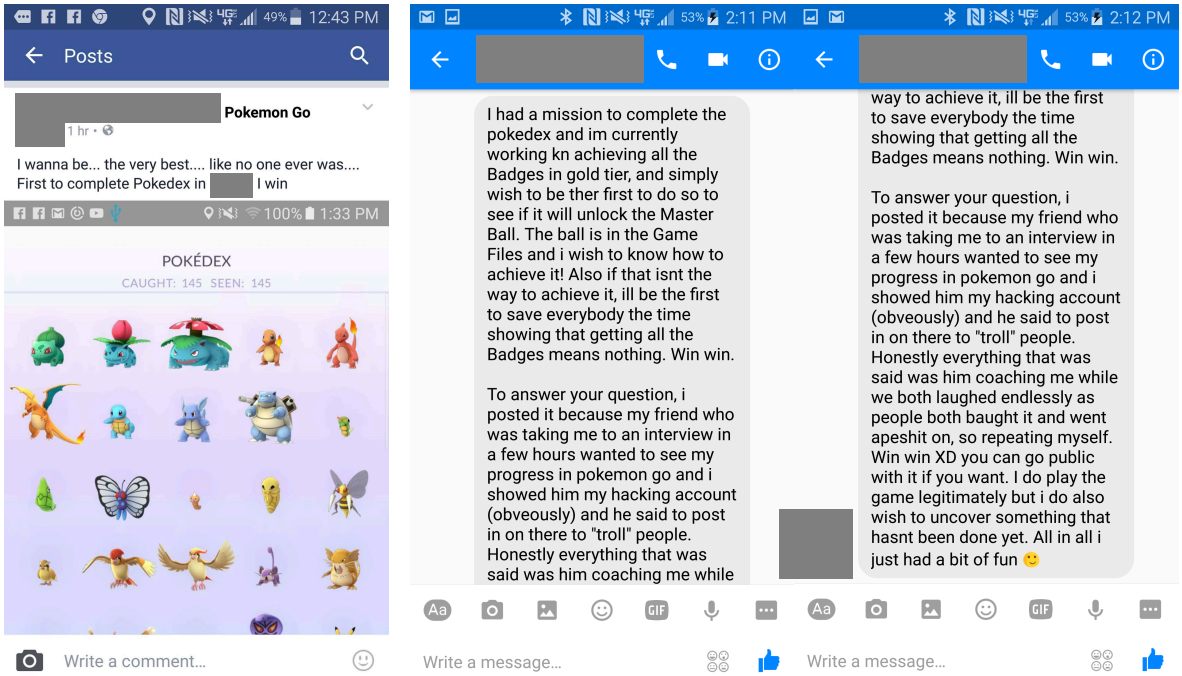

Figure 3. Example of a Post and Correspondence (Aug 10, 2016) from a Player Using a Bot

The lack of information from game developers on certain game design elements also encouraged active testing and validation of multiple “theories”. For example, questions occurred about the possibility of hatching region-specific Pokémon in other regions. Ambiguous sources of information, such as a popular egg hatching guide and deceptive messages resulted in massive player confusion. Eventually the Reddit *Pokémon GO* community initiated a project to crowdsource egg hatching results (Weinberger, 2016). The project resulted in 40,507 egg hatching observations, zero of which produced a region exclusive Pokémon from outside of the area. This lead the organizers to pronounce “region-locked Pokémon do not hatch outside of their region”. The “distributedness” of the information sharing seemed to support the validity of information since any one person could easily falsify the evidence.

Another example of crowdsourced data projects is curated Pokémon nest maps, which are locations of where a specific type of Pokémon is frequently and reliably found. One example of this type of project is the Pokémon Nest Locations Google Map (Figure 3, top), a global map with many nest and spawn locations plotted by users. An example of a curated map of a smaller local area made by local players is the *Pokémon GO* London Nest Map 2.0 (Figure 4, bottom). Many players contribute to these geospatial datasets, collectively playing across a very large area, and reporting observed and suspected nests for the benefit of the entire player base. This form of collaboration and information sharing is unique to *Pokémon GO*, made possible by the relevance of real-world locations in the game.

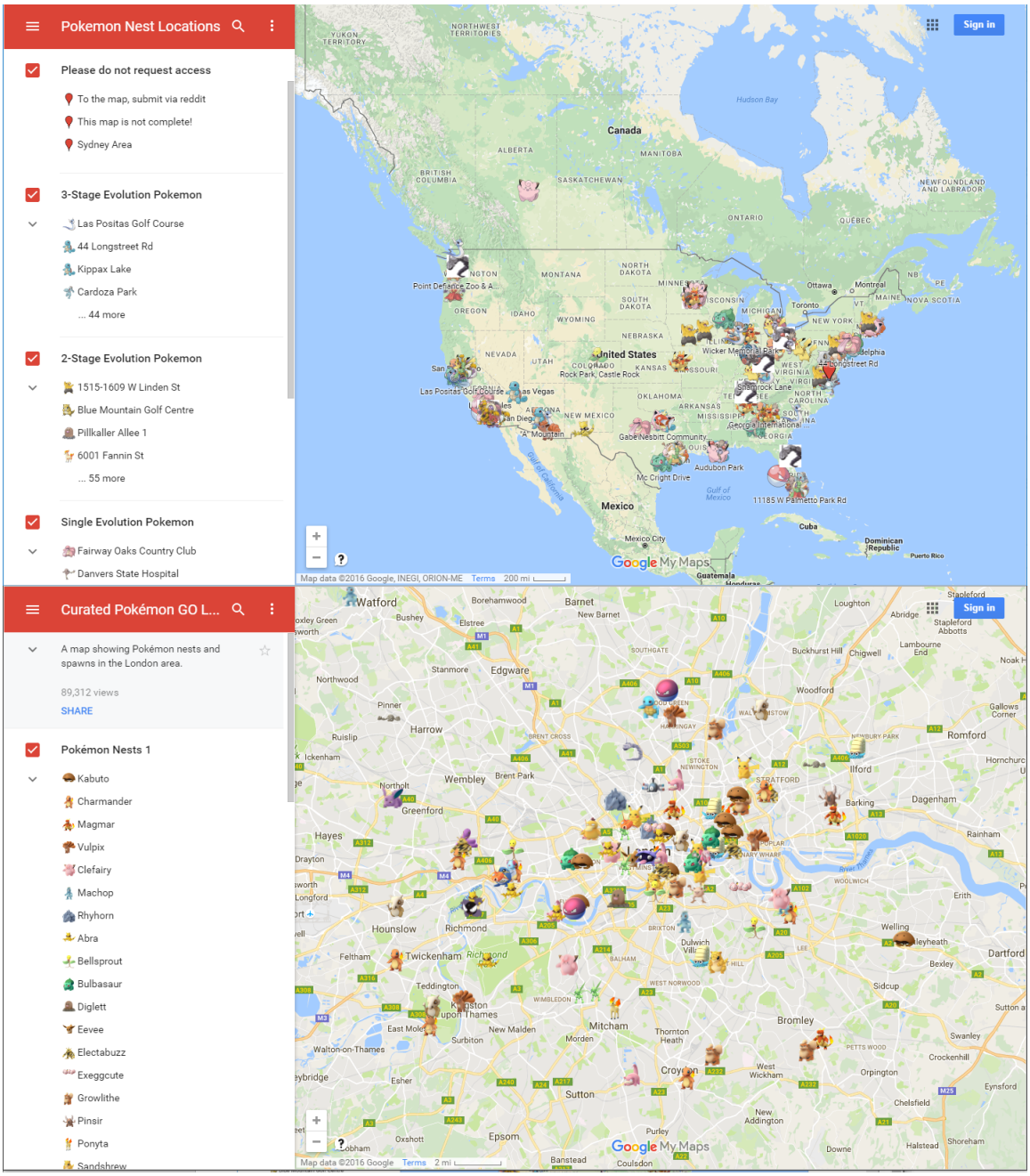

Figure 4. Pokémon Nest Locations Google Map (Top) and *Pokémon GO* London Nest Map 2.0 (Bottom)

4.2.2 Information sharing in the virtual space

Pokémon GO players utilized social media to self-organize communities that connect players and provide space for sharing stories and organizing events. Information discussed within these communities included local hotspots, nests, bargains, events, safety concerns, memes, and personal accomplishments. The key differentiation in the types of information that these ARG communities are sharing are reports of dynamic events and circumstances only observable by players out in the "real world". Game information sources are typically accessed via computers, phones, or pre-published books, and are utilized near the game platform. With ARGs, the physical presence of players at a site is required to observe such things as Gym status, lured PokéStops, presence of specific players, weather, hazards, and changing situations. For example, an ad-hoc lure party was reported to the Charleston *Pokémon GO* Facebook community on Facebook (Figure 5, top-left). In the Denver group, a player assessed a specific area and determined it was weakly held by another team, and called for assistance (Figure 5, top-right). We also saw posts

where players informed others about the real-life situations of different places. For instance, in the Seattle group, a player warned others of foot traffic and ground conditions (Figure 5, bottom-left). In the Las Vegas community, a player warned of a suspected car prowler (Figure 5, bottom-right).

Figure 5. Examples of Online Posts in Various *Pokémon GO* Facebook Groups

4.3 Areas for Further Investigation

Our exploratory work examined *Pokémon GO* as a new sociotechnical phenomenon in physical and online spaces. For *Pokémon GO*, the sharing and verification of information still required physical player presence in both spaces. In the physical space, information was shared through loudly calling out information, visually checking crowds, directly asking questions to strangers, and walking/running to locations for confirmation. In the online space, information verification could only occur by going and observing dynamic PokéStops and Gyms in real time and even checking local weather and obstacles. Additionally, a massive scale of crowdsourced experiments and community watching occurred. One immediate question we have is: What is the prolonged effect of these kinds of games on people's behavior? Despite the initial popularity of *Pokémon GO*, it is still unknown how long this will last and what conditions are necessary for prolonged engagement. Also, while we showed that information behaviors can change through an ARG, further research is needed to understand how these technologies affect how people think about their own communities and public spaces and how social ties are influenced.

5 Conclusion and Future Work

We believe that the mobile gaming trend of blending the virtual and real space will become increasingly prevalent in the near future. Understanding the kinds of information sharing that emerge due to these games can not only help us understand the impact of these behaviors but also allow us to start conceptualizing the kinds of information tools and technologies that can support these behaviors. In our work, we have seen the emergence of ad-hoc information grounds in physical spaces where much of the information sharing occurred, as well as some unique pattern of community-led, distributed, data-driven approach in problem solving and information sharing in online environments.

For our future work, we plan to implement a large-scale survey in order to further test the generalizability of our findings from observation and interviews. In particular, we want to expand our scope and explore the relationship between people's real-life identifies and characteristics and their gameplay, social aspect of ARGs, and privacy and safety issues.

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[i] Examples include: University of [hidden for blind review] Campus, Discovery Park, Bellevue Downtown Park, Gasworks Park, Cal Anderson Park, Lincoln park, Green Lake, Center for Wooden Boats, Safeco Field, and University Village Shopping Center in Seattle; Washington Square Park, Central Park, and Union Square Park in New York; Waterfront, Bremerton

[ii] Full questionnaire accessible at: https://docs.google.com/document/d/1QLf6u8d8ubUZ4VVv2v_gJdZNF2SmJD7AmuG5VFZmvoQ/edit?usp=sharing