Group Interactions in Location-Based Gaming: A Case Study of Raiding in Pokémon GO

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ABSTRACT

Raiding is a format in digital gaming that requires groups of people to collaborate and/or compete for a common goal. In 2017, the raiding format was introduced in the location-based mobile game *Pokémon GO*, which offers a mixed reality experience to friends and strangers coordinating for in-person raids. To understand this technology-mediated social phenomenon, we conducted over a year of participant observations, surveys with 510 players, and interviews with 25 players who raid in *Pokémon GO*. Using the analytical lens of Arrow, McGrath, and Berdahl's theory of small groups as complex systems, we identify global, local, and contextual dynamics in location-based raiding that support and challenge ad-hoc group formation in real life. Based on this empirical and theoretical understanding, we discuss implications to design for transparency, social affordances, and bridging gaps between global and contextual dynamics for increased positive and inclusive community interactions.

CCS CONCEPTS

• **Human-Centered Computing → Collaborative and Social Computing**; • **Human Centered Computing → Human Computer Interaction (HCI)**.

KEYWORDS

Location based game, mixed reality game, raiding, groups

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1 INTRODUCTION

Digital games have fostered both positive and negative social interactions among people online and in collocated spaces [15]. In augmented reality social games, players interact dynamically in both virtual and real-world environments [6, 19]. Location-based mobile games, such as *Ingress* and *Pokémon GO*, provide opportunities for people with common interests and proximity to one another to meet in real life (IRL) and work toward game-related goals by collaborating and/or competing in various sizes of groups or teams.

In 2017, Niantic, Inc. launched a gaming format in *Pokémon GO* called Raids where the goal is to defeat and catch different powerful *Pokémon* (called raid bosses) that spawn at special physical locations called Gyms [40]. For a successful collaborative raid, players must physically meet at the same time at these Gyms. At the time of this study, the game itself did not include any in-game features to support direct communication among players (e.g., chat, messaging, etc.) to help coordinate the raid, including identifying the required number of people, the timing, or the location. In response, existing communities of players of *Pokémon GO* organized location-specific social media groups on other apps such as Reddit, Facebook, WhatsApp, and Discord.

Behaviors of social groups that organize, coordinate, and adapt around emerging technologies, including gaming, have long been studied and theorized by the HCI community (e.g., [18, 36, 45]). Technologies can facilitate social presence among groups in virtual or collocated shared spaces [11–13]. However, they may not necessarily scaffold active social interactions and the building of social capital among group members, a phenomenon which Turkle conceptualized as being "alone together" [48] and which has been studied in massively multiplayer games by Ducheneaut et al. [16].

We present an empirical understanding from a case study of raiding groups in *Pokémon GO* where players organize and

coordinate online and meet in-real-life (IRL). The *Pokémon GO* raiding environment forms a complex, fluid, large-scale experiment in collaborative augmented reality gaming involving millions of players of all ages across a wide range of communities, cultures, and countries around the world. Interactions of this complex dynamic social system and specific game design choices have generated consequences unique to the location based raiding format. To understand these consequences and inform the design of future location-based games, we explore the following research questions: (1) How do groups coordinate and interact online and in real life for raiding in *Pokémon GO*? (2) What factors contribute to participation, coordination, and social interactions in raids in *Pokémon GO*?

To answer our research questions, we conducted emic participant observations of *Pokémon GO* raids, administered a qualitative survey on online social media platforms with 510 respondents (majority USA), and conducted interviews with 25 *Pokémon GO* players around the Seattle metropolitan area in the USA. We included casual raiders (fewer than 100 raids), those who engaged in raid battles regularly (over 100 raids), and those who quit raiding.

We found that the raiding design explicitly incentivized players to collaborate IRL for a collective goal in ad-hoc raiding groups. We analyzed the interactions in raiding groups using the theoretical lens of small groups as complex systems developed by Arrow et al. [3]. Although there has been a large interdisciplinary body of work building upon and modifying this theory (e.g. [24, 25, 27, 47]), the theory provides a useful conceptual framework to analyze the interactions and dynamics we observed within gameplay. This framing enables us to reveal structure in the underlying dynamics of group play and its social and behavioral effects to draw conclusions and develop implications for design.

We discuss implications for designing location-based gaming technologies that require transition from online to real-world environments and interactions with strangers. Our primary contributions are: (1) An empirical understanding of how people coordinated in small groups for raiding in *Pokémon GO* through Arrow et al.'s [3] theoretical lens of small groups. (2) Implications for designing future location-based games and other location-based ad-hoc community interactions facilitated by technologies.

2 RELATED WORK

2.1 Social Interactions in Digital Gaming

Collaborative gaming technologies provide affordances for social interactions facilitating social presence among friends, strangers,and family members, both online and IRL (e.g., [11, 12, 45]). Players interact through chat rooms and virtual avatars to coordinate complex collaborative goals (such as in guilds and raids in *World of Warcraft* (WoW) [12]), and form temporary teams (such as in *League of Legends* (LoL) [26]). Players can be in collocated spaces and collaborate in the game online and IRL or play separately with individual goals warranting different levels of social engagement (e.g., [50]).

In addition, these social games also facilitate externally derived interactions among players who know each other, such as "hanging out" where the central focus is interacting with people rather than with the media [23]. Cultural differences manifest globally in players' interactions in online games [29, 35, 52]. Online game chats are not free from discrimination, bullying, and harassment toward groups that are typically culturally oppressed IRL, especially women (e.g., [14, 22]), LGBTQ [32], and other minorities (e.g., [9, 22]). We examine how these and additional factors facilitate or hinder online and IRL interactions among players in raiding groups in *Pokémon GO*.

Augmented reality games require players to navigate and interact in both the virtual world and IRL [6, 19]. *Ingress*, for instance, is a location-based mobile game in which players are required to collaborate in one of two teams to capture and expand portals located IRL [46]. Players communicate through an in-game chat protocol and are able to track location of other players. *Ingress* players work together online and IRL to complete missions. However, players have also experienced real world safety issues–such as being stalked or harassed–while interacting with strangers [5].

The design of *Pokémon GO* to explore locations and catch *Pokémon* attracted a larger and more diverse player base than *Ingress*. The initial success of *Pokémon GO* motivated information sharing among community members online and IRL [28, 51] and increased physical activity (e.g., [2, 54]) and wellbeing [56] among players. The uniqueness of *Pokémon GO* lies in social aspects scaffolded into the game itself. Wang et al. [51] investigated the mechanism of network formations both IRL players and virtual avatars, what they called cyber-physical symbiotic social networks. They noted that *Pokémon GO*'s merging of the physical and the virtual is unique; changes in physical social behavior are the result of the existence of a cyber-social network. Such social behavior changes include talking to more strangers [49], visiting new public places they normally would not go to, and modifying daily routines and routes to increase sociability [17]. As *Pokémon GO* players engage IRL interactions, they feel a deeper sense of belonging, linked to a sense of place and development of social ties [49].

The app design also facilitated hanging out and joint media engagement (JME) among parents and children [44]. JME is the social interaction phenomenon in which people (e.g., parents, children, siblings) learn together through the mediation of digital technologies and new media. The game's cross-generation appeal and the importance of critical mass

of players have been discussed in Paavilainen et al. [42], and Colley et al. [7], through a geostatistical analysis of game elements, also found that the majority of players play in pairs or groups. While these studies discussed various aspects of social play in *Pokémon GO*, the raiding feature only became recently available and thus was not discussed in previous literature. In the raiding format of *Pokémon GO*, players do not necessarily have to collaborate in teams but still rely on social capital to attain the goal of defeating a raid boss. We analyzed the nature of these interactions as family, friends, and strangers are motivated to get together IRL for raiding.

2.2 Raids in Online Gaming

Raiding is a format of gameplay where two or more players need to form groups and coordinate to achieve a common goal in the game that cannot be achieved alone. This format has been studied in the online game of WoW, where players formed groups and coordinated online using in-game chat tools and raid in "dungeons" [15]. The asynchronous nature of the chat tools in guilds and raids in WoW promoted awareness of having an online audience during gameplay yet challenged active social interactions between online players [16]. Leadership was particularly found to be influential in raid group interactions. Early communication by leaders or peers in online WoW raid groups had a positive influence on the likelihood that players stay in their raid groups [11]. Using the Leadership Grid [4] to study leadership styles in successful WoW guilds [43], these styles crossed two extremes: putting human needs and relationships first and focusing on maximum efficiency. In the MMORPG game *Everquest*, designated leaders attended more raids, earned more in-game rewards, were more central to the raid, and had longer tenure than "regular" members [21]. Yee [55] found that MMORPG raid leaders frequently experienced the feeling that they were obligated to play and experienced burnout.

In location-based raids in *Pokémon GO*, players coordinate in real-world physical locations to attain a common goal of defeating and capturing a *Pokémon* "raid boss". The nature of grouping in *Pokémon GO* is different from traditional guild structures in WoW and temporary teams in LoL. Raids in *Pokémon GO* are often a mix of ad-hoc and planned groups in which a leader may initiate its formation or contextually emerge over time. We studied this phenomenon to understand how members of raiding groups in *Pokémon GO* adapt to interact with the system and the real world.

2.3 Theoretical Framework

Interactions among groups of players are socially and contextually situated while they interact with the technology. Group members continually adapt interactions with each other and with technologies to meet their goals. Arrow et al. [3] theorize small groups (i.e., less than about 20 members) as complex, dynamic, and adaptive systems that interact with group members, as well as larger systems (e.g., embedding organizations). These interactions exist in context and are shaped over time as members of the group continually cycle and recycle (dynamic and adaptive). The changes in teams, team members, and their environments due to these interactions are more complex than can be captured by simple cause and effect perspectives.

Within groups, there are three levels of dynamic causal interactions—global, local, and contextual. Global dynamics may involve behavior of system-level variables that shape and constrain the local dynamics, such as, in our case, device affordances and company policies. Global dynamics may also involve emergent whole-group properties arising from local behavior, but due to the short-term and ephemeral nature of raid groups (task forces in Arrow et al.'s taxonomy [3], formed for a single project over a short duration), those aspects are less relevant to our study. Local dynamics are activities of members who constitute a group and engage in using tools and resources. Contextual dynamics are determined by the group's embedding context such as availability of potential members and cultural differences.

These three levels of causal dynamics operate simultaneously as the group forms, operates, and dissolves or transforms into another social entity. For the purposes of our case study [33], we focus on these dynamics. We use Arrow et al.'s lens [3] to make sense of how ad-hoc collocated IRL raid groups coordinate and interact online and IRL, the factors that contribute to participation in raiding, and the design implications for raiding as it pertains to social interactions.

2.3.1 Global Dynamics in Pokémon GO raids. Key global dynamics in *Pokémon GO* raids include the implicit and explicit rules and affordances set by Niantic's design of the game [39], which constrains and shapes how people in a raid group can interact. In *Pokémon GO*, there are three formats of raids [39]: Raids (levels 1-4), Legendary Raids (level 5), and EX Raids (level 5, accessed with an exclusive invite). Raid bosses are powerful and/or rare *Pokémon* that spawn from an egg for limited time in the game at designated public locations called Gyms (approximately 1-2 hours from the appearance of an egg to the disappearance of the hatched raid boss). For a raid to be successful, between 1-20 players are required to defeat a raid boss depending on the level of the players, and the type and difficulty level of the raid boss *Pokémon*.

Players in a raid group aim to defeat the raid boss to receive a baseline number of Premier balls, which represent chances to catch the *Pokémon* boss. To start a raid and ensure that it is successful, all group members at the physical location need to enter a virtual raid lobby on their mobile device within 120 seconds of the first group member entering the lobby. The raid begins when the countdown timer hits zero. Each group gets 176-290 seconds to defeat the raid boss depending on

the boss' level. Players can create private lobbies that allow two or more groups to raid separately at the same Gym. The probability of catching the raid boss is determined by a combination of player skills and a catch rate.

Nearby raids are visible on a player's map in the game. A player needs a raid pass for each raid battle and every player gets one free daily raid pass, or they cost $1 USD each as an in-app purchase (with occasional special prices). Only when a player reaches the physical Gym location of the raid is the player able to see how many other players have used the raid pass to join the raid. A player can battle multiple times until they win or the raid clock times out and the player loses their raid pass. EX Raids (exclusive raids) are invitation-only raids where players can defeat a powerful raid boss (at the time of this study, that boss was Mewtwo). These passes are given out one week in advance to randomly selected players who raided at select locations, such as parks or sponsored gyms. While Niantic has attempted to provide more specific information, opacity remained with regards to aspects such as which gyms qualify and which players get an invitation.

All players need iOS or Android smartphones and/or tablets that can run the game‘s software, data connection, and GPS for real-time play. Raiding requires the device to access players'real-time data and may render the software prone to frequent crashes. Raiding consumes more battery power than regular phone use, and players often carry extra portable battery chargers. Game coins (Pokécoins) can be bought or obtained by defending Gyms (maximum 50 coins per day) for in-game purchase of items, storage space, and extra raid passes. Team based bonuses are available in the form of extra Premier balls for the team that owns the gym and/or has most players (thus, does the most damage) in a raid battle. To encourage safe hours of gameplay in the real world, raids spawn approximately between 6 am and 8 pm local time. This time falls majorly during regular work and school hours. The safe hours are not region or season specific. For areas further from the equator, 6 pm local time in the summer still has enough daylight to play, but 6 pm in the winter has no daylight. Raids spawn at distant locations within a constrained time window that sometimes requires players to travel by car or bike.

3 METHODS

We conducted participant observations, interviewed 25 raid battle players, and obtained 510 survey responses from raiders in *Pokémon GO*. We collected data between November 2017 and February 2018. The study was determined exempt by our university‘s Institutional Review Board.

3.1 Participant Emic Observations

All researchers participated in raid battles in *Pokémon GO* in public locations in a metropolitan area. Author J.H. Lee also participated in raids in Germany, Korea, and Japan. All researchers participated in Facebook groups and Discord channels dedicated to coordinating raids and discussions on *Pokémon GO* from July 2017 to March 2018. We conducted this research through an emic perspective [20], that is, all authors in this study are *Pokémon GO* players who collectively engaged in over 1,500 raid battles and related community events and have an “insider‘s perspective”of the dynamics of raid battles. Our emic interactions allowed us to get to know players over the duration of a year. After raid battles, we documented our observations as written notes, chat logs, and/or audio recordings followed by discussions among authors. We made observations about who was present, what kinds of interactions occurred during the IRL meetups, and how the gamers organized themselves to raid.

However, Lincoln and Denzin [30] warn that the involvement of investigators in the phenomenon of inquiry requires cautious and conscious attention towards bias and influence. Therefore, to guard against our own personal bias and influence, we sought multiple, socially constructed, and sometimes conflicting perspectives [53]. To do this, we triangulated our observations with additional data through online surveys and interviews from communities outside of the ones we were a part of. Our observations helped us develop the survey and interview questions [10].

3.2 Online Survey

We posted a recruitment blurb inviting people who are 18 years of age or above and have participated in at least one raid battle to respond to a 25-minute survey about *Pokémon GO* raiding experiences. We posted the survey on the Reddit group r/pokemongo, on 180 regional *Pokémon GO* Facebook groups, and researchers' social networks. Participants were entered in a drawing for $50 per 50 respondents.

We deployed the survey from December 2017 to February 2018 and received 727 responses out of which 510 survey responses were eligible, valid, and complete (70% completion rate). We labelled survey participants S1-S510. The survey comprised of questions that were based on information gathering behavior, online coordination to plan for raids (e.g., apps used for learning about raids, managing notifications, coordinating time and location with players online), IRL coordination during raids (process of forming groups, challenges in raiding), social interactions with raiding groups, schedule and lifestyle changes (e.g., change in work schedule), social interactions with people who do not play *Pokémon GO*, perceived impact on health and social wellbeing, and their experience with and opinions about EX Raids. Respondents took an average time of 17 minutes (median) to complete the survey (mean is 19 minutes). Our population is skewed with the majority of the sample being Female, Suburban and White, and living in the US (Table 1).

Table 1: Demographic distribution of survey participants (N=510). NR indicates "No Response".

Gender	Female (54%), Male (43%), Something else (1%), NR (2%)
Age	18-20 (5%), 21-30 (46%), 31-40 (27%), 41-50 (13%), 51-60 (7%), 61-64 (0%), 65+ (1%)
Race	White (77%), Asian (8%), Native American (1%), Native Hawaiian or Pacific Islander (1%), Black (1%), NR (5%), Other (6%)
Region	Suburban (47%), Urban (43%), Rural (9%)
Country	US (90%), Non-US (9%), NR (1%)
Income (USD)	<$35k (23%), $35-$50k (11%), $50-$75k (17%), $75-$100k (11%), $100-$150k (13%), >$150k (10%), NR (16%)
Education	High School (9%), Some College (24%), Bachelor's (38%); Graduate (15%), Post-Graduate (6%), Professional Degree (6%)

Table 2: Demographic distribution of interview participants (N=25). NR indicates "No Response".

Gender	Female (44%), Male (56%)
Age (in years)	18-20 (12%), 21-30 (32%), 31-40 (16%), 41-50 (16%), 51-60 (0%), 61-64 (4%), NR (20%)

3.3 Interviews

We recruited people gathered at public locations around the Seattle metropolitan area (USA) for raiding through word-of-mouth (convenience sampling). We interviewed 16 participants who were mostly casual raiders (less than 100 raids). We then sought to selectively recruit players with diverse experiences in raiding. J.H Lee is a highly active member of the raiding community in the metropolitan area and selectively sampled and requested players who were active raiders (completed over 100 raids and currently raiding at the time of this study), frequent raid organizers, or were active but had quit raiding, while maintaining cautious and conscious attention towards bias and influence. We then conducted eight interviews with nine participants (one interview with a couple that raids together). The interviews were semi-structured asking about players'coordination techniques online and IRL during raiding, experience moderating groups or leading raids (if any), challenges, social interactions during and after raiding, influence of raiding on wellbeing, and ideal raiding experience. In Table 2, we detail demographic information of 25 interview participants (labeled R1-R25). We did not ask interview participants their race or ethnicity. Interviews were either voluntary (no compensation) or participants were offered $20 in Amazon, Google, or Apple gift cards, depending on their choice. The interviews lasted between 20 and 80 minutes (average 40 minutes). With permission from the participants, we audio recorded 23 interviews, had them professionally transcribed, and took notes for one interview (Appendix A, survey/interview protocol).

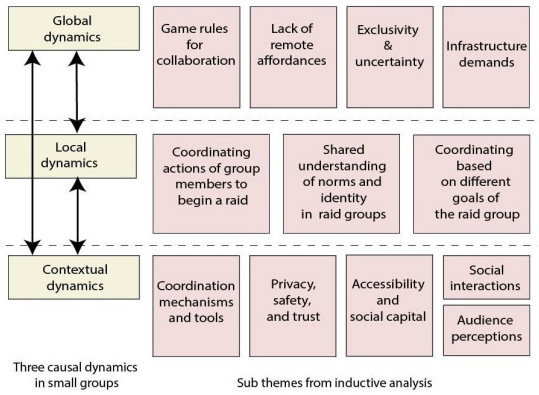

Figure 1: Affinity diagramming of subthemes based on theoretical lens of small groups as systems [3].

3.4 Data Analysis

We analyzed the data using inductive thematic analysis [8]. The first author read through 100 survey responses and 16 interviews, prepared a coding library, and divided the data among two other coders. After debriefing and discussion on the coding library, each coder independently coded 170 survey responses and 8 interview transcripts inductively using the coding library. We encouraged coders to add new codes or iterate on the codes during the coding process, but no new codes emerged. The first author read all the interviews and codes, and we discussed any discrepancies identified. All coders wrote, shared, and discussed memos. To understand contextual differences across regions and international cultures, we grouped the data based on area (rural, suburban, and urban) and then based on countries. We did not code observation notes but referred to them to triangulate findings in our interviews and survey data.

Based on researchers'expertise, observations, and memos, the sub-themes that emerged from our inductive analysis aligned with Arrow et al.'s three levels of causal dynamics: global, local, and contextual [3, 31]. We then conducted deductive affinity diagramming, where we mapped and grouped the sub-themes that emerged from our inductive coding under the three levels (Figure 1). We present our findings with respect to these dynamics of group interactions.

4 FINDINGS

As per Arrow et al.'s taxonomy [3], groups raiding in *Pokémon GO* can be classified as a unique mix of (1) concocted

groups, where external factors support formation and planning of the group, and (2) self-organized groups, where the groups form spontaneously without much planning and are primarily driven by group members with common interests. Our core unit of analysis is the raid group, which forms, operates, and dissolves under the strict temporal global constraints determined by Niantic (within 5-15 minutes). These small groups are embedded within a larger context spanning a worldwide game played by millions across a multitude of cultures. Within global constraints set by Niantic–including but not limited to strict temporal boundaries–contextual and local dynamics shape the formation, operation, and dissolution of each individual raid group. Based on our analysis using this theoretical lens [3, 31] we explain our findings on local and contextual dynamics that are integral in answering our research questions. Arrow et al. devote a large portion of their theory to contextual dynamics [3], an emphasis we echo here.

4.1 Local Dynamics

Based on Arrow et al.'s theoretical lens [3, 31], local dynamics in raids are activities that groups use to coordinate amongst each other and with tools during operation of raids in real life (IRL). These activities include implicit and explicit norms and procedures of the group or members' inference of other members' abilities and intentions. There are three aspects of coordination that are visible IRL in raiding groups: coordinating actions, understanding, and goals.

4.1.1 Coordinating Actions to Begin a Raid. Starting a raid with a sufficient number of players requires that the group coordinate actions in spatial, temporal, and interactional synchrony [3]. For coordinating gameplay at a raid location, group members made sure enough people are present to have a successful raid, decided whether to split into smaller groups, decided on the start time, and determined whether to back out of the lobby if a player was unable to join or arrived later than the scheduled time (Appendix B). Once all players are in the lobby, the game does not require other collaborative efforts. Players then tapped on their separate phones to attack, dodge, and defeat the raid boss. This operation required minimal cognitive load, allowing players to interact with one another depending on individual and cultural preferences (contextual dynamics in section 4.2). Survey respondents (75%) and interviewees (84%) reported they raid with strangers and/or people they met during raiding. *"Once a group is together we normally do several raids in succession and gain group members with each one."* -S141, Male, age 31

4.1.2 Shared Understanding Among Group Members. Players played in more than one group and developed a shared identity and understanding of norms of the raiding groups. They identified other players who gathered at a location for a raid through common traits, as summarized by S166, *"Typically, look for people standing in a cluster or circle facing each other near the Gym location with phones out. Usually some if not most will have a charger cable going from the phone to a battery in their pocket."* -S166, Female, age 37

Another common tacit norm in raiding groups had been to introduce oneself and identify other players based on their usernames in the game or the online communities they were a part of (e.g., Discord) rather than using real names. Most participants knew others by their pseudonyms and found it helpful to maintain selective privacy and safety boundaries. S217 explained, *"I do not [have privacy or safety concerns], mainly because everyone, including me, uses a username and refers to others by their username. The only people who I know in person are ones that I've met a lot at raids."* - Female, age 21

4.1.3 Coordinating Different Goals of Raid Group. Arrow et al. explain that group members coordinate goals through mutual adjustment of the intentions and purpose of its members [3]. This behavior was explicit in raid groups when players coordinated to make decisions on whether to divide a larger group into smaller ones based on teams to gain team bonuses or go in as one group. Participants first prioritized getting the adequate number of players to defeat a raid boss. With large groups of high-level players, members further strategized by splitting into their respective teams to get more damage balls and created private lobbies. Contextual factors were negotiated among group members to form common group goals, such as getting done in time to get to other errands, waiting or backing out for children or other members, or working around difficulty in reaching people IRL. S198 (Female, age 43) described, *"Sometimes we do split into teams to maximize Pokéballs awarded from the raid, but often the group is not large enough to split. Sometimes, even with a large group, we don't split up because coordinating is harder."*

These local dynamics of how groups coordinate action, shared understanding, and goals are influenced by contextual dynamics of specific regional, individual, and cultural factors that develop outside the IRL raiding group [3].

4.2 Contextual Dynamics

4.2.1 Differences in Coordination Mechanisms. Coordination among players before going to a raid location varied in four ways: no coordination at all, arriving at the raid at the start time, online coordination, and emergence of leaders within the group. Sixty-six survey respondents and four interview participants (all from urban and suburban regions) said they only used the "nearby" raid map feature on *Pokémon GO* to look up raids nearby and go there without prior coordination, hoping a group will show up. The method worked when Niantic released a new legendary raid boss or in areas where the game was popular. S282 (Female, age 38) who did 1-10 raids said, *"[I] just find them [raids] by happenstance while exploring an area. I do not specifically seek them out."*

Another practice was arriving at the raid Gym at the egg hatch time, which is the earliest time a raid can occur. In dense urban areas with many *Pokémon GO* players around to form a large enough group, pre-coordination may not be necessary. From our observations and participants' responses from busy areas-such as downtown San Francisco (CA), Seattle (WA), Disneyland in Anaheim (CA) and Japan (e.g., Tokyo, Kyoto, and Tsukuba)-the raid lobby in these locations filled up as soon as an egg hatched, and people were there at the hatch time to raid. R21 (Female, age 23) who raided in Japan during her honeymoon, said, *"In Japan raiding is more popular. I don't think I went to a single raid that didn't have 20 or so people unless it was 6 a.m."* In some cases, it was impossible to interact with other public players due to overcrowding. In other cases, players were clearly identifiable (as in raids in Japan) but the cultural norm we observed was to not interact with other players very much.

Third, players in existing *Pokémon GO* online communities (e.g., Reddit, Facebook) organized to divide the online space into geographically tailored groups for this location-based game. Players created and participated in chat channels for cities, neighborhoods, and specific areas of a town. They dynamically switched between online groups of different cities and/or channels of specific neighborhoods depending on their location. Due to a lack of remote affordances (global dynamics), participants used third-party raid maps to scan locations and be notified about raids beyond the region that is shown in the "nearby" tool within the *Pokémon GO* app. In a location-specific channel, the goal of the group was to decide on a location, set a time to meet in the one-hour window of the raid boss spawn, and the number of people who are attending the raid (Appendix B). Players who were initially unaware of online tools reported that they were usually introduced to online raid coordination apps and channels through other players at a raid.

Levels of online group interaction ranged from passive and undirected (anyone in the group can respond) to active and directed – such as tagging "regular" players in a certain area, texting, or calling neighbors. Online group coordination may be ad-hoc or structured. In ad-hoc coordination, a member first posted a raid location as text and/or a screenshot from the *Pokémon GO* app or a third-party scanner map. Group members then typically communicated and agreed upon a meeting time. In some apps, the coordination is more structured using scheduling tools such as the "plan" feature on Facebook Messenger, "polls", or bots that automatically redirect notifications of raid spawns from scanner maps to a location specific chatgroup and coordinate. S180 (Male, age 32) explained, *"Sometimes regulars that have been known to attend [raid] location will be tagged. Facebook Messenger, plans are created with suggested time, Pokémon name, and location. People then just mark themselves as going or not going. Discord bot has the facility to schedule raids for people and list who can come, but no one in our area uses it– Typically, [on Whatsapp] just suggest location and time and then people discuss and it's difficult to get a proper head count."*

Fourth, some members emerged as leaders in coordinating raids both in online and IRL groups. Sometimes a designated community member took on lead in coordinating. Other times, multiple people participated in coordinating decisions for the group or take on different responsibilities (e.g., one person informs on Discord, another starts a private lobby and so on). Most participants switched between roles of organizing and waiting for others to organize raids and 137 participants stated that they frequently or always took on the role of organizing a raid. In our observations, we saw that community members such as R2 and R4 helped to moderate, mentor, and welcome new members in the online community and IRL during raids. S133 (Male, age 38) explained his process of organizing raids, *"(1) Identify location (2) Post to all Discord & Facebook groups that are in the same geographic region (3) Identify a start time (4) Have players confirm raid participation availability and number of accounts they can contribute (4) Do a roll call when at raid, to ensure all committed players are there."*

Finally, EX Raids, which were prescheduled about a week in advance, often attracted larger groups of people than regular or legendary raids. Typically, more planning was involved for the EX Raids because only 20 people can enter a lobby to raid at a time. In the online platforms we observed, a separate channel or group was set up where players indicated their intention to participate in the EX Raid, reporting the number of accompanying players, team(s), and expected arrival time at the EX Raid. This helped the organizer(s) plan groups, maximizing the benefits of individual players and ensuring players were not left out. However, sometimes players who do not use the specific online platform will come to the EX Raid, and other times some players experience technical issues that prevent them from joining the raid as planned. Group members then dynamically coordinate to form and execute a new backup plan. A frequent community organizer, R2 (Female, age 38), explained, *"Well for EX Raids in particular, I have my attendance sheet-my spreadsheet that I print out copies of. I have markers - and I can write in peoples'names who just show up that aren't on Discord or Facebook– In general, when I play the game, I usually travel with a couple battery packs and charging cords for like three different types of phones–it's for other people."*

4.2.2 Need for Accessibility and Social Capital. The global dynamics of *Pokémon GO* raids favor people with higher mobility and access to resources and larger social capital. To our knowledge, the designers did not factor the physical accessibility of neighborhoods into deciding the location of Gyms and Pokéstops. The raid structure rewards people

that are highly mobile around a neighborhood (e.g., jogging, biking, driving), and who have more free time. The lack of accessibility was a disadvantage for people with mobility issues (e.g., wheelchair access). Raids in restricted property, small sidewalks, parks, or close to private property such as homes and small businesses are not accessible for large groups. R7 (Male, age 50) explained, *"But their [Niantic's] computers don't have a way of intuiting, this is a good place – You might have the Mewtwo raid at Penguin Park, which is between two people's houses. If you drew like 60-80 people, the police would respond, probably. It's like, that's way too many people for that area, but it's technically a park."*

We received 50 survey responses from people who live in rural areas. Out of these 50 participants, 26 said they raided in suburban regions. These participants explained that rural areas have a smaller community where most people know each other. However, they also lack the number of people required for large raids and in-game resources, such as a lack of Pokéstops to collect items and Gyms to battle. Being in a team with fewer players globally (the "Instinct" team in *Pokémon GO*) [18], players are also often unable to cause enough attack damage or unable to gain gym bonuses. R20 (Male, age 30) explained, *"Either we beat the Pokemon fast or in most cases didn't have enough people to even hope to beat it. Lack of proper ways to play the game out in rural areas has hurt me and my friends'ability to level up at a decent rate as well as catch anything that could help us in raids."*

Some players have resorted to spoofing GPS locations– where they use third party apps that modify longitude and latitude variables of the GPS signal received by the *Pokémon GO* app. It allows players to use virtual controls to transport their game avatar to raid locations without going to the Gym location IRL. Spoofing is a form of cheating (Appendix B). Two players in rural areas said that spoofers helped when they needed large groups. However, some also said spoofers do not target rural regions due to low turnout, expecting a raid to fail. Two participants brought up that people with disabilities can benefit from spoofing. R9 (Female, age 41) suggested, *"Instead of just doing the regular AR, they [Niantic] actually need to create a virtual reality for [disabled] people so they can actually spoof to Paris and it's immersive."*

4.2.3 Cultural and Individual Differences in Social Interactions During Raiding. Participants raided with family members (e.g., spouses/significant others (n = 69), siblings (n = 18), and parents (n = 15)), but mostly with strangers. The raiding format facilitates 5-15 minutes where people are co-present IRL and can have face-to-face interactions while raiding on their phones. Most conversations happened before or after the raid battle, but the simple game controls also allow groups to converse during raiding. Thirty participants reported having no social interactions while raiding IRL. Others reported four main types of social interactions:

Figure 2: Left: Raids in US (people in a group facing each other) Center: Raids in Japan (people raiding in a crowded area but not facing each other) Right: Trays with six smartphones used by two players for raiding in Pokémon GO using separate accounts and devices.

(1) Acknowledgements (n = 10), which are nonverbal gestures to acknowledge others in the group; (2) Game derived conversations (n = 385), which include talking about coordinating the raid, battle strategies, *Pokémon*, Niantic, and theorizing about the game and upcoming updates; (3) Casual small talk (n = 152), such as conversing about the weather or local places; and (4) Personal conversations (n = 26) such as talking about children, job, common interests (other than *Pokémon*). The majority of the participants had game derived conversations. S389 (Male, age 24) said, *"We talk about the game, current/recent game events, recent catches or challenges, we sometimes talk about how funny or strange we look gathered on the sidewalk, or the safety of the location, the weather, how we got into the game."*

These social interactions differed based on cultural norms in different regions. In Japan, people may not communicate with out-group strangers or foreigners [34]. We observed that in raids in Japan, people rarely talked to each other and if they did, it was mainly with the people they came to the raid with. S140 (Female, age 30), a foreigner living in Japan, confirmed our observations, *"Outside of that one experience [speaking with a lady about her phone crashing] I've yet to speak with any other raiders outside of my small group. Japanese people are pretty shy with strangers and foreigners."*

A few players considered themselves "anti-social " or wanted to stop coordinating with others based on prior negative experiences of people excluding them based on team color or other reasons. These players created multiple accounts and used multiple devices to raid as it can be difficult to get a group together (Figure 2). Fifteen participants said they prefer to raid alone (either lower level raids or using multiple accounts). R8 and R9 (age 41, 42), a couple that raids together explained, *"We're both a little anti-social; we were just out in parks walking around and we'd be on our bicycles playing Pokémon. We were just catching stuff. Then they came up with the raids, which to us were like forced socialization against our will."*

Maintaining privacy and safety was another contextually varying aspect of interactions with other players online and IRL. Of the survey participants who use online tools for coordinating raids, 283 participants said they did not have any privacy and safety concerns online and 32 said they did. Some participants expressed concerns with sharing their phone number on WhatsApp or sharing real names and/or receiving friend requests from strangers on Facebook. Participants often preferred that they could choose the degree of anonymity on Discord. For example, S132 (Female, age 36) said, *"I don't like that Facebook Messenger uses my real name. Most have changed their displayed name to their Pokémon GO handle which I haven't done as I don't want both accounts to be linked and to be easily identifiable."*

Survey participants (n = 95) indicated some safety concerns during raiding IRL. Among interview participants, six participants reported privacy concerns and safety concerns. IRL safety concerns included fear of theft, going out to unfamiliar locations, Gyms located in dangerous areas, speeding cars near raid Gyms, being out after dark, and increased safety concerns for women and children. Participants who raided frequently explained that both trust and social interactions with the community evolved over time as they learned about players' nature (e.g., politeness/ kindness) and gaming patterns of specific community members (e.g., availability in a specific location, availability during specific time such as work break, can always rely on them to come, organizes raids well). Arrow et al.'s theory predicts this will happen with these types of contextual dynamics [3]. A few players said they do not prefer to split based on teams even if there is a large group because there are children and/or neighbors in the group who want to play together. S252 (age 27, Male) said, *"We all just group together, we are all neighbors and don't care about teams so much."*

Some participants discerned that privacy and safety was less of a concern in being able to raid IRL with strangers but made cautious decisions when sharing credentials and devices. Sixteen percent of the survey participants mentioned getting a car ride with strangers they met during raiding. R7 (Male, age 50) explained, *"You might be willing to raid with all sorts of people, but you might be more discriminating in who you get in a car with, who you give your device to, who you give your log in credentials to [do EX Raids for you]."*

Participants explained bridging of social capital among community members who raid together when people met outside raiding either deliberately such as planning happy hour or meeting unexpectedly during running errands. R4 (Female, age 20) described, *"We'll hang out for a while and then go do a thing for example, like an EX Raid or whatever [community] event they have. Sometimes we get together for dinner. There's always happy hour."*

With EX Raids, we observed that people's motivation to raid changed to more individualistic goals of trying to increase chances of obtaining EX Raid passes. They drove farther from their nearby communities to find sponsored gym locations. Not all players who raided at a specific gym obtained EX Raid passes, sometimes even excluding members of the same family who raided together. R8 (Male, age 40) shared, *"I know several Pokémoners who simply hung the game up, and stopped playing– It still isn't fair. We did a raid with some people recently. Five of the six people we raided with, got EX Raids. We and one other person didn't get EX Raids."*

5 DISCUSSION

Our findings show that the complex and changing nature of group interactions mean that global, contextual, and local dynamics operate simultaneously and are interwoven to both scaffold group interactions and create challenges in the location-based social format of raiding. Using Arrow et al.'s theoretical lens [3], we understand that norms and design decisions guide common local dynamics in group interactions. Contextual dynamics determine nuances in how these group interactions may or may not lead to building of social capital. This deeper examination of the online/IRL interactions in the raid battle helps understand social interactions through technology and design to support coordination for location-based games and activities.

5.1 Implications for Design

Based on our empirical and theoretical understanding, we provide design implications for future location-based games to provide better affordances for ad-hoc coordination, bridge global and contextual dynamics, and scaffold social bridging.

5.1.1 Providing Low-Barrier Affordances to Support Ad Hoc Coordination. Raiding is a short-term activity in which a small group typically forms and dissolves within 5-15 minutes. Going to a raid requires investment of a player's time, money, social capital, and physical effort. At the time of the study there were no in-game chat features, but players transcended privacy boundaries by appropriating other social apps for forming and coordinating raid groups. Information about remote raids and coordinating norms were crowd-sourced on these online communities.

Design can provide remote affordances for coordination and balance personal cost for IRL engagement with rewards (e.g., waiting at a location, losing raid pass if no one shows up). A discreet in-game feature can provide a means for players to signal to nearby players that they are interested in doing raids with opt-in or opt-out options. Privacy controls can ensure they do not have to share personal, social media, or contact information with strangers while making it possible to drop in and out of the time and location bounded collaborative activity. There is growing interest in the HCI

community around strangers and social engagement through apps such as Next2You [41].

5.1.2 Bridging Global and Contextual Dynamics. Players expressed frustrations with Gym locations not being safe or appropriate for doing raids with large groups. They requested the assignment of a community manager (a representative from the local player community) who could provide timely feedback to designers and developers to change global affordances. Feedback from community managers can be made visible to all players in the game in the form of virtual tags on Gym locations, such as "unsafe at dark", "small curb", or "child friendly". These tags can help designers select appropriate locations for social events requiring large number of people such as EX Raids or community days (timed event where special *Pokèmon(s)* appear more frequently). This kind of feedback mechanism could be expanded to community tags where avid players can interact with designers and other players to dynamically adapt the game for raids that are safer, more accessible, and less disruptive to non-players.

Other features that can foster equity of participation include adapting the global dynamics to provide extra damage bonus to compensate for lower social capital in rural areas. Community managers in rural areas can provide the count of available regular raiders (excluding spoofers) based on which the system can dynamically lower the damage required to defeat the raid boss. Alternatively, additional damage bonus can be offered in-game at raids spawning at gyms located in remote locations. Game developers do not have control over making public locations accessible. However, game designers can strive for equity by creating a separate mode for people who are disabled (as also suggested by R9) to enable these players to remotely access raid locations – such as in the current practice of spoofing – but without penalty.

5.1.3 Scaffolding Social Bridging. Some features of raiding supported players in a neighborhood to interact repetitively. EX Raids motivated larger groups to get together while some players felt unfairly excluded. The newly added social features in the game (e.g., friending, gifting, and sending EX Raid invites to friends) provide more scaffolds for social bridging. Additionally, there could be new features related to raiding to augment such effort; for instance, we can imagine a feature where players are able to signal for help to nearby players when the raid is failing. The game can incentivize passers-by to provide such help by rewarding them with meaningful items. This may lead to more reciprocal interactions between the players such as expressing gratitude IRL.

The EX Raid format itself raises questions as we found that the EX Raid format may actually negate all three fundamental intents of Niantic for this game [38]. First, players indicated they drove more to EX Raid specific locations, leading to reduction of health benefits from walking. Second, players indicated they socialized less with the known community as they would choose to travel to EX Raid eligible Gyms rather than their typical raiding locations. Only some community members received the EX Raid passes every week and this exclusivity created awkward social situations in which people felt bad for celebrating and/or getting into heated discussion about how to get the passes. Third, some players also aimed only for specific targeted locations which led to lack of exploration IRL.

6 CONCLUSION

Our study is a case study of a widely adopted location-based game, *Pokémon GO* (last known update from Niantic is about 65 million in 2017 [37]), which may differ from games with smaller user bases. In future work, researchers can include demographics beyond those studied here, for example, people who want to participate in location-based raids but are unable to, live outside the US, or communicate in languages other than English. Our sampling resulted in a majority of White participants. There are several discussions that people of color do not feel safe playing a game that requires them to wander in public and interact with strangers (e.g., [1, 42]), which needs further investigation. After the period of data collection for this study, Niantic launched several additional features, including the Field and Special Research feature [39] at the end of March 2018, a friendship and trading feature at the end of June 2018, and the ability to share EX Raid passes with a friend in September 2018. Though these features launched after we completed our study, anecdotal conversations we have had with players have been positive and can be further explored.

Innovative modalities of interactions make gameplay and real-life social connection possible. It is important to understand how communities adapt around these technologies. We presented an empirical analysis of interactions in a case study of location-based gaming-raid battles in *Pokémon GO*-through the theoretical lens of small groups as complex systems. By examining how local groups self-organize around IRL raids, we demonstrate how people make decisions on coordination efforts for local meet-ups. Our design implications can inform the design of future location-based games and other technologies to scaffold other activities that require small groups to gather in specific locations and coordinate for time-bound activities (e.g., volunteer response, online marketplaces, and neighborhood social interactions (Nextdoor)). Designers should be mindful of contextual factors that affect group participation and consider how to design better global affordances to support social capital to cross boundaries of existing societal divides to shape a more equitable future.

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