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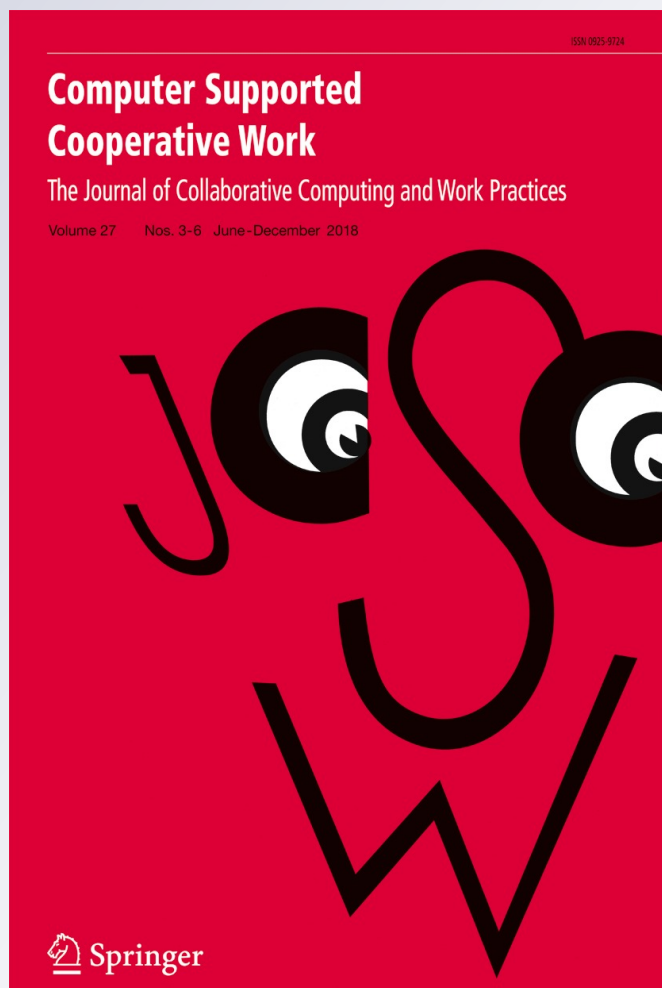Volume 27   Nos. 3–6   June–December 2018

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Understanding eSports Team Formation and Coordination

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Abstract.   Team activities that were traditionally offline are increasingly incorporating mediated elements where there is a mix of physical and computer-assisted activities. In this study, we provide a preliminary insight into this understudied yet emerging genre of mixed-form CSCW. Specifically, we present a qualitative research of team formation and coordination mechanics in Electronic Sports (eSports), a unique combination of action and knowledge/decision teams. Our findings highlight online users' particular needs to coordinate their team activities under pressure (e.g., a mix of online and offline team formation/coordination strategies; technology-enabled knowing and judging before the team is formed; and reinforcing personal relationships to enhance the professional performance) and higher requirements for sophisticated multimodal communication patterns to sustain such coordination. We contribute to both confirming and augmenting existing theories of team formation and team coordination. We also suggest further avenues of research in HCI and CSCW to design systems that support the formation of teams, to explicate the optimal modalities of communication for different teamwork situations, and to fully understand the delicacies of how personal and professional relationships could intertwine in virtual teams.

Key words: Computer-mediated collaboration, Virtual teams, Distributed teams, Team formation, Team coordination, Electronic sports, eSports

1. Introduction

A core research question in CSCW is to explore how people work, live, and interact in various forms of collective lives such as groups, organizations, and communities (Ackerman 2000). The main reason is that it is more efficient to accomplish tasks from the coordinated contributions of people with diverse backgrounds and resources than from the independent work of the same group of people (Geyer et al. 2001). Following this call, extensive research has been done in CSCW to investigate the nature of coordinated activities across distance (e.g., Bjørn et al. 2014; Bjørn and Ngwenyama 2009), the role of technologies in such settings (e.g., Turban et al. 2011), and social experiences in distributed or virtual teams (e.g., Gutwin et al. 2004; Hossain and Wigand 2004; Huysman et al. 2003; Koehne et al. 2012).

Yet three key issues have arisen that are of significance for CSCW and HCI researchers: First, it is often challenging to apply strategies of team formation in traditional offline workplace settings to online communities. Prior work on the formation of online teams does not provide a homogenous picture (e.g., Kraut and Fiore 2014;

Lykourentzou et al. 2016; Yang et al. 2017): not only do online communities give rise to virtual teams in diverse ways, the strategies to build and sustain these teams also vary by platform. More research is needed to explore unique contexts of online social spaces.

The second issue is that there is a disconnect between studies of high performance action teams and decision/knowledge based CSCW teams. The former is largely based on small action teams performing in-person tasks in the offline world (e.g., DeChurch and Mesmer-Magnus 2010; Mathieu et al. 2000; Stout et al. 1999; Toups and Kerne 2007) while the latter is based on distributed teams (e.g., IT or business professionals) in the relatively stable, organized, and safe context of a workplace (e.g., Bjørn and Ngwenyama 2009; Dabbish et al. 2012; Geyer et al. 2001; Gutwin et al. 2004; Hossain and Wigand 2004; Huysman et al. 2003). Therefore, both bodies of literature are questionably applicable to other contexts.

Third, while online gaming provides a valuable research site for virtual team coordination in stressful and time-sensitive contexts, existing work (e.g., Leavitt et al. 2016; Tang et al. 2012; Williams et al. 2007) often focuses on a certain particular game, player group (e.g., skilled players vs. average players), or type of team (e.g., random, matchmaking teams vs. long term guilds). Games have different mechanics as well as different social norms. With constantly evolving genres, it is necessary to examine the multi-dimensions and more general aspects of competitive/collaborative gaming.

The present work endeavors to address these research gaps. We report our qualitative research of team formation and coordination in Electronic Sports (eSports) — defined as the play and spectating of competitive online games (Hamilton et al. 2012). We interviewed 26 eSports players in the United States and conducted an in-depth analysis to explore two research questions: *RQ1: How do eSports players identify potential teammates? RQ2: What are the strategies they use to develop the capacity to coordinate their activities?* RQ1 focuses on the formation of a mediated team, including the mechanisms and criteria of identifying and selecting team members. RQ2 focuses on strategies (e.g., interactions, behaviors, and events) that develop and sustain a team's capability to coordinate in a highly stressful and competitive virtual environment.

Our work makes a number of contributions to CSCW and HCI. Our investigation of eSports teams, which can be considered a unique combination of action and decision/knowledge teams, points to how team formation and coordination occur in a hybrid environment. We take a broader examination of team coordination in different contexts and examine how online users perceive and understand the meaning and significance of cooperative communication mechanics to their subjective social experiences. Based on these insights, we also suggest opportunities for system design that support the formation of online teams, to explicate the optimal modalities of communication for different teamwork situations and fully understand the delicacies of how personal and professional relationships could intertwine in virtual teams.

2. eSports: An Overview

While there has been much inconsistency in its definition (Freeman and Wohn 2017a, b), in this study we consider eSports the competitive play and/or spectating of online games (Gandolfi 2016; Hamilton et al. 2012). eSports typically involves a team of players. For these players to perform at peak performance, they must make reflexive and precise hand-movements, process large amounts of information, and work effectively with their team members. This field has grown drastically over the last decade—increasing competitions and events have attracted millions of online and offline spectators worldwide (Kresse 2016). The large similarities that eSports has with traditional sport have led the Olympic Council of Asia (OCA) to announce that eSports will become an official medal sport at the 2022 Asian Games, representing a mainstream recognition of competitive gaming (Graham 2017). Yet in contrast to traditional sports, the 'primary aspects of the sport are facilitated by electronic systems,' and 'the input of players and teams as well as the output of the eSports system are mediated by human-computer interfaces' (Sjöblom and Hamari 2016, p. 1).

We chose eSports teams as our research context because they are at a unique intersection of action teams and decision/knowledge teams, adding a physical layer to teamwork that is mainly missing from extant CSCW literature on knowledge-based teams. According to DeChurch and Mesmer-Magnus (2010), there are two extremes of teams: action-oriented teams (e.g., military teams, firefighters, trauma teams) perform highly interdependent and time sensitive tasks in stressful and risky environments, and decision/knowledge-oriented teams (e.g., teams in business or software development) perform tasks in the relatively 'calm' context of traditional workplace settings. For eSports teams, on the one hand, teamwork is task-based—similar to that of a traditional organizational setting. On the other hand, eSports teamwork happens in a highly competitive, stressful, and intense virtual environment that requires fast decision-making and response rates associated with physical activities, making them action-oriented. Therefore, eSports offers a valuable and unique opportunity to further explore the social and organizational processes of team formation and team coordination.

3. Background

3.1. Team Formation Online and Offline

Teams are considered being beneficial for accomplishing complex tasks due to their capability of allowing team members to share workload, track others' work behaviors, and foster and contribute expertise on subtasks (Mathieu et al. 2000). Yet a main challenge to form an effective team is to select team members who have potential to help achieve high performance (Reagans et al. 2004). Past studies on teamwork have explored how to form a successful team from various perspectives. Some focused on team members' personal attributes/skills such as personality (Hodgkinson and Healey 2009) or social attributes/skills such as the social sensitivity of group

members (Woolley et al. 2010) or relationship dynamics (Curşeu et al. 2010; Reagans et al. 2004). In contrast, some others found that it was challenging to predict team performance only based on individual and social attributes/skills. Rather, a more scientific way to explore collective performance is to use *c factor* (collective intelligence) (Woolley et al. 2010).

As distributed or virtual teams increasingly permeate our lives, one question is how much of these findings of team formation in offline settings can be applied to online situations. Kraut and Fiore (2014) found that online groups' founders' human and social capital, their decision making, and behavior within the group in its first week could be used to predicate the survival of a new online group. Yang et al. (2017) explored how members of online health support communities, rather than community founders, were crucial for retaining a successful online community. Lykourentzou et al. (2016) investigated team formation in crowdsourcing. Instead of the traditional centrally-coordinated team building, they proposed *team dating*, a self-organized and decentralized strategy for online crowds to select and evaluate potential partners. Pobiedina et al. (2013) investigated a multiplayer online game *Dota 2* and showed that role distribution, player experiences, interplayer relations (e.g., friends), and the selection of a qualified leader all positively influenced a team's success in this game. These studies exemplify how online communities function differently from traditional offline workplaces due to the loose group structure (Faraj et al. 2011), weak ties among community members, the diminished role of physical contact and face-to-face inter-action, and the lack of information of team members' history, skills, and qualifications because of anonymity. Yet even the prior work on online teams does not provide a homogenous picture of how online users select potential members to form effective teams: not only do online communities give rise to virtual teams in diverse ways, the research also shows that strategies to build and sustain these teams vary by platform.

3.2. Team Coordination in Offline Action Teams and CSCW Teams

In a team, coordination is a process of interaction that integrates a collective set of interdependent tasks, actions, and knowledge and allows individuals to realize a collective performance and achieve goals (Okhuysen and Bechky 2009; Rico et al. 2008). It often results in collaborative behaviors and team cohesion (Carless and De Paola 2000). Previous studies have identified *shared mental models* (i.e., knowledge structures shared by team members) and *situational awareness* (i.e., a sense of the surroundings and other team members) as two key cognitive constructs of successful teams that can coordinate in rather stressful and high risky offline environments (e.g., Mathieu et al. 2000; DeChurch and Mesmer-Magnus 2010; Stout et al. 1999). According to Entin and Serfaty (1999), a team's high performance depends on both 'a shared mental model of the task environment and the task itself' and 'a mutual mental model of interacting team members' tasks and abilities' (p. 312). These two mental models generate anticipations and expectations about team members' behav-iors, which allow for the emergence of *team cognition*— how a team as a whole can

process information and respond to the environment based on the processed information (MacMillan et al. 2004). Following this understanding, researchers have proposed a number of strategies to develop common cognitive abilities or experiences that improve team members' sense of 'sharedness,' including effective planning (Stout et al. 1999), building both shared-team- and task-based mental models (Mathieu et al. 2000), and measuring elicitation, structure representation, and representation of emergence in a team (DeChurch and Mesmer-Magnus 2010).

Especially, the switch from *explicit* to *implicit coordination* is crucial for team cognition: while *explicit coordination* requires team members to communicate in order to coordinate their activities, *implicit coordination* allows members to act without the need for overt communication (MacMillan et al. 2004). This is particularly valuable for teams who perform risky, stressful, and time sensitive tasks, such as firefighting (e.g., Toups and Kerne 2007), medical teams (e.g., Klein et al. 2006), and SWAT teams (Bechky and Okhuysen 2011): explicit communication demands substantial efforts in terms of time, cognitive capacities, and technological affordance, which may cause unexpected risks during periods of intense task load. Therefore, members of high performance teams in fact communicate less, and if they do communicate, they do it more efficiently (MacMillan et al. 2004).

In summary, existing studies have examined the cognitive characteristics of high performance action teams and proposed a number of strategies for effective and reliable teamwork. Yet these findings are largely generated from empirical studies of similar contexts and datasets (i.e., small action teams perform in-person tasks in the offline world). When people work face-to-face over shared workspaces, team cognition can emerge naturally (Gutwin and Greenberg 2001). Proximity is also considered an effective dynamic to coordinate team actions (Okhuysen and Bechky 2009). To what degree, however, can these existing theories of team coordination accommodate the new phenomena of virtual/distributed teams?

To explore these questions, CSCW researchers have focused on designing systems that coordinate geographically distant teams' activities. Two main strategies to support virtual/distributed teams have been identified: **1) Improving virtual team members' awareness of co-presence.** Geyer et al. (2001) proposed that consistent awareness of team members' activities and the flexibility to move between individual, social, and work mode was the key to successful and efficient teamwork. This is evident in a geographically distant work settings—since team members are not physically co-present, there is a lack of cues of others' status and progress. Similarly, Gutwin et al. (2004) explored group awareness in open source software development teams. Their research had two key findings: a) developers' group awareness was mainly achieved by relying on text-based communication such as mailing lists and text chat; b) such awareness mechanisms greatly depended on discussions happening on the public channels. **2) Communication as a design intervention to manage virtual teams as well as promote team members' commitment to the team and mutual trust.** Many researchers (e.g., Bjørn and Ngwenyama 2009; Dabbish et al. 2012; Hossain and Wigand 2004) have explored how communication technologies can coordinate

distributed teamwork and affect commitment and mutual trust within a team. For example, Huysman et al. (2003) highlighted the so-called 'media stickiness': all virtual teams tended to stick to the particular mode of communication they developed early in the teamwork. This became an important pattern for managing teamwork and solving information problems that the team faced. Dabbish et al. (2012) discussed how inducing communication in ad hoc virtual teams improved team members' affective connection to and caring for the group. Focusing on trust, Hossain and Wigand (2004) noted that a key challenge for managing distributed teams was to develop trustworthy relationships, and that establishing such trust largely depended on the level of face-to-face communication support.

In general, existing research in CSCW has not only shed light on the challenging social/interaction experiences that team members encounter in a globally distributed team but also suggested useful strategies and design implications for building technologies and infrastructures that address these challenges. Like the literature on offline action teams, however, these findings generate from empirical studies of similar contexts (i.e., distributed teams in a relatively 'calm' context of workplace). In addition, some findings/strategies of team coordination in CSCW settings are inconsistent with those identified in the literature of action teams. For example, in CSCW, *explicit communication* has been promoted as a central design principle to improve team coordination. Yet in offline action teams, *implicit coordination* that reduces communication is widely used. It is uncertain what the role of communication would be in other hybrid contexts. In this sense, eSports teams offer a new dataset for exploring team coordination in a mixed context.

3.3. Virtual Teams in Online Gaming

Since eSports is a type of online gaming, it is necessary to explore literature on coordinated behaviors in the gaming context. Multiplayer Online Games (MOGs) integrate communication and entertainment in a computer-mediated environment that evolves through user interaction (Ducheneaut and Moore 2004). In those games, guilds[1] and raiding[2] are considered high-pressure, emotionally intense, and ritualistic team activities (Bardzell et al. 2012; Golub 2010) and communication plays an important role in forming, developing, and maintaining teams. Some researchers posit that in-game communication is more important than playing the game itself (Griffiths et al. 2004). In this view, communication in online gaming is not only instrumental but also social (Hahsler and Koch 2004). In addition to text, voice communication is also crucial for online teams, which can make the gameplay more social (Wadley et al.

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[1] Guilds are virtual associations run by players who are natural organizers; they usually have formalized membership and rank assignments in order to encourage participation; and they involve a complicated leader-subordinate and leader–leader relationship.

[2] Raiding are large-scale, complex group activities that involve 10–40 people working together in real time to solve extreme problems raiding (Bardzell et al. 2012).

2015). Williams et al. (2007) have found that the addition of voice led to an increase of liking and trust among team members in *World of Warcarft*, and Tang et al. (2012) have highlighted the importance of the temporality and spatiality of tactical verbal communications (i.e., 'callouts'[3]) among expert first person shooter (FPS) players who used a shared voice channel to coordinate their in-game activities.

Prior research also points out how varied cooperative communication mechanics support team communication in multiplayer games. Those mechanics differ from automated awareness cues or synchronous/asynchronous text/voice communication. Rather, they allow team members to exchange information by directly interacting with game systems (Leavitt et al. 2016). Toups et al. (2014) classified these mechanics into explicitly communicative ones (e.g., map pings to draw teammates' attention to specific locations) and emergent communicative ones (e.g., self-developed in-game activities). Yet they found that the cooperative communication mechanics as designed game features were usually insufficient for players' social needs. Leavitt et al. (2016) examined how pings (i.e., the non-verbal communicative alerts) can affect the performance of ad hoc teams in a popular eSports game – *League of Legends* (*LoL*). They concluded that while pings allowed for quick and targeted communication in a rapid paced game session, they also posed extra burdens on team members to balance between situational awareness and unexpected interruption, overload, and distraction.

Most of these studies, however, focused on how people played specific games. Some findings were also indecisive when taking different player groups into account: for example, many studies argued that voice communication would benefit team performance and improve the experience of social gaming. Yet Wadley et al. (2015) found that high performance MOG players were in fact likely to give up voice communication for the sake of utility. Not all games are alike; and how different players (e.g., high performance vs. average) coordinate in teams of different natures (e.g., ad hoc teams vs. long-term, stable teams) may also vary. It would be important to take a broader examination of team coordination mechanics in eSports to identify higher-level patterns that could be generalized beyond a particular game, player group, or type of team.

4. Methodology

4.1. Data Collection

Data were collected as part of a larger study that examines player experiences in eSports. After consulting with two professional eSports players, we

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[3] In many online games, 'callouts' refers to places on a map, so players can quickly inform their teammates where the enemies are or where the team needs to go to assist others.

learned that eSports players usually used Facebook groups to communicate and organize events. Therefore, we searched groups on Facebook using keywords related to eSports, including 'eSports,' 'Dota,' 'Overwatch,' 'League of Legends,' and 'LoL.'. Then we sent requests to join the retrieved groups and posted a message on those groups who accepted our requests ($N = 12$) in order to recruit players who had played eSports games as part of a team and were willing to be interviewed as voluntary participants. All players who responded to our messages and agreed to participate were interviewed. As a result, 26 semi-structured in-depth interviews (Table 1) were conducted via text/audio/video Skype chat by the first author based on participants' modality preferences from May to July 2016. In each interview, 23 predefined open-ended questions regarding eSports players' gaming experiences (see Appendix) were asked and the average length of interviews was 85 min.

One of our interview questions investigated how serious participants were with eSports and how they perceived and made sense of the dichotomy of amateur and professional players (Q7). Most of them agreed that the amount of time and commitment they spent and the money they earned differentiated professional players from amateurs. For example, 'a pro player is one who plays as a full time career. This includes both professional team players and full time streamers. The financial aspect certainly plays a part. Most players who I would consider professional make enough to consider it a full time job' (P3, male, 20, amateur); 'if you would consider gaming your career and are earning money then you would be a pro' (P5, male, 21, amateur); and '8 hours a day minimum. Paid by salary or by hour. Actively participate in tournament on the world stage. Heavily sponsored. I would call those guys Professional' (P26, male, 29, amateur). In general, many participants considered a player professional if he/she engaged in the following activities: in a sponsored team playing for tournaments, conducting eSports-related business, or streaming to make income. Based on these understandings, six (23%) of the 26 participants self-identified themselves as professional players and 21

Table 1. Interviewee demographics ($N = 26$).

Gender	Female: 4 (15%)
	Male: 22 (75%)
Age	Average: 21.5 years old
	Oldest: 52 years old
Location	All located in USA
Professional players	6 (23%)
eSports games played	*League of Legends* (*LoL*), *Dota*, *StarCraft*, *Counter Strike*, *Super Smash Bros*, *Overwatch*, *SMITE*, *Hearthstone*, *Guild Wars*, *Halo*, *World of Tanks*, and *Rocket League*
Experience in eSports	Average: 3 years (max. = 15 years)

(81%) as amateur players. Being amateur, however, did not mean simply playing for fun like casual players. Rather, these amateur players were quite serious about eSports and 'enjoyed putting enough effort in to continually improve their gameplay' (P10, male, 19, amateur). Many of them were even motivated to 'go pro' if they had the chance, as the following quotes show: 'I always said if I played my cards better I would be a professional in some way' (P6, male, 21, amateur);. 'my dream career is to work in the eSports industry, either in playing, marketing, event coordination, or something related to my major (communication technology)' (P11, male, 19, amateur); and 'with school and work it [eSports] is not something I have much time for, otherwise I'd probably try to go pro.' (P20, male, 20, amateur). In this study, we distinguish between 'professional' and 'amateur' based on participants' own perceptions of what these two concepts meant for them, as these perceptions were tightly linked with their attitudes toward coordinating team activities.

Both authors were experienced gamers and had conducted extensive research on social/collaborative game play (e.g., Freeman and Wohn 2017a, b; Freeman et al., 2015, 2016a, b; Wohn and Lee 2013; Wohn et al. 2011). As a supplement, the first author observed players' social interactions on the identified Facebook groups at different times every day for one hour from May to July 2016 and the second author spent 250 hours engaging in observational work in varied eSports games (e.g., *Overwatch*). These observations were used to understand the gameplay contexts and eSports culture so as to better interpret players' accounts in the interviews.

4.2. Data Analysis

Using a Grounded Theory approach (Glaser and Strauss 1967), an in-depth qualitative analysis was conducted to code and interpret the data. This method focused on players' unique perceptions and understandings of their teamwork in eSports in order to provide rich and detailed descriptions of human experience (Lindlof and Taylor 2002). Specifically, our coding and analytical procedures were:

1) all authors closely read through participants' narratives to acquire a sense of the whole picture about their experiences and attitudes toward eSports teams and teamwork;
2) all authors identified a preliminary set of narrative themes emerging in participants' experiences and interpreted them in light of the authors' observations and expertise in gaming culture; quotes from participants' narratives were used to support authors' interpretations;
3) three months later, all authors repeated step 1 and 2 to increase the intra-rater reliability;
4) all authors collaborated in an iterative coding process to refine initial findings from step 2 and generate a rich description synthesizing those themes;

5) initial findings were shared with the two professional eSports players mentioned above for feedback and validation.

5. Findings

In this section we present our findings about team formation and coordination in eSports, including how players identify and select potential teammates and strategies they use to coordinate their play. A significant benefit of our dataset is that it includes both (self-identified) professional and amateur players who have played a wide range of different eSports games and engaged in both random matchmaking teams and long term, stable teams. This diversity allows for a broader examination of team formation and coordination in different contexts. Therefore, we did not specifically separate results related to professional versus amateur players for findings regarding both player types in the hope of offering a more comprehensive picture of eSports teams. Yet we still highlighted the social practices or patterns that were not shared between the two types of players, if any, to demonstrate players' unique social needs and behaviors in their teamwork.

5.1. Formation of Teams: Identification of Teammates and Selection Criteria

Our first research question explores how eSports players identify potential teammates. We found that both professional and amateur players tended to use a two-fold process of identification and criteria to form their teams, though their priorities and strategies varied. Identification was a seeking process that described where and how they found a pool of potential teammates, while criteria described how they whittled down and selected people from that pool.

5.1.1. *Identification of Teammates*
Optimizing Offline Networks to Identify Teammates. By far one of the most popular methods for amateur players to find teammates was through existing offline social networks. Eleven amateurs described how they tapped into classmates, friends from high school, and family members. eSports became just another social activity. As amateur players often focused on having fun and solidifying existing relationships, their friends' actual gaming skills did not seem to matter much: 'I don't care what rating they are. I play with them because it is fun and I have that friendship with them,' said P4 (male, 20, amateur).

Another motivation for participants to recruit from existing friends was to build and sustain a stable team: the formation and development of an eSports team required a great amount of investment in terms of time, effort, emotion, and money; and the high interdependence among team members suggested

that the cost of one member leaving shortly would dysfunction the team as a whole. To protect these sunk costs and to avoid feelings of disappointment and betrayal, participants tended to rely on people whom they already knew and trusted to assure a sustainable virtual team. P5 (male, 21, amateur) explained:

> If you aren't paying the players then they have no reason to stay with you other than that they enjoy playing with you. With people you know in real life, part of your relationship with that person is their stake in the game. With online strangers, there is no stake and they can get up and leave at any moment that happens extremely often.

For them, it was natural to do so since they already knew that they would be compatible with their offline friends in terms of personalities. In contrast, professional players seldom recruited team members from their offline friends. According to P15 (female, 18, professional), 'it is hard to find someone who has comparable skills as mine in my own social circles.' For them, playing eSports was a serious task that required specific skills rather than a casual activity with friends. Yet this did not mean that they completely ignored their offline social networks. Rather, they would use their existing social connections to reach skilled players. P16 (male, 20, professional) said, 'we'll send inquiries to top players based on recommendations of amateur and professional players we have existing relationships with, while also keeping an eye on collegiate and high school tournaments.'

In sum, both amateur and professional players resorted to their offline social networks to recruit team members. Yet the former preferred to play with their actual offline friends while the latter mainly used the network to reach other expert players, who were most likely strangers.

Leveraging System Matchmaking Features to Identify Teammates. Some players enjoyed teaming up with online strangers to gain fresh social experiences – they described this process as an adventure, an exploration of uncertainties, and an escape from their existing social circles. Nine participants (all amateurs) said that they relied on the matchmaking features in the game systems to identify potential teammates from millions of online strangers. These complex algorithms differ in their criteria depending on the specific game, and constantly change based on the game operator's analytics. Yet the matching is not completely random – for the purpose of fair gameplay, it usually involves parameters of pairing players who have similar levels of skill or rankings in the game. Many participants perceived finding a compatible teammate through the matchmaking system as more of a passive strategy where there was little control one could execute over the process of seeking. Yet this uncertainty can be surprisingly appealing: 'You are connected by chance. You never know who will be introduced to your life in the next second. I love meeting people,' said P18 (female, 18, amateur).

Sometimes players organically found strangers whom they liked and developed close relationship with them over time. In this sense, one of the most significant benefits of system matchmaking for many amateur players was that they could meet people transcendent of geographic location. P10 (male, 19, amateur) noted, 'I met this guy from Canada and we just messaged each other. He invited me to Skype and I started playing with all of his friends. There is always a possibility to meet new people and kind of get to know each other through the game.'

This was somewhat different compared to how professional players found teammates. Some professional players were open to the idea of playing with strangers in their spare time, as P24 (female, 18, professional) explained, 'I am willing to make a connection with complete strangers. I've learned that sometimes, great things can happen from talking to strangers. You may find another awesome candidate for your team. Who knows.' Yet they still tended to recruit team members who were physically close unless they were one of the nationally or internationally known stellar teams who could afford hire the best players all over the world. P16 (male, 20, professional) explained, 'Geographic location is a big factor, and most top players in a region know each other. We would try to recruit them first. Unless you're a top level professional team, it's not viable to draw from a talent pool outside of your own region. Relocation costs, family issues, financial stability, etc. all play a big role.' According to him, practicing face-to-face was often required for professional teams to 'bond' together so as to achieve the best team performance. Sometimes players even had to live together in a so-called "gaming house" with their teammates, which would be very expensive if they needed to bring in someone far away.

Therefore, while both amateur and professional players were willing to play with online strangers, amateurs tended to play with people who were geographically distributed to expand their social circles, and professionals often played with those who were close for the convenience of necessary face-to-face group practice.

Crowdsourcing Social Media and Online Forums to Identify Teammates. Both amateur and professional players discussed the possibility of seeking potential teammates as a crowdsourcing practice: using online forums or social media to gather resources and talents in order to form their dream team. This was especially important for those who craved to become one of the best teams in the world.

The most common sites used to recruited team members were Reddit, Facebook pages, leaderboards, and online game forums. Yet they were often cognizant and selective about which sites were best for certain games. P19 (male, 19, amateur) said: 'In LoL specifically, I used to browse either the public forums or forums on a third party site like Reddit to find teammates from around the continent.' Players of *World of Warcraft*, however, mentioned using leaderboards:

High level arena was a staple years ago to how good of a gamer you were. 2v2 , 3v3, 5v5 format. The best balance existed in 3v3. So it was most sought after title or #1 seed. Looking for a partner in that was like finding a needle in a haystack.

> We would search the entire *WoW* populous for potential. There were leaderboards that existed on every server so you would go in thinking, 'I need this class or this type of player.' (P14, male, 23, professional)

The unique technical features of each social media also afford some participants' special needs for team members. For example, a couple of participants mentioned how the interactive livestreaming service Twitch (a platform where gamers can broadcast their gameplay live and chat with viewers in real time) enabled viewers not only to watch the streamer's play style but also to interact with him or her synchronously. Another example is Facebook pages; many participants mentioned that they found 'birds of the same feather' in those groups. For instance, P22 (male, 22, professional):

> *Overwatch* is fairly new, so everyone is either playing with friends or asking around on *Overwatch* Facebook pages or Facebook pages for other games they play, or even online friends from other games. *Smash* is completely different. It's a console game that can't be played online, so the community grows through Facebook socializing and *Smash* specific Facebook pages.

At last, similar to in-game matchmaking systems, an obvious benefit of using social media was that participants were able to expand the scope of their search, finding teammates with higher skill levels or more compatible personalities from other countries or locations far from theirs. When searching online, participants, no matter they were amateur or professional, used a combination of passive and active strategies: sometimes they browsed online forums, looked at advertisements for team members, and decided whether they would respond to the call; other times they would be the ones posting the advertisements with a clear idea of what type of team members they preferred. While most amateur players were prone to the idea of using social media to seek physically distant team members, professional players' attitudes were somewhat split. With concerns of financial investment (as we mentioned in the last section), some still endeavored to use social media to seek teammates who were geographically close, while some others who belonged to more established.

Using Formal Recruiting Methods to Identify Teammates. While the first three methods (i.e., offline social networks, system matchmaking, and social media crowdsourcing) were usually considered unstructured and favored by ama-teurs, professionals used more formal means of recruiting such as scouting, interviews, trial period, and word of mouth to seek highly skilled players. Six self-identified professional players mentioned that they used formal recruiting. P14 (male, age 23, professional), who used to manage a profes-sional team, highlighted how rigorous the recruiting process could be: 'We will find the ones on top of the leaderboards, and trial them for hours. It's always about reputation. OMG the application process was nuts.'

Though skill seemed to be the main concern in the formal recruiting process, personality and compatibility were not ignored. In fact, their significance was the very reason why the formal recruiting process could be extremely time-consuming. For example, P25 (male, 18, professional), who was the founder and operator of an eSports organization, described tryouts as being a multi-stage process that involved assessment of both skill and compatibility:

> I went through a 2 month process before picking the members of my roster for my team, because I went through interviews to learn people's playstyle, their roles, what they are comfortable with playing such as champions [characters that a player plays in *League of Legends*]. Then it comes down to 75 people I deemed as 'Worthy,' when only 5 can be on the starting roster.

Under some circumstances these formal methods of recruiting could also trigger the transition from an amateur to a 'pro,' as P25 added, 'I have met people who started the application to "play" but then took it as a serious job after the interviews.' For most amateurs, however, these methods still seemed to be too intensive, serious, and exhausting.

5.1.2. *Selection Criteria for Identifying Teammates*

With the understanding that multiple factors were taken into account in identifying potential team members, we now turn our attention to players' decision-making process of selecting compatible team members out of the potential pool (i.e., the selection criteria).

Gaming Skills: Fundamental for Forming a Team. Half of our participants, including both amateur and professional players, considered gaming skills essential for forming a team, since a team could not achieve high performance if members had no or low skills. For example, P4 (male, 20, amateur) described, 'I generally look for a player who is at my skill level. I play mostly ranked play that is where I get a rating for wins and losses, so I want someone who is going to perform the same that I am.'

The emphasis on skills was even more prominent among professional players, especially because it was harder for them to find people of their proficiency. They seemed to be ready to play with someone they did not particularly like for the sake of high team performance in professional tournaments, which would lead to reputation and financial benefits:

> Skill is by far the most important. While we do take into account personality, it usually doesn't become a factor unless there is a significant problem. You need to win to attract sponsorships to help you grow, unless you're able to attract Silicon Valley investors. The ultimate goal is to make money' (P16, male, 20, professional)

The definition of skill, however, varied under different circumstances. All participants agreed that achieving a certain level in a game signaled a strong familiarity with the game in general, but sometimes they were looking for players with more specific skills. For example, to play games that have different characters—each with different abilities—it was important to find a team member who not only played well but played a role that complemented other team members' roles. The criteria of high skill could be subjective: It was not determined by a player's overall ranking but depended on which specific role that the team as a whole needed most at a given moment, as P20 (male, 20, amateur) described:

> If it's a serious game and I have a choice, experience is usually my first factor in choosing. Someone who has at least finished through level 30 [in League of Legends after level 30, then you stop leveling and play for regional rankings instead]. After that it usually comes down to roles and their skill in those roles.

As a result, gaming skills were valued by both amateur and professional players when selecting potential team members, though their definitions of what could be counted as 'high skills" may vary.

Attitude and Personality: Bonding the Team as a Unity. Gaming skills were fundamental for an eSports team, but meshing personalities and gameplay styles was critical for making this team sustainable. This was especially true for amateur players. For example, a few participants explained why being a pleasant peer was the key to bond the team, as P1 (male, 23, amateur) described, 'You can always develop skills or teach mechanics over time. But you cannot teach passion or attitude. A selfish player is a bad fit no matter how good.'

For some amateur players, attitude and personality even overweighed gaming skills. P5 (male, 21, amateur) noted, 'Skill can be taught easily. Manners are a different story. […] If someone has skill but doesn't work well with others, that's something a lot harder to teach and most people who are bad at working with others don't have a very strong desire to learn how to.' Several players also described that they used people's responses to negative situations to decide on whether or not they should team up. For example, P4 (male, 20, amateur) said, 'I don't want to play with someone who complains all the time or tries to forfeit the match. Negative attitudes are no fun to be around.' Similarly, being a sore loser would drive potential team members away: P3 (male, 20, amateur) said that it was important for the ideal player to not be 'toxic' and verbally abusive, and P10 (male, 19, amateur) described how one teammate would always start cursing when he was killed in the game, making the gameplay difficult and the gaming experience quite unpleasant.

Again, it should be noted that there was a difference between amateur and professional players. Personality was not the top priority for the latter because their goal was task-driven and focused on team 'productivity' overall – to win rather than having fun. P22 (male, 22, professional) explained,

At a casual level, it's 99% personality. Once people start getting more and more competitive, personality still matters, because being on a team with someone you can't cooperate with is extremely detrimental, but skill starts taking over. […] The more competitive it is, the more skill matters.

This did not mean that professional players would not take personality into account at all. Once establishing at having the technical expertise, they started to focus on 'soft' skills such as attitude and personality or at least seek a balance between skills and personality. P14 (male, 23, professional) described, 'Skill was what you always wanted to see. You need proper timing, proper knowledge, etc. After that you can look more into personality or try to balance both. You need someone who wouldn't rage quit, or use you for high rating only to leave to another team.'

In general, participants made it clear that getting along with other teammates was important for both amateur and professional players. Yet the former emphasized teammates' compatible attitudes and personalities much more than the latter.

Willingness to Communicate: Breaking Geographical and Language Barriers. Seven participants, including both amateur and professional players, emphasized the importance of effective communication in better knowing team members and coordinating team endeavors over distance, time, and culture. P12 (male, 18, amateur) considered communication a necessary instrumental factor for accomplishing in-game tasks (e.g., win) and was reluctant to work with team members who were unable to communicate well because it led to unavoidable failure: 'For example in counter strike there are certain call outs for each map and if someone doesn't know the callouts then the team cannot succeed in winning the match because the communication is off.' Similarly, since the lack of proper communication directly indicated a loss, P10 (male,19, amateur) described how teams would try their best to have members constantly talking to each other: 'Our mid laner[4] has a problem where he kind of, it somewhat sad to see because he is a nice guy, but if he is getting his lane camped[5] and he's under pressure and he's starting to crack, he won't communicate at all. And we kind of have to coax him out of that shell.'

For some other players, good communication skills were not only tightly linked to instrumental goals (e.g., win a match) but opened opportunities for knowing, understanding, and being close to each other. P18 (female, 18, amateur) explained how a satisfactory in-game communication led to interests in chatting with a player more and even inviting him/her to join the team later: 'Usually if I get along with certain players and we have an open space in our team, we will invite them to join us

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[4] In *LoL*, there are three paths that champions follow to defeat enemies: Top, Bottom and Middle. A mid laner is a player who follows the middle path.

[5] In *LoL*, this term refers to a situation when a jungler (or players from other lanes) is devoting more attention than normal to a player's assigned lane or waiting around this player's lane for a surprise attack. Someone who is angry that he/she is losing often uses it as an accusation.

for the next couple of games. We will invite them to our skype call so nothing gets mixed up by in game communication.'

In addition, eSports are an international playground. Therefore, it is important for players to avoid potential language issues when playing with teammates who speak a different language, or to identify a way to work around the language barriers. Apparently, this is not just an English-speaking issue but rather universal. P6 (male, 21, amateur) described:

> Teams have much higher success with 5 English-speaking players than people who can't communicate well in a native language. A cool example is in China. Chinese teams began importing Korean players, but those teams with a mix of Chinese and Korean players speak English because it's what they have in common.

At last, it should be noted that all of the above criteria (skill, personality, attitude, and communication) could seamlessly intertwine in a single cooperative unit, which generated a synergy of attraction. Most participants called it 'chemistry' – one of the most ambiguous and fuzzy criteria for teammate selection. They described such chemistry as being a type of feeling, subjective experience, or intuition. P4 (male, 20, amateur) defined 'chemistry' as a willingness to be with someone: 'When I meet someone in game that I liked playing with sometimes I will invite them to be my friend in the game, and we will play more together.'

For some, such chemistry was instantaneous; for others, it took effort and time. In professional teams, players often attributed it to similar philosophical and tactical approaches cultivated during collaborative gameplay over time, which signaled the team's high performance. P24 (female,19, professional) described, 'I play games with teammates that I click very well with! That means that we think similarly when it comes to the game. That's the very sign of how successful and compatible we are.'

For many amateur players, such chemistry could lead to deeper relationships that were extended outside the game as well. As a result, the focus shifted from playing the game to enjoying the company of each other. For both groups, chemistry indicated a recruit that was a good fit for the team.

5.2. Developing Capacity to Coordinate

eSports teamwork is situated in a highly competitive virtual environment. Its successful performance depends on both tacit coordination and fast group decision-making. In this section, we present three strategies that participants used to develop the capacity to coordinate their activities.

5.2.1. *A Natural Switch between in-Game and out-of-Game Multimodal Interaction*
It is not surprising to observe that in-game and out-of-game interaction is an efficient strategy to foster many eSports players' capabilities to coordinate their team

activities, since the willingness to communicate with others is considered one of the most important criteria for selecting compatible team members.

Above all, strategic communication is important in eSports because the interaction takes place in a virtual environment. The lack of behavioral cues such as eye contact or body language makes it difficult to coordinate fast-paced teamwork. Therefore, both amateur and professional players used a variety of multimodal communication tools in gameplay for the sake of synchronous information sharing, status updating, and group decision-making under extreme time pressure. Although most games already had in-game communication features, many participants chose to use a third party applications such as Skype[6] and ooVoo.[7] Participants also preferred those specifically designed for gaming or watching game streaming (e.g., Discord, Curse, and Teamspeak) due to their low latency, in-game overlay (i.e., seamless integration with the gaming environment), encrypted server to client communication, and the affordance of multiple chat channels/groups.

> I'll Skype them [my team members], so we will have an audio chat going on during our games. This helps a LOT when we're planning strategies in-game and need a way to communicate quick decision-making. (P25, male,18, professional)

> I also have a Teamspeak server, so I voice chat with the people frequently. There are some people I regularly play games with that I've never met, but have been talking to for 3, 4 years. (P8, male, 21, amateur)

While most of these communication tools supported multimodal communication (e.g., videos, images, GIFs), participants mostly chose to stick with text and audio. For them, these two modalities were most efficient to coordinate their teamwork but 'seeing' each other was unnecessary. P5 (male, 21, amateur) said, 'We have a Discord channel that we all kind of hang out in (there are about 10 of us). I don't think any of us really care much for video chatting versus voice only. We just don't feel the need to see the other person face to face when we can interact without it just as easily.'

In addition, many participants rarely separated their game-related and task-oriented communication with personal, social communication. For example, even if the participants were talking to each other outside of the game, their conversation topic would often be about the game:

> We do often just kind of call each other randomly and talk for what I feel is a pretty long time (1-3 hours). It usually starts with 'OMG did you hear about this new patch to this game?' and then branches off to other games until it becomes small talk or talk about our days. (P22, 22, professional)

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[6] An instant messaging software that offers free online text, audio, and video chat.

[7] A free software that offers video chat, instant messaging, and collaborative stories.

Likewise, even if players were engaging in a competitive gaming session, they would share personal information that was irrelevant to the game. Teams who met online and were in different geographic locations especially tended to do so in order to know each other more. The following accounts well explained the mismatch of communication content and context:

> Chatting is more interesting and gives a new perspective if you're talking with someone in Korea and someone else in California! We chat [about] day to day life in their area, or differences between countries. Politics sometimes. (P20, male, 20, amateur)

> When we chat, mostly gameplay but perhaps some small talk. My friend who introduced me to the game would add players he knew from league to our skype calls regularly. Usually those conversations were an even mix of daily stuff and league. (P3, male, 20, amateur)

This communication feature, however, seemed to be more evident among amateur players than professional players. One reason was that professional players' high team performance largely depended on frequent communication out of the game to help either strategize the gameplay beforehand or reflect on (un)successful team performance afterwards. P25 (male, 18, professional) explained how these pre-game planning and post-game discussion sessions served as opportunities to evaluate team members and coordinate future games: 'Usually if someone plays really well in a game, there's a chance that my group would friend them through the game and invite them to play again. Whenever this is done, my group usually asks for the person skype and everyone talks through there because it makes it way easier to communicate and plan that way.' Therefore, professional players tended to focus on game-related, task-oriented, instrumental communication both during the actual gaming sessions and out of game, or they at least would rather complete such communication before moving to social conversations.

5.2.2. *A Seamless Mix of Multiple Communication Platforms*

Another popular strategy that both amateur and professional players used was to seamlessly mix multiple communication platforms or channels (e.g., text messages, Facebook chat, and social media) to better coordinate their team activities. For example, professional player P24 (female, age 19) explained how she used text messages 'a lot in high school' because her team members were 'frequent texters.' Even when communicating with the same people, some participants chose different communication platforms for different purposes. P11 (male, 19, amateur) described that he used Facebook chat for 'casual conversations' with team members out of game and Skype for chatting during gameplay. This pattern was also consistent with how young adults communicated across different channels (Isaacs et al. 2012; Wohn and Birnholtz 2015).

In addition to private chat or messaging applications such as Skype or Discord, social media was a means of 'public' communication that went beyond single instances of interaction. Teammates 'friended' each other on Facebook and were able to build personal relationships beyond dyadic or team interaction, since they could access a more comprehensive image of their teammates' social lives. Players also considered social media an essential way to verify someone's true identity, build mutual trust, and promote a sense of community. P8 (male, 21, amateur) noted,

> I have some [team members] added on Facebook and Snapchat. I've done everything from small talk to serious conversations with some people. Chat, watch movies together through sites, some of what we can do is limited of course. My university is a very active league community so we have Facebook to bring people together.

Due to the wide range of social media affordances, we could not pinpoint a use of a single social media for a particular behavior—rather, the nature of a certain social interaction largely depended on the specific affordance that was utilized. For example, P10 (male, 19, amateur) described how his team used group messaging through Facebook: 'if somebody is on campus and wants to meet up for lunch, then whoever is on campus at the time can meet up for lunch.' In a different example, P25 (male, 18, professional) mentioned how his old teammates of *LoL* used to be classmates from high school, but since then, they went to different colleges so they communicated through a Facebook group. 'Sometimes about League, sometimes just having fun bantering.' Overall, both amateur and professional players used a range of communication methods, from text, social media, voice, to face-to-face. As a result, this mix of communication often led to closer offline relationships among teammates, no matter for amateur or professional players.

5.2.3. *Offline Social Activities: Reinforcing Coordination by Hanging out Together*
Though playing eSports is a computer-mediated activity, engaging in various offline social activities in fact effectively maintained and reinforced a team's capacity to coordinate. This was a common experience for both amateur and professional players, but seemed to be valued more by the professionals.

One of the most popular offline social activities that players did together was to play other online games or board games, as P15 (female, 18, professional) described, 'It's funny because a lot of times we'll still end up playing games together! Even in person.' Similarly, P12 (male, 18, amateur) said, 'We usually gather together play some smash on the Wii U, or some board games.' In addition, participants described watching other people—usually professionals—playing on YouTube or livestreaming sites (e.g., Twitch) as the most distinctive social activity that eSports teams would do.

Numerous participants said that their activities were 'normal' or 'traditional' things that offline friends often do. They described going to the movie theaters, amusement parks, playing (offline) sports, going out for coffee, traveling, bible studies, and attending sports events. The choice of activities usually depended on personalities, personal preferences, and local culture. For example, P16 (male, 20, professional), who had lived in many different regions and played in different teams, said that in California he usually went to clubs, movies, or sporting events, whereas it was mostly eating and karaoke in Taiwan.

Another finding was that participants made an exerted effort to arrange face-to-face interaction. P10 (male, 19, amateur), a college student, described how members of his team would plan to go to see a movie as a group. He explained that most of the team members lived in the dorms and played games in the dorms, but that they 'made efforts to get outside of dorm rooms and kind of interact with each other face to face.' P21 (male, 21, amateur) mentioned how simply eating together on a regular basis brought people together and quickly led to close interpersonal relationships: 'When I had my local team, I took it upon myself to take everyone to lunch/dinner. I wanted to form a team bond and share laughs. Just get out of the room and have some fun. We all became friends and helped each other in emergencies like running out of gas, or car in repair.'

Professional players would even spend a large amount of time, money, and effort arranging special events, such as parties, vacations, and team building activities. P14 (male, 23, professional) said that every summer someone from the team would invite the entire guild out to his house for a weekend: 'We bonded so well there. The big thing he wanted to promote was family aspect. [He] wanted us to really get along so when it came to killing things together, we'd be efficient.'

For those participants who initially found online strangers as their teammates, hanging out together offline was smooth in some cases, shocking in others, and purely fascinating for some. P18 (female, 18, amateur) narrated the complicated feeling of both excitement and awkwardness of her first offline meeting with a team member: 'I had this large grin on my face and was laughing but it was so surreal. He couldn't form words while I just kinda rambled. I remember touching his shoulder and in my head I was "he is real! He's not a computer screen anymore!"'

In our study, most participants, both amateur and professional players, confirmed that the conducting offline social activities with teammates often amplified their team coordination in a positive manner, as P17 (male, age 22) explained, 'It almost felt natural to meet up. You already spend a bunch of time with your teammates while you're playing online. Now you know a lot about their lives and who they are as a person.' It also should be noted that in some other cases, hanging out offline might create disappointment and even undermined their willingness to coordinate. P16 (male, 20, professional) described such a case: the disconnection in his teammates' online and offline personas in fact discouraged him to work with them afterwards.

6. Discussion

By investigating team formation and team coordination in a unique online social context (i.e., eSports as a combination of action and knowledge/decision teams), we have highlighted online users' particular needs for distributed teamwork in a highly stressful environment (e.g., a mix of online and offline team formation/coordination strategies; technology-enabled knowing and judging before the team is formed; and reinforcing personal relationships to enhance the professional performance) and higher requirements for sophisticated multimodal communication patterns to sustain such coordination. In this section we discuss how our findings contribute to a better understanding of and further address the three issues regarding team formation and coordination that mentioned at the beginning of this paper.

6.1. A Mix of Online and Offline Team Formation Strategies

As we have shown, prior to any team activities, players sought varied technologies and tactics to identify and select teammates based on a set of criteria. Both professional and amateur eSports players had these mental models in place, mostly based on their prior experience. This process not only directly affected the role allocation afterwards (Dafoulas and Macaulay 2001) but also the productivity (e.g., performance) and sociability of the team over time. In this process, indicators of a specific competency (Rodrigues et al. 2005) was not the only desirable system feature for team formation. Instead, finding cues with regard to other factors that are unrelated to competency (e.g., attitude and personality) was a crucial task for team selection.

Especially, we found that the formation of an effective eSports team depended on a mix of strategies of member selection and team maintenance used both online and offline. On the one hand, founders' human and social capital (e.g., offline social networks) and self-organized strategies (e.g., crowdsourcing social media), which were often conducted to form online teams (e.g., Kraut and Fiore 2014; Lykourentzou et al. 2016; Pobiedina et al. 2013), were widely used to seek a pool of potential teammates. On the other hand, evaluations of team members' personal attributes and social attributes (e.g., Hodgkinson and Healey 2009; Reagans et al. 2004), which were crucial for creating effective offline teams, were also popular strategies to identify compatible candidates from the pool.

Yet it is often challenging to reveal online users' personal and social attributes in online communities. Potential conflicts of individual or cultural differences may already be embedded in the team before any coordinated activities can be performed. A valuable strategy that eSports players used to learn about potential team members' personal and social attributes in an online environment was to spend a certain amount of time playing with each other temporarily in order to identify (in)compatible personality traits before forming a sustainable team. This computer-mediated 'trial' process of knowing and judging has not been widely considered a useful team formation technique in studies of online communities and offline teams, but is

regarded as meaningful as (if not more than) using quantitative measures (e.g., levels and scores) to select team members in the context of eSports. At the same time, it is important to note that these temporary teams were only possible because of the relatively low cost involved with finding a new team, due to the abundance of players in this space. This makes the eSports context unique because the human resource pool, while not unlimited, is plentiful. To a certain degree, finding a good team is akin to online dating minus the romance factor — evaluating and identifying the most compatible partner in a large pool of candidates.

In this sense, a design implication is to better reveal offline social cues of a potential team member (e.g., degree of friendliness, frequency of procrastination, and personal hobbies) at the very early stage in a collaborative online system for successful team formation. In addition to the widely adopted features such as levels of skill, time when last online, and total amount of time online, offering indicators of someone's overall personality and behavioral patterns would further improve the efficiency and accuracy of selecting compatible team members by shedding light on not only instrumental qualities (e.g., skills and competency) but also the probability of sustaining a team (e.g., willingness to cooperate and sense of responsibility). These social cues could be generated by some elements of player statistics that indicate cooperation, or even ratings by other players.

6.2. High Performance Teams in Online Environments

We made the claim early in this paper that eSports offers a valuable and unique opportunity to further explore the social and organizational processes of team coordination in a hybrid context. Our findings still confirm that some strategies (e.g., effective planning; see Stout et al. 1999) used in offline action teams to improve *shared mental models* and *situational awareness* would also lead to successful coordination in collaborative online systems. Regardless online or offline, in a relatively 'calm' context of a workplace or under a risky, stressful, and time sensitive circumstance, a shared understanding and collective knowledge about the task and each team member's responsibility is always crucial for effective team performance. Many eSports players were well aware of this and preferred to spend a substantial amount of time to strategize their gameplay beforehand or reflect on successful or unsuccessful team performance afterwards.

Our findings also point to some aspects of team coordination that may have been overlooked in other studies. First, research on offline action teams who perform in highly stressful and risky environments consider shared leadership, dynamic delegation, and role shifting (Bechky and Okhuysen 2011; Toups and Kerne 2007) effective strategies for coordinating teamwork. Yet eSports teams showed a decentralized team composition – there is no obvious leadership structure such as project manager and developers in a software development team or captain and players in a soccer team. Even when leadership existed for formality purposes, the effort required from all team members was almost equivalent. Players, however, must

also continue to adjust to their assigned roles in the team and improve the compatibility to others' roles over time. Eventually, such a combination attributed to the stability, compatibility, and high performance of a team in an online environment.

Second, we offer a new insight on how members' commitment affects team coordination. Many studies of online teams suggest that increased commitment (e.g., Dabbish et al. 2012) would improve how a team coordinates. While our findings did not contradict this claim, we found that short-term or even no commitment could still lead to successful teamwork under some situations. For example, when playing for leisure, players placed high importance on personality and attitude, leading to strong commitment and stable team structure. Yet the higher the competitive stakes were, the more likely they were willing to sacrifice those factors for hard skills. A team of highly skilled players could still team up temporarily for positive performance even without commitment, though this may not work well in the long run. Such a complex and fluid relationship between degree of competitiveness, skill and coordination requirement, and team commitment highlights the importance of 'chemistry" for high performance teams in online environments – it serves as a mix of both subjective and objective factors: objective factors determine whether and to what degree members are qualified/capable of taking actions and performing tasks in a coordinated way, while subjective factors determine how team members react in tense, risky, and unclear situations (Muramatsu and Ackerman 1998) and generate a sense of 'sharedness.'

Third, our findings offer empirical evidence for how communication affects a team's capacity to coordinate in hybrid contexts. Implicit coordination, a strategy that reduces communication and is largely used in offline action teams, did not appear to be an effective strategy for eSports teams due to the lack of real time in-person interactions and non-verbal cues. Instead, eSports teams used an extensive volume of communication and wide range of communication applications (including arrangement of face-to-face social activities) to coordinate their teamwork. In addition, communication techniques used by CSCW teams in workplaces were insufficient to improve eSports teams' ability to coordinate, since they had to perform tasks during risky, stressful, and time sensitive work. Rather, eSports players exhibited an even more sophisticated and veteran communication pattern than other distributed/virtual teams by actively appropriating and incorporating various technologies from different domains (e.g., both gaming and non-gaming technologies, both online and offline social spaces). Yet this did not mean that eSports players ignored the time and energy costs related to explicit communication. In fact, their awareness of these risks led to their constant communication with one another even out of game and/or offline: the 'chemistry,' tacit mutual understanding, and familiarity with team members that they achieved via extensive communication in non-gaming occasions effectively helped building their capabilities to coordinate during periods of intense task load, without introducing extra costs and risks,

At last, our findings show how players purposefully (and for the pure enjoyment) engaged in social activities that were irrelevant to their in-game tasks. Many amateur

players described that winning was not their priority since they considered spending time with friends a meaningful experience, while others explained that becoming friends in non-gaming contexts encouraged them to coordinate better in gaming contexts. All of these phenomena point to how studying the uniqueness of eSports teams can contribute to future research in CSCW and HCI to explicate the optimal modalities of communication for different contexts (e.g., competitive, risky, unclear, safe, or stable), and to fully understand the delicacies of how personal and professional relationships could intertwine in virtual teams.

In summary, coordination in eSports teams can be considered comparable to action teams or workplace teams such as software development teams or traditional sports teams because of the common importance of *shared mental models* and *situational awareness*. Yet it is also unique in terms of its absence (or decentralized) leadership structure, the loss connection between strong commitment and capability of coordination, the even more sophisticated and veteran communication pattern, and the delicacy of intertwined personal and professional relationships.

6.3. Team Mechanics in Online Gaming

Though the focus on social gameplay is not new in game studies (e.g., Bardzell et al. 2012; Williams et al. 2007), our findings add nuances to this issue by shedding light on how team formation and coordination are situated in and driven by particular games, player groups, or types of teams. We have discussed how amateur and professional players showed distinctive patterns of identifying, selecting, and coordinating with team members. These differences demonstrate the need for an online system that can accommodate various contexts and user groups' needs for team-up and coordination. The selection criteria for potential team members are not standardized but dynamic; the weight on each criterion also varies across different users. In this sense, it is necessary to introduce a customized filter feature to any system that endeavors to facilitate team formation and coordination: In addition to reveal both social and instrumental cues of a potential team member, it also supports context-sensitive, personalized recommendation based on user-generated/modified criteria.

Another finding is that while existing studies highlight how cooperative communication mechanics (e.g., pings and gesturing) support team coordination in online gaming, our participants did not specifically mention them when describing how they coordinated in gameplay. Possible reasons can be that participants only considered self-motivated personal actions 'team coordination.' Therefore, coordination mechanics that were built in gaming systems did not count; or that those mechanics had been seamlessly embedded in their teamwork and became a natural/invisible part of their gaming experience. Therefore, our participants' neglect of these built-in game features raises interesting questions regarding how eSports players perceive and understand the meaning and significance of cooperative communication mechanics to their subjective gameplay experiences.

Moreover, our findings contribute to a growing social science literature in HCI and CSCW on multimodal communication in online social spaces (e.g., Wadley et al. 2015; Williams et al. 2007; Tang et al. 2012). In our study, both amateur and professional players strongly preferred voice communication over text, which differed from Wadley et al.'s (2015) finding that high performance MOG players would sacrifice voice communication for utility. The fast paced gameplay in eSports can be a possible reason, since it would be challenging to type while controlling the game with one's hands. We also found that eSports players engaged in all modes of communication (e.g., text, voice, videoconferencing, and even face-to-face) outside of the game. Professional players in particular valued face-to-face communication. Current game systems do not have the semi face-to-face modality (e.g., via webcam) built into the system. An interesting question emerges: How would seeing the faces of someone's teammates on the screen in the gaming session alter team coordination strategies? Would it reinforce the trust and promote team performance in virtual environments, or vice versa?

7. Conclusions

Traditionally, CSCW studies focus on 'work'—the tasks that people carry out and their workplaces—and 'groupware,' which is technologies that do or could provide support for work (Borghoff and Schlichter 2000; Grudin and Poltrock 1994). The evolution of sociotechnical systems, however, has allowed for the emergence of many new forms of teams for all types of user groups in various contexts (e.g., collective content creation, making, multiplayer online gaming, citizen science, and crowdsourcing).

These phenomena have introduced new challenges for designing and implementing collaborative systems. More and more team activities that were traditionally offline are now incorporating mediated elements where there is a mix of physical and computer-assisted activities (e.g., war, crime-fighting, rescue operations). In this work, we have used eSports teams to investigate how team formation and team coordination operates in this particular hybrid environment. This study sheds light on this understudied yet emerging genre of mixed-form CSCW; it also provides insights that can open up future research opportunities for expanding and advancing existing theories of computer-mediated team formation/coordination by taking the diverse context of coordination, the seamless interweaving of (or tensions between) personal (e.g., romantic/intimate) and professional relationship, and the decision making process prior to coordination into account.

At last, a few limitations of our study should be noted. All participants were volunteers recruited from Facebook groups. There was a potential bias toward players who used social media. In addition, interviews were the primary data with online observations as supplement. In future research, a variety of other data sources (e.g., logs and large-scale surveys) could be used as a way to reach a broader participant population and further validate findings from the interviews.

Acknowledgements

1. Appendix

List of interview questions
1. Have you read the information sheet I sent to you? Do you have any question regarding this interview?
2. Can you tell me something about you? Such as your gender, age, location, and occupation?
3. How long have you been engaged in the field of eSports?
4. What's your definition of eSports?
5. What are the eSports games you usually play? What types of games you consider "eSports"?
6. Why did you start to play eSports games?
7. How serious are you with eSports? Is it a hobby or something more? How do you feel about differentiating amateur v. pro players? Does that dichotomy make sense?
8. How do you meet potential team members? How does this process work? What kind of things do you look for in a teammate?
9. Have you ever used eSports as a way to seek friends, romance (i.e., boyfriends and/or girlfriends) or any type of close interpersonal relationship? If so, how?
10. What do you usually do together with your teammates, in-game and/or out-game?
11. What do you usually do together with your teammates, on a daily basis and/or on special occasions such as anniversaries, birthdays and holidays?
12. Have you ever meet your teammates in real life? If so, can you recall the first time you met in real life? How did you feel about that?
13. In what situations you do not want to hang out with your teammates, in-game and/or out-game?
14. Can you recall any experience you count as "collaboration" with your teammates? Can you list any examples of "collaboration" with your teammates, in-game, out-game or offline?
15. Do you consider your eSports team a group, in-game and/or out-game? Why?
16. How close are you with your teammates?
17. Do you feel encouraged/discouraged to collaborate with your teammates? Why?
18. Do you consider eSports more of a positive or a negative experience (in terms of both gameplay experience and social experience) for you? Why?
19. What are the benefits and/or disadvantages to you of engaging in eSports?
20. Do you use Twitch or other livestreaming platforms to broadcast your games? If yes, why?
21. Do you view others' games on Twitch or similar platforms'? If yes, why?

22. Some might say that eSports games are aggressive since they are highly competitive, can you tell me your thoughts about this?
23. In general, can you summarize the social atmosphere of the eSports community?

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