Communication, Collaboration, and Coupling: What Happens When Friends Try to Escape the Room?

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ABSTRACT
Real-life escape rooms represent a new genre of game where players are locked in a room or series of rooms and have to solve puzzles in order to escape. Escape rooms are growing in numbers as a means to promote team building and collaboration. To understand how escape rooms actually support collaborative practices, we conducted an observational and interview study with 38 escape room players. Our results show that players participate in both loosely and tightly coupled collaboration when the escape room contains a sequential path of puzzles. Verbal exchanges become the primary means for communication and awareness because of the escape room environment and time pressure. Escape rooms containing a single path through them are well suited for those who have an existing relationship as this structure allows players to collaborate at various points while also working individually.

Author Keywords
Alternate reality games; pervasive games; escape rooms

ACM Classification Keywords
H.5.3[Information Interfaces and Presentation]: Group and Organization Interfaces – computer supported cooperative work.

INTRODUCTION
Real-life escape rooms represent a new genre of game where players are locked in a room or series of rooms and tasked with solving puzzles in order to escape. Real-life escape rooms are based on live-action role playing games, treasure hunts, as well as a similar video game genre where players help an avatar escape from an on-screen room [33]. Technology is a core part of many real-life escape rooms. This includes the use of sensors, lights, displays, etc. While the name “escape room” implies a location that one may never be able to leave, in actual fact they are very carefully controlled and monitored by company employees.

Escape rooms represent a collaborative experience where players work on team building, communication, and coordination. They are used by groups of friends who want to socialize as well as companies who want to have team building events [33]. Our research goal was to understand how groups of people collaborate in escape rooms, what collaborative roles they take on, and how the design of the room affects collaboration. By addressing these questions, our aim was to understand what works well in the design of escape rooms and what could be improved to better foster aspects of collaboration, communication, and awareness.

We studied escape rooms through direct observations of players along with post-play questionnaires and interviews. We had thirteen teams participate with 38 players in total. Our study revealed that players enjoyed the experience of escape rooms regardless of whether they succeeded or failed at escaping. Players took on a leadership role when they had prior experience in puzzle solving or escape rooms. We found a sequential structure of puzzles supported both tightly and loosely coupled collaboration where players could smoothly move between each. Unlike real world collocated collaboration, which relies on a mixture of verbal and non-verbal cues for awareness, players relied heavily on verbal exchanges to maintain situational and workspace awareness. Conflicts invariably arose between team members with more occurring for those who did not know each other well.

The overarching implications are that escape rooms present a fun and challenging setting for players. Escape rooms that support a sequential path are well suited to support a mixture of collaboration styles, which could lead to improved communication and collaboration skills. Yet because situational and workspace awareness is heavily focused on verbal exchanges, the development of non-verbal communication skills may be hindered. Players hoping to forge new relationships with others may be better served by escape rooms that include fewer acts of tightly coupled collaboration since this would better support individual efforts. Together, these implications raise design questions for escape rooms and future studies.

BACKGROUND
Real-Life Escape Rooms
In real-life escape rooms, players try to escape within a set time limit, typically 45-60 minutes. When players arrive at the escape room, they are asked to lock their possessions, including all technology, in a locker. They are also typically not allowed to bring any paper or writing utensils into the room to help solve the puzzles. Next they are explained the rules of the escape room, which include not damaging objects in the room. In order to assist players, escape rooms...
allow teams to ask for a predetermined number of hints (typically 2 or 3). When desired, a staff member will come into the room and help the team overcome their current task. Hints can be given at any point in time. Many rooms contain technology in some form, such as the use of RFID sensing (e.g., bringing an artifact near a hidden sensor causes a door to unlock). The clues and hints to puzzles are often hidden in boxes with combination locks that need to be unlocked in a predetermined order. The final door to escape the room usually contains a combination lock or requires the use of a special key that must be found in the room. Rooms are decorated with objects and décor to match a theme and narrative where the objects themselves are typically used to help solve the puzzles. For example, the position of darts on a cardboard may give hints to a combination lock’s code.

There is very little empirical research on real life escape rooms. The only documented study that we know of is Nicholson’s [33] white paper that reports on a survey completed by employees of 175 escape room facilities around the world. Most notably, the survey documents the different styles of escape rooms in terms of genres and shows that they contain a range of puzzle types including logic puzzles, spatial and mechanical puzzles (e.g., moving an object a certain way), and word or math puzzles [33]. Puzzles are presented in an open (13%), sequential (37%) or path-based model (45%). Open models allow players to solve a number of puzzles all at once where they converge to provide clues to a final puzzle. Sequential models have a linear sequence of puzzles that must be solved in a certain order. Path-based models have multiple sequential paths where solutions from each path allow players to solve a final puzzle. Player groups consist of groups of adults over 21 years (37%), corporate groups (19%), groups of young adults (19%), intergenerational groups (14%), and date night couples (11%). Nicholson suggests that escape rooms be designed for varying demographics and player experiences, replayability, and cultural diversity.

Alternate Reality Games

Similar to escape rooms are Alternate Reality Games (ARGs)—a type of pervasive game that takes place in the real world and includes an overarching narrative that seeks to blend together the game and real life [6,14,25,29]. ARGs are seen as a form of transmedia storytelling as narratives are presented across a series of mediums including web pages, mobile device applications, and real world artefacts [7,8,9]. This can make it difficult to design replayable ARGs [20]. While escape rooms contain themes, narrative, storytelling, and sometimes actors [33], their level of orchestration is much less when compared to ARGs. ARGs have been found to be open-ended where they provide players with flexibility in terms of how they understand the ARG, as well as closed-ended where play is carefully planned and orchestrated with a definitive end game for players [7]. Escape rooms are only closed-ended, given the single overarching goal of escaping the room. They also do not tend to blur together real life and the game environment in the same way that escape rooms do [6]. To complete an ARG, players move along trajectories or paths, which intersect at varying points with the canonical path created by the game’s designers [3,4]. As mentioned, escape rooms can vary in their model of paths through the game.

Collaboration has been studied in several pervasive games. For example, studies have explored trust in strangers [6], the limits of connectivity and GPS [5], heightened awareness of one’s environment [1], improved navigation, and community creation of game content [30,31]. Collaboration has been shown to occur amongst pervasive game players who know each other either as family, friends, or schoolmates [8,30]. Such collaboration benefits player motivation [34], learning [8], and can create a shared sense of history and location [35]. In escape rooms, we see collaboration occurring amongst players to solve the puzzles and escape the room, yet we do not know the details of such collaborations; this is the focus of our study.

Workplace Awareness and Coupling

There is also a body of research that explores how small groups of co-workers collaborate together in shared physical spaces such as meeting rooms. This is not entirely different from escape rooms; thus, we detail such processes.

Situation awareness is defined as “being aware of what is happening around you and understanding what that information means to you now and in the future” [15]. It helps people decide what information is important in order to accomplish a particular goal [15,22]. Even when seeing the same information, people’s awareness can be different; this can benefit team activities by providing a broader perspective [36]. When groups collaborate, they naturally maintain workspace awareness: knowledge of each other’s interactions and activities in the workspace [18,19]. Workspace awareness allows people to coordinate actions with collaborators, anticipate the actions of others, discuss tasks, find opportunities to help one another, and move into and out of closely-knit groupwork [18,19,22]. This latter aspect is known as coupling and focuses on the degree to which collaborators are working together [39,40]. When partners need to wait for others fairly frequently for them to finish their own work it is tightly coupled [37]. If partners can go for long time periods on their own without interactions with other group members, it is loosely coupled [37].

Collaborators are often mobile in common spaces working together (e.g., around a shared table) [40]. Sometimes they use divide-and-conquer strategies to complete tasks, sometimes they will perform parallel work, and other times they will be performing closely coupled work [40]. Social protocols are often used to negotiate and move into and out of different coupling styles [40] and this behavior is fluid and frequent [39]. Workspace awareness comes from people explicitly talking about what they are doing, overhearing the conversations of others, listening to any
verbal alouds that people create along with their actions, and paying attention to body language and the use of artifacts [19]. Workspace awareness helps people to simplify their verbal communication [19]. Many team members can understand what is happening through verbal exchanges of only a small number of words [22]. As group members work in different areas in a collocated setting, they also tend to partition spaces as theirs or the groups to exhibit aspects of territoriality [38]. They also maintain a certain social distance to give each other appropriate space to work [22].

While the above behaviors are well known for collaborative tasks in shared settings, what is not known is how they might extend (or not) to escape room settings.

**Team Cognition and Shared Mental Models**
Team cognition is “the seamless execution of coordinated behaviors” amongst team members [17,23] while distributed cognition refers to cognitive processes distributed across members of a social group [23]. Team cognition and coordination is aided by awareness and communication [17] and is created by pre-existing knowledge of team members and conditions and ongoing interactions between team members [10,21]. Team cognition will more easily develop if team members know each other and train together [16,21]. Awareness of team member expertise is important for team cognition to be efficient and effective and it allows team members to effectively assign tasks [21,27]. Gender diversity can help team develop team cognition as the genders offer different strengths [21]. These can drive team coordination in different and valuable directions. Team members who are familiar with one another have been found to perform better at tasks initially in a group setting; yet, over time, such differences fade as team members get used to one another [21]. Group communication and team dynamics are critical and affect how well a team does at a task [13,24].

Teamwork also depends heavily on the ability for a team to develop a shared mental model of their situation [11,28]. A mental model is an understanding of how something works that lets people understand and interact with their environment [11,15,27]. A team or shared mental model is a mental representation shared by team members [11,21,27,28]. Team mental models consist of knowledge of equipment and tools, goals of the team, awareness of what teams members know, and knowledge of effective team processes [11]. Teams with a shared mental model are likely to work better together because they will be in synchronization more [27]. We explore these concepts for teams in escape rooms.

**STUDY METHODOLOGY**
The goal of our study was to understand how groups of people collaborate in escape rooms, what collaborative roles they take on, and how the design of the room affects collaboration.

**Participants**
We recruited teams of players through word of mouth, email advertisements to our university department, and social media posts on Twitter and Facebook. Thirteen groups of players, including a total of 38 people (19 female), agreed to participate. Groups ranged in size from two to five players and were self-selected, typically representing a group of co-workers, friends, couples, or family, though four teams had people who were strangers with at least one other person on the team (recruited by a mutual friend). Most players were in their early to mid twenties with the exception of four players who were in their 50s. 15 of 38 participants had played in at least one escape room prior to the study, 17 participants had never participated in an escape room, and 6 participants had done more than five. A large amount of participants were undergraduate or graduate students, though many held additional jobs outside of school. Occupations varied, e.g., programmers, administrative assistants, health care providers, analysts, architects, and researchers.

**Location**
We partnered with Time Escape, an escape room located in Greater Vancouver, Canada. Time Escape hosts eight different themed rooms for players to choose from. Each theme has a different narrative and a different set of puzzles to play through. We also played in four different escape room facilities (Time Escape plus three others) in order to gain a firsthand understanding of how teams participate in an escape room and how rooms and puzzles might vary across facilities. We found a large consistency across facilities in our region in terms of the general style of puzzles and escape room themes yet they varied in quality.

**Method**
Players first selected which type of themed room they wanted to participate in from a set of four. These included a room focused on spaceships and aliens, a historical castle, a haunted cabin, and time travel. All rooms had a 45 to 50-minute time limit and teams were allowed two hints. Rooms varied in size but all were under 150 square feet; thus, they were relatively small rooms and spatially could only reasonably accommodate six people at a maximum. This was the limit imposed by the escape room facility. Three of the escape rooms contained a series of 2-4 interconnecting rooms with a locked door between each. All four rooms had a sequential structure of puzzles such that they needed to be completed in a predetermined order; however, one could find clues for future puzzles ahead of time.

During each game session, one researcher accompanied the team into the escape room to observe game play and collect handwritten notes about collaboration styles, player interactions, general spatial orientation and player positioning within the room, and puzzle-solving strategies. The observer did not assist the players in any way.
After the session, participants completed a paper-based questionnaire that asked them questions about their past experiences in escape rooms, their motivations for playing escape rooms, what they felt was easiest/hardest about the room, their strategies for solving the puzzles and working as a team or individually, and how the escape room affected their relationship with their teammates. Most questions were open-ended in order to be exploratory, as we did not have prior theories that we were attempting to confirm. For example, we asked, “Were some people better than others when playing?” “Would you take the same people next time? Why or why not?” “What would you change about your strategy for next time, if anything?” “What would you change about the escape room, if anything?” After completing the questionnaire, participants were interviewed as a group about their experiences. This lasted 15 to 40 minutes depending on the team. Teams of participants were compensated for their participation in the study with a $40 payment and a 10% discount on their admission price of ~$20 per person.

**Data Collection and Analysis**

Data was in the form of observational notes, handwritten questionnaire responses, and interview notes. The escape room company did not permit us to collect any photo or video data from the observations because of privacy concerns; they did not want to risk any visual clues or secrets of the rooms becoming public. Our paper is deliberately nondescript in some places to preserve confidentiality of the escape rooms’ contents and puzzles.

We analyzed our results by iteratively reading through our data. We explored the various data using thematic analysis and affinity diagramming where we categorized responses from participants and our observations into groups with similar meaning and ideas. Our results uncovered several main themes surrounding team member roles during play, verbal and non-verbal communication, awareness of team member activities, the use of physical artifacts, the physical constraints of the room, puzzle solving strategies, and social challenges and conflicts. We explore these themes next in our results sections.

Anonymous quotes from participant interviews and questionnaires are shown along with vignettes of player activities from our observations. Vignettes are based on our observations while participants’ thoughts and feelings articulated in them come from our questionnaire and interview data. To preserve the confidentiality of the escape room’s puzzles, we have changed the types of objects described in the vignettes to similar yet different objects, e.g., a photograph might be changed to be a book cover. This does not affect the behaviors we describe.

**GENERAL EXPERIENCES**

All participants told us that they enjoyed their experience of participating in the escape room and gave positive feedback about the room they participated in. Participants liked the challenging nature of the puzzles and enjoyed playing with their teammates, for the most part. Newcomers were motivated to try the escape room because it was a new experience for them, some wanted an activity to do with friends, and some valued the reduction in cost associated with the study. All but one player felt they would play in an escape room again for the challenge, while the remaining participant told us that it was too easy for him.

Only two teams escaped their room and the remaining eleven teams did not—this reflects the escape room’s reported acceptance rate of less than 20%. The common approach to solving the puzzles was to use one’s common sense and prior experiences. One’s pre-existing knowledge was generally enough for teams to solve the puzzles. Yet sometimes they did require players to ‘think outside of the box’ or in the ‘shoes of the game designer.’

“I would have it in mind that the designer is the same person for every puzzle, because the thing like the first puzzle you have to look for shape, and that the same thing [happened in the final puzzle], just the same logic.” – P37, Male, Interview

Teams generally started out trying to solve the puzzles in a very organized fashion where they appeared methodical and careful in their searching for clues and tried to apply logic when solving puzzles. Movement was typically without panic and voices reflected a relative patience. However, as time went by, teams began to be less meticulous and more random with their attempts. Many team members would quickly move through the room and puzzle solving attempts turned more to ‘brute force’ efforts such as trying all possible lock combinations and solutions they could think of. One of the recurring problems participants had was ‘overthinking’ puzzles by expecting that all artifacts in a room were a part of the puzzles when in reality only a few were.

“Our knowledge of technology kept us from fiddling with the keypads on top. They are just stickers!” – P11, Female, Questionnaire

Teams faced challenges in understanding that the puzzles were sequential in nature and became overwhelmed with clues contained in the room’s artifacts, some of which were for future puzzles rather than the current one at hand.

**TEAM MEMBER ROLES**

When teams first entered the escape room, one or more players in the team took on a leadership role within the group. Players did not explicitly call them the ‘leader’ but implicitly they acted in this capacity. We observed men take on this role in 7 of 13 teams, while in the remaining teams a woman took on a leadership role initially. Consider Team 1 as they first entered the escape room:

*Team 1 consisted of five players who were all friends—one woman and four men. When they first entered the room, there was little discussion of strategy or what to do. Instead, P3 (male) started directing players to perform...*
certain actions. He told P2 to start looking for clues and P4 to point her flashlight at the wall. P3 had done several escape rooms—more than his teammates who were new to the concept. P4 found a card on the back of the door that she thought was the first puzzle to work on. P3 noticed and started describing how he would solve the puzzle to his teammates.

As can be seen, P3’s leadership role reflected his past experience of competing in several escape rooms. He knew what types of items to look for and had strategies in mind for solving puzzles. Thus, he had a clear mental model of what needed to be done. He was quick to tell his teammates this and share his experience. While not recognizing it, he was trying to quickly develop a shared mental model amongst his teammates in an attempt to scaffold their teamwork.

Other teams followed a similar process to Team 1 where leadership roles happened quickly and without any discussion. Players with the most experience in escape rooms nearly always took on a leadership role. If there were several experienced players in the group, they would share the leadership role and guide those who were less experienced than them.

When all team members were inexperienced at escape rooms, social roles and personalities outside of the escape room played a large role in determining a leader. For example, in Team 7, all three participants were first time players but one of them was more vocal in the group. The participants were from the same church group and P21 was one of the public speakers for the youth service. P21 assumed a leadership role in the group by suggesting what other players should do.

In general, we found that the inexperienced players listened to the more experienced players and tried to do the tasks given to them. Such assignments may be searching for clues in the game room or performing repetitive tasks (e.g., counting items), while the experienced players focused more on figuring out solutions to the puzzles. Most of the inexperienced players valued the help and leadership of others who were more experienced.

"I got lost completely, so I just sat down and watch; not disturb my teammate, will be my best efforts." – P22, Male, Questionnaire

Team member roles tended to persist throughout the duration of the team’s escape room time for teams with three or more players. However, roles did sometimes change as puzzles were solved and participants built up their experience and credibility. If a particular player solved a puzzle, she was likely to have more influence with her team members on subsequent puzzles. Consider Team 10:

P31 became the leader of Team 10 early on in their session when he discovered a series of hidden symbols on portraits hanging on the escape room’s wall. He told his teammates about them and suggested how they should use them. As team members tried to solve the puzzle using P31’s suggestions it became apparent that P32 had her own ideas about how to solve the puzzle. She figured out the meaning behind the portraits and then solved the puzzle. When the team found the next puzzle to solve, P32 led the team by making suggestions of what to try.

A participant from Team 1 commented about a similar situation in his team:

“Generally I take on a leadership role when I do escape rooms. With that being said there isn’t always only one leader. As puzzles are varied generally the person who is best suited to each puzzle will take over.” – P3, Male, Interview

Teams that were made up of just couples (Teams 11 to 13) saw more fluctuation in terms of leadership. Here leadership roles were fairly fluid and changed frequently. For example, P36 (female) took the lead at first because she had played in escape rooms before. As her partner, P35, began to understand how the game worked he gradually took more control over their efforts:

Team 12 started in the escape room with P36 telling P35 what he should look for and try to find. The two searched for several minutes and then P35 appeared frustrated. He said aloud that he wanted to receive a hint. Rather than talk with P36 first, P35 walked directly to the button to call for the hint and pushed it. After receiving the hint from staff, P35 began telling P36 not to waste time looking around the room aimlessly anymore and that she should be more focused on the clue. He began walking between two pictures on the walls to double check what numbers P36 had read off of them to ensure she was correct. P36 stood watching as she waited for P35’s next directions.

This example illustrates the shifting of roles as a mental model of how to participate in the room is developed. In this case, once P35’s mental model of the escape room developed, he started to take on a leadership role.

COUPLING STYLES

While one might expect that the linear nature of the escape rooms we studied would require collaboration that was always tightly-coupled—team members working together and requiring each other—collaboration instead moved fluidly between loosely and tightly coupled teamwork.

Transitions Between Coupling Styles

First, team members often began by working in parallel to figure out what they first needed to do in the room; thus, this collaboration was fairly loosely coupled. For example, when teams first entered the escape room, they often spent the first couple of minutes searching around the room for combination locks that they would need to open as well as any artifacts that they might be able to use to solve puzzles. This included, for example, pictures hanging on the wall and toys or other props. Once one or more team members
realized what needed to be done, they would converge and naturally transition to a more tightly coupled style of collaboration where they would discuss what to do and sometimes work in small groups on specific tasks. Such tasks often relied on the work of others. Consider Team 12:

Team 12 entered the escape room and the players began searching independently for objects that they could use. P36 (female) found a UV light and started to shine it around the room. P35 noticed P36 shining the flashlight and went over to help her. Together they started to see what they could use to unlock the first lock in the room. P36 handed the UV light to P35 so she could enter numbers into a combination lock. As she did this, P35 started telling her possible numbers to try. P35 waited for P36 to test out each number that he told her.

As can be seen, P35 and P36 started out in a form of loosely coupled collaboration and this transitioned into tightly coupled work.

When players became stuck or unsure of what to do next, they typically would transition to a loosely coupled style of collaboration. Here players would be working in parallel and thinking through ideas of what they could try to solve the puzzle or looking around the room for clues. If what appeared to be a good idea emerged, they would either try it out on their own or ask others for help. Thus, the emergence of a ‘good idea’ was often a trigger for more tightly coupled collaboration.

“People tend to work together when they both understand the puzzle. Otherwise if someone doesn’t understand a puzzle they will either step back or try to work on something else.” – P19, Male, Interview

Teams also commonly converged together when they became stuck over a period of minutes and were unable to progress. At this point they discussed if they should ask employees for a hint. For example, Team 10 sat down on the floor together for more than ten minutes when they became stuck on a puzzle. They brainstormed and exchanged thoughts about potential solutions to the puzzle. Once they figured out the puzzle, they stood up and moved on.

Sometimes puzzles contained elements that required players to work together by performing synchronous actions together. Consider Team 13:

Members of Team 13 encountered a puzzle that required them to compare two thermometers that were on different walls of the room. It was not possible to see both thermometers at the same time given the distance between them. P37 started by walking back and forth between the two thermometers. It appeared difficult for P37 to remember the numbers on each thermometer when arriving at the next one. P38 recognized this and started telling P37 what number was on the thermometers closest to her. P37 stopped walking between the thermometers.

Taking a hint was considered to be a fairly major decision since they were a limited resource. As such, teams most often came together and tried to reach a consensus on whether or not they should ask for a hint.

“We ask for hint when we all feel like we are stuck for a great amount of time! Depending on consensus and time left.” – P28, Female, Interview

In some cases, however, one or two team members were ignored in the decision making process because they were either preoccupied with their own individual work or team members felt their decision was less relevant because of inexperience.

Physical and Spatial Constraints

The physical constraints of the room itself affected coupling and where people positioned themselves or moved. As mentioned, the escape rooms we had in the study were relatively small (~150 square feet or less). This meant that there was not a lot of room for team members to work in. Team members moved throughout this space readily and we did not notice any sense of territoriality. That is, team members did not avoid areas in particular because they thought their team member was working in it despite sometimes being relatively close to one another. When team members were working closely together on a puzzle, they would situate themselves in the same area and stand or sit right next to each other. Often this was very close—sometimes touching shoulders or bumping arms—because of a lack of space. Consider Team 1:

P1 was staring at a series of light up buttons on the wall trying to figure out how they worked. He was stuck for several minutes so he yelled out to others for help. P3 came over quickly and moved very close to P1’s position in front of the lights. They were almost touching. P1 and P3 stared at the wall for a moment together and then P1 started to move away from P3. There were no verbal exchanges and P3 then took over the space previously occupied by P1 to get a better view. P1 wandered to a different part of the room in an attempt to search for more clues and assist P2 on his respective puzzle.

As can be seen, movement sometimes did not involve verbal exchanges. In other instances, team members would ask others to move so they could get better access to an area. These requests were sometimes abrupt likely because of the time pressures brought on by the escape room.

As team members unlocked doors and moved between rooms in a multi-room escape room, they would sometimes be working in separate rooms. This often made it harder to collaborate. Consider Team 3:

Players in Team 3 were standing around a dimly lit lamp wondering what it could be used for. P9 noticed that there was a power cable running from the lamp to a hand crank on the other side of the wall, in a separate room that they previously unlocked. P10 went into the other room to look
around to see where the power cable went. After some searching, he found that it went to a hand crank. He started cranking it not knowing what effect it might have. This started to generate enough power to increase the brightness of the lamp in the first room. P9 starting yelling to P10 in the other room to keep cranking the hand crank.

The above vignette shows that players sometimes needed to split up and move into different rooms in order to solve the puzzles. Even in different rooms, they may be required to move back into tightly coupled collaboration, despite not being able to see each other.

Artifact Constraints
The escape rooms that we studied were all relatively dark given their mysterious themes. To assist players, staff provided teams with a limited number of flashlights, dependent on the number of players in a session. For our study sessions, it was between two to three flashlights per team. In addition, rooms contained a number of physical artifacts that were needed to solve the puzzles. These items, again, affected how team members worked together or did not. Consider Team 11:

P33 found a UV flashlight in the room and starting panning it around the wall to see if it would illuminate any hidden text. P34 suggested shining it on a particular area and P33 did so—they both looked around the room together. Eventually, P34 asked to use the flashlight and P33 gave it to her. P33 then started moving around the room to look for other useful items. P33 found a rope and started to toss it towards a box a few feet away. P34 continued to look for hidden text with the flashlight. P34 managed to retrieve the box using the rope and P33 and P34 then came together and took turns trying different passwords for the lock on the box.

As can be seen, items were scarce. This meant team members had to share them. This sometimes necessitated players to work in a tightly coupled way. We also observed that the person who found the item would most often maintain a sense of ownership over it, at least initially. Thus, they would use it on their own, or follow the directions of others for how they should use it. For example, P33 took P34’s suggestion on where to shine the flashlight rather than initially giving it to her.

When items were eventually exchanged it often implicitly suggested a responsibility to take over the task of directly using the object. For example, in the above vignette, the handing over of the UV flashlight saw P34 take over the searching task and P33 move on to another task. There was no verbal acknowledgment. Instead, P34 understood her new task and took it on.

SITUATIONAL AND WORKSPACE AWARENESS

Verbal Communication
The most common way that team members stayed aware of what others were doing was through verbal communication. Players would often shout across the room to get a response from a team member or to form an agreement to ask for a hint. For example, if one player found a clue or a solution that would benefit the team, s/he would verbally announce it to the team. Similarly, if a team member needed assistance from another team member, s/he would yell across the room. These types of situations were found throughout several of the previously presented vignettes. In addition, consider Team 4:

Team 4 consisted of a very experienced escape room player and two first time players. When the experienced player, P13, came to the realization that the puzzle he was working on was very similar to a puzzle he had done before in another escape room, he became noticeably excited and called P14 and P15 over. P13 told them he knew what to do to solve the puzzle and described the steps for it and logic. He started moving back and forth between two pieces of paper that were attached to the wall at different locations. He told P14 and P15 to match the lines drawn on the paper together and that they should form four digits; this would likely be the combination to the current lock they were working on.

While searching for clues, some players would often ‘think aloud’ as they worked. Here they verbalized what they saw and what they were trying to do to solve the puzzle. The hope was that others would hear what they were doing and try something similar. Consider Team 11:

P33 and P34 were trying to figure out what the numbers on two different wall maps meant. P33 was standing near one map while P34 stood near the other. As they thought through the puzzle, P34 kept saying her map’s numbers out loud over and over: P33 heard this and would occasionally glance between P34 and the map closest to him.

Similar to the above situation, we noticed other teams and players counting items out loud and reading words out loud that they found on walls or objects. Our interviews showed that other players noticed this behavior and found it helpful to gain a sense of what others were doing.

Non-Verbal Communication and Peripheral Viewing
The use of non-verbal communication tended to be more rare than verbal communication. That is, team members tended to rely on what others said to maintain a sense of situational awareness rather than looking around frequently. When people did look or glance around to see what was going on around them, they would notice where people were generally positioned and if they were using any artifacts in the room. Again, some of our previous vignettes illustrate these acts. In addition, consider Team 12:

P35 was looking around the escape room and found a remote control for a toy helicopter that was out of reach. He used the controller to try and fly the helicopter. P36 glanced over and noticed what P35 was doing. P36 stopped her current searching efforts and came over and stood next to P35. She proceeded to give him advice and navigation.
Suggestions on how to use the helicopter. After a few trials, P35 handed the controller to P36 and she started trying.

As can be seen, the peripheral awareness of the actions of others was used to change one’s own course of action.

The nature of the puzzles themselves and the way in which team members solved them somewhat limited players’ abilities and desires to use non-verbal behaviors to maintain a sense of workspace and situational awareness. Because of the time pressure of the escape room, team members tried to stay very focused on what they were doing. As a result, they were often more focused on their own efforts as compared to that of their teammates and they did not often look around to see what other people were doing. Instead, they quickly tried to work on their own tasks.

Body language was also not seen to be very useful for communicating steps to complex logic puzzles. Unless the room supplied team members with some form of writing board, they could not write down notes or answers which others could see and understand. Thus, information about how a team member was solving a puzzle was often ‘in their head’ and not somewhere visible for teammates to see. Sometimes team members even preferred to not write things down because they felt it was faster. Consider Team 2:

Team 2 consisted of two women and one man. P7 was trying to memorize a sequence of symbols to enter into a combination lock. P8 stood next to her with a writing board and marker but did not write anything down. Instead, P7 tried to only use her memory. P6 and P8 watched but did not know why P7 was trying the numbers that she was.

As can be seen, P7 did not want to write down the answers and preferred to memorize them. In our follow-up interview, we learned that this was frustrating to both P6 and P7, but they felt they needed to trust P7’s memory and judgment so that they did not get into a conflict with her.

At times team members found it difficult to notice the actions and non-verbal communication of others. The nature of the escape room environment itself made it difficult to see what others were doing, what artifacts they were using, and what body language or gestures were being conveyed. This was because rooms had dim lighting—as a means to create mystery—and teams sometimes had only a limited number of flashlights or objects with light to help them see. Other times, lights on the ceiling or wall only shone on specific locations. For example, Team 3 described the challenge of seeing what their teammates were writing on a ‘scribble board’ given to them in the escape room.

“The light board! The blue lights on the scribble board were too weak. The low light and the writing board were hard to use for our older eyes.” – P10, Female, Interview

When team members were spread across multiple rooms, it was impossible to use non-verbal communication since team members could not see each other.

Social Conflict

Our participants saw social conflict as somewhat inevitable given the time pressures placed on them. When teams progressed smoothly through the game session, we found it unlikely that conflicts occurred. As one might expect, it was only when a team began to struggle or was not satisfied with their progress that conflicts arose. Most often team members recognized that they should set aside any differences in opinion in favor of focusing on solving the puzzles rather than arguing with team members. That is, the conflicting parties understood the pressing need to escape the room and were willing to put their emotions aside to work towards escaping. The conflict, however, sometimes resumed post-game when team members would chat about their experience. We observed that the teams who worked best together as a cohesive unit where comprised of people who knew each other well previously.

Major conflicts between teammates arose amongst only two of the ten teams. For example, a major conflict arose with Team 5 where two participants (P16 and P17) refused to talk with each other after the game. Prior to their participation in the study, P16 and P17 did not know each other and had been recruited by a mutual friend to participate. During the course of the escape room, they recognized that they had different play styles and personalities. The team had been unable to escape their room and felt this was a result of a logic puzzle that the team spent more than ten minutes on. While the team tried to complete it, P16 became impatient and offered to take over the puzzle. P17 was primarily working on the puzzle and refused to let P16 help and, instead, she continued to solve the puzzle at her own pace. The puzzle was eventually solved, but participants became wary of each other’s suggestions. After the study session, P16 and P17 said:

“I found it is hard to prove something is wrong to people you just met. If you try you could possibly offend someone. If you don’t, you won’t make progress! It is a tradeoff.” – P16, Male, Questionnaire

“If the people you’ve known and they play well, definitely will play together next time. If the people you’ve known and play not good (not good at team work, and no contribution), may be not playing next time. If the people you don’t know and they play well, may be made friends. If the people you don’t know, and not good at team work or no contribution, definitely would not want to be friends and never play again.” – P17, Female, Questionnaire

Conflicts of a lesser intensity where found for teams that disagreed or were not asked about seeking a hint. For example, in Team 6, P21 was accidentally ignored during a hint vote. While voting for the first hint, every team member was given the chance to voice his or her opinion. But as time passed, the more active team members forgot P21 during the voting for the second hint. The team did not
realize their mistake and apologized to P21 after the study session.

“Feel a bit bad forgetting to ask my friend if he wanted to ask the second hint.” – P20, Female, Questionnaire

**DISCUSSION**

Our study of escape rooms has revealed the ways in which team members collaborate to try and escape the room and how the structure and style of the rooms affected collaboration. We now discuss our results and their implications where we raise design questions for future explorations of escape rooms.

**Experience and Team Member Roles**

First, our results revealed that experience in escape rooms and puzzle solving often dictates the kind of roles that team members take on when playing in escape rooms. Those who are more experienced tend to take on a leadership role. Like other teamwork situations [11,21,27,28], leaders work to share their mental model of the situation—in this case, how the escape room puzzles might be structured—with their teammates to develop team cognition and coordination. Leaders assign tasks, but unlike other situations where detailed knowledge of a team members’ abilities might be known [16,21,27], the leaders in our study did not always know their teammates specific puzzle solving skills. They also did not always know what the puzzles involved; thus, it could be very difficult to assign tasks to specific people based on skill. This raises design questions about how escape rooms could be designed to support different player abilities, especially when such abilities may not be known beforehand.

Based on our post-game discussions with teams, we recognized that players and groups come into the escape room with an existing set of social roles and structure. For example, some people may be used to being social leaders in a group because of workplace or family dynamics and hierarchy (e.g., a manager of a workgroup, a parent of a family). Yet these dynamics can easily dissolve in an escape room and new ones may emerge based around one’s experience with puzzle solving tasks. If players are not expecting a shift in social status and it occurs, then it might easily disrupt relationships and cause conflict. On the other hand, players may have a positive experience if they are interested in experiencing a new role within the group.

This raises design questions around if and how escape rooms should be designed to preserve existing team dynamics and roles. For example, should escape rooms be specifically designed for workgroups where elements of the escape room ensure that a team manager remains as a leader? This could be done by giving certain instructions or clues to just the manager. Might a similar approach be used to strengthen existing notions of family hierarchy? On the other hand, there might be ways to consider the design of escape rooms that purposely work to disrupt the normal social order of groups so that people learn new skills and, perhaps, a greater sense of appreciation for the skills that others bring to the table. Compared to the prior literature on team dynamics where a priori knowledge of team members’ skills is beneficial to guide team cognition [16,21,27], our results begin to point to escape rooms being places where people can learn more about their teammates through the construction of team cognition. Thus, skill knowledge of one’s teammates may often be an outcome, rather than an ‘input’ to the experience.

**Tightly and Loosely Coupled Collaboration**

The escape room we studied contained a sequential puzzle structure where puzzles needed to be solved in a specific order. Thus, the path of play was straightforward and players could not deviate from it. The challenge, however, was that they did not know this linear structure ahead of time, what elements it contained, and what order they were to be played or solved in. While one may consider constructing escape rooms that have multiple possible paths through them, our results show that a sequential structure permits players to move into and out of both loosely coupled and tightly coupled collaboration to enhance both their individual and teamwork skills. This is especially the case when multiple clues are present and players must decipher which clues or items are relevant at each stage. This allows team members to break off from the main group to find or solve smaller portions of the puzzle, return to work with others to decipher puzzles as a whole, and provide help for others as needed; these behaviors are similar to the way that collaboration occurs in other settings where work migrates fluidly between individual and joint efforts [22,37,39,40].

Thus, our results suggest that if escape rooms want to promote both tightly and loosely coupled collaboration to foster both team and individual skills, creating an escape room with a sequential path will likely achieve this result. This, in turn, raises questions about what effects escape rooms with multiple paths through them might have on collaboration and whether or not efforts may turn out to be more individual in nature if team members are not forced to come back together throughout their play.

**Situational and Workspace Awareness**

One may posit that escape rooms would be good places for team members to develop real world skills that allow them to more effectively work together in a collocated setting. Research shows that in collocated settings it is important for team members to gain situational awareness of what is happening [15,22] and workspace awareness of collaborators’ activities [18,19,22]. This comes from hearing others, seeing artifacts and actions, and listening to what people say [15,18,19,22]. Yet unlike meeting room settings, which are usually well lit and may only contain a single meeting room, escape rooms have different architectural and environmental attributes. The ones we studied were dimly lit to create an aura of mystery and sometimes collaboration spanned multiple rooms. This
made it hard to see other people. Players were overly focused on their own efforts rather than what others were doing given the time pressure. Again, this resulted in nonverbal behaviors and peripheral awareness being less critical. Team members did not often write down items because they often lacked resources to do so; this is unlike meeting settings where writing on surfaces is a natural occurrence and aids collaboration [40].

Together this meant that the escape room settings we studied were quite different than meeting settings. Team members relied heavily on verbal communication rather than a mixture of non-verbal information, verbal information, and peripheral awareness of the environment. This suggests that escape rooms like we studied may not necessarily teach people about real world collaboration skills that might, for example, be utilized in a meeting setting and contain the above acts of awareness gathering and communication. Instead, such escape rooms would likely be very good at encouraging and teaching awareness and group communication through verbal exchanges. That is, players may be more likely to develop skills that allow them to be more vocal rather than use non-verbal communication. In essence, this suggests a greater sense of extroversion amongst team members, which not all players may prefer. This raises questions around how escape rooms might be designed to encourage real world collaboration skills beyond just verbal communication. For example, it suggests that escape rooms with a single room that is brightly lit and contains artifacts for writing may better map to real world meeting settings.

Of course, it is not necessarily the case that the goal of an escape is to build real world collaboration skills. Though, we know that many people go there for such reasons, e.g., team building [33]. People going to escape rooms to build verbal communication skills as part of their relationship (e.g., couples on date nights, friends) [33] may find them escape rooms to be especially valuable for these reasons.

Reducing Conflicts and Improving Social Relationships

Lastly, our results showed that conflicts will invariably arise for some teams in an escape room. We found that players who did not know each other well had more conflicts or harbored more contempt for one another; however, this should be verified with a study containing a larger sample since only two of the thirteen teams in our study had major conflicts. Nonetheless, conflict is inevitably going to occur for some teams. Players may be able to put aside differences while in the escape room together, but there is a chance that such situations may cause longer-term relationship effects. This suggests that escape rooms like those we studied may be best conceived as team building activities for those people who already know each other and can strengthen their collaborative practices and social relationship, rather than forge new ones. But, again, this should be verified with larger samples.

Some escape rooms attempt to fill players slots within the room for each time session. For example, if a group of four players sign up for an escape room time and the room can accommodate six players, the facility will allow two strangers to join the initial group (likely as a means to increase profits). Yet setups such as this could easily create negative social situations for players.

An open challenge then becomes, how can one design an escape room to support the building of relationships amongst people who do not know each other well? Our results suggest this may be possible by designing the escape room so that individuals may have to rely less on others and can choose to work on their own individual tasks rather than being forced to collaborate on a single puzzle as a group. In this sense, escape rooms that have multiple paths may better support teams of players who do not know each other well as each could start down their own path within the game, and ask others for help only when needed. The increase to more parallel-play may cause less tension amongst players. Of course, this would need to be confirmed with further studies of multi-path escape rooms.

Limitations

Our results are applicable to the specific type of escape room that we studied where puzzles were sequential in nature, rooms are dimly lit, and artifacts are constrained in numbers. Our players were mostly of a younger demographic (early adulthood) with a cultural background specific to the area of Canada that we studied. Thus, our findings could be culturally specific to this age group and cultural background. Further studies should explore how players collaborate in escape rooms that contain multiple paths of play as well as how those of both an older and younger demographic (e.g., children) play together. Studies of escape rooms in countries with likely different cultural backgrounds (e.g., Asia) would offer compelling cross-cultural comparisons to our results.

CONCLUSION

Our paper described an observational and interview study of players’ participation and collaboration in escape rooms. Our results describe the ways in which collaboration occurred in escape rooms and how the design of the room affected such collaboration. Here we found that players took on various roles, often based on their experience in puzzle solving. Our escape rooms had a sequential path through them and this caused players to move into and out of loosely coupled and tightly coupled collaboration. Workspace and situational awareness was difficult to maintain given the environment of the escape rooms, however, verbal communication became a key communicative act. Our results suggest that escape rooms that include a single path may be best-suited for players who have an existing social relationship since team members will need to work closely with each other frequently throughout the experiences. Furthermore, we raise design questions around how to best support varying
team member roles in escape rooms, methods to improve awareness, and reduce social conflict.

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