COOPERATIVE PLAY IN AUTISTIC TEENS

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DEDICATION

This thesis is dedicated to the participants in this study and all autistic persons.

ABSTRACT

Autism Spectrum Disorder (ASD) is a developmental disability that affects the brain, resulting in social and communication deficits. Play therapy is one way in which we can assist autistic persons in developing and growing social and communication skills. The study consisted of a control group with three neurotypically developed teenagers and three test groups comprised of three autistic teenagers. Each group participated in three problem-solving rooms where the group had to work together to complete the room and played four different cooperative video games together throughout seven sessions, scheduled across a three-and-a-half-week period. A behavioural and social network analysis was conducted to determine the effectiveness of the cooperative play intervention. It was found that there was no notable difference between the neurotypically developed teenager (control) group and the autistic teenager group, with no improvements in pro-social behaviour.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
ASD	Autism Spectrum Disorder
DSM-5	Diagnostic and Statistical Manual of Mental Disorders Fifth Edition

Chapter 1: Introduction

1.1 Play and Cooperative Play

There is a rich research history regarding the importance of play in the development and learning of both animals and humans. Stevens (2020) argues that play is seen in all human cultures, functions in all aspects of human life and that the discipline of neuroscience is important to research play. Play has an important role in the early development and learning of children. Play promotes cognitive processes, such as communication, memory, attention, perception, learning and thought. Play involves using our senses, such as sight to see what we are doing, using touch to feel and pick up objects and hearing allows communication with others. During play, the senses enable children to explore their environment and learn through thought and engagement with others. Shared activities such as pretend play and cooperative play are central to cognitive growth (Ramani & Brownell, 2014). Repeated exposure to play with peers strengthens cognitive processes and furthers a child's ability to learn through play; these social interactions through play with peers are critical for neurodevelopment and learning how to problem-solve (Blakemore, 2010; Poole, Miller & Church, 2004).

Problem-solving is a skill that develops in early childhood; generally, by age three, children possess simple skills to solve fundamental problems and are experienced problem-solvers by age 5 to 6 (Poole et al., 2004). Problem-solving is a skill we use throughout our lives; as children, this can be a simple task, such as learning how to stack blocks from largest to smallest. As an adult, problem-solving is a valuable skill to have when changing a car tire for the first time. Play is one way in which children learn how to problem-solve. However, cooperative play can require discussion and can bring about conflict. This conflict involves the need for the individual and the group to problem-solve to achieve common goals (Forman & McPhail, 1993).

All aspects of play mentioned prior develop through stages. Parten (1933) suggests that six stages of play develop as the child matures. The first stage is unoccupied play; in this stage, the child observes the world around them and what happens now without engaging with others. As this stage occurs in the first few months of life, there is little motor movement, but the child is making random movements, such as moving legs, arms, and hands, to explore their environment. This observation and random movement behaviour provide a foundation for the following five stages of play.

The second stage is solitary or independent play; the child focuses more on their play, with the child entertaining themselves without social engagement with others. During this play stage, children grow curious about their environment, ask questions about observations, and interact more with their environment by standing and walking. This stage allows for free exploration and mastering of personal, motor, and cognitive skills that prepare the child to play with others in the following stages.

The third stage, onlooker play, is when the child watches other kids play without engaging in play themselves. During the third stage, children learn diverse ways to play, use objects in play, and recognize relationships and social rules. The third stage is essential in development as children develop motor and decision-making skills, develop their personalities and learn the connections between actions and consequences.

The fourth stage is parallel or adjacent play; in this stage, the child plays independently but within proximity to other children, mimicking or copying another child's play. In its simplest form, this stage is where social play develops as children play next to peers but not with them. The fourth stage can be seen as a transitionary stage, where the child socially matures in how they play, and

they transition from playing alone, to playing alongside peers, to playing with peers. In this stage, the child starts interacting with peers and sharing activities with others.

The fifth stage is associative play, where we see the child interacting with peers and using the social rules that they have learned, to engage with others. This stage sees children participate in similar activities with peers that teach children how to get along, play together, and help develop language skills to prepare for the next play stage.

The sixth and final stage of play is cooperative play, a form of social play that involves peers working together to achieve a common goal. In this stage, we see the child engage in organized social play with peers, that aids in establishing and building social relationships. The sixth stage requires an elevated level of social maturity and can create conflict as the child learns to express their emotions, share, and take turns. The sixth stage sets the child up to learn how to play, work with others, and solve problems.

This sixth stage, cooperative play, has many benefits, including increasing social interactions and social skills, problem-solving skills, promoting sharing, and increasing teamwork (Kingery, Erdley & Scarpulla, 2020; Toppe, Hardecker & Haun, 2019; Tudge & Caruso, 1989). Cooperative play also reduces anxiety through playing itself and structured social interactions where a participant can be provided with a role or a "script" (Parten, 1933; Sung & Hwang, 2013). Furthermore, when children understand what cooperation is, they are better able to understand what their role is and are more successful in engaging with peers; this engagement is further promoted when children feel a connection to the group and share group goals (Jahr, Eldevik & Eikeseth, 2000; Liebal, Colombi, Rogers, Warneken & Tomasello, 2007).

Play is essential in childhood development; for neurotypical children, play can develop organically and requires little adult intervention. However, for autistic people, play can be a

difficult task due to social and communication deficits. Sometimes, autistic children need interventions to help promote social behaviours and help guide them through play. The following sections will discuss what ASD is, how ASD is diagnosed, available therapies that can help autistic people and what play therapy is.

1.2 Autism Spectrum Disorder

ASD can be difficult to diagnose; no medical test can be taken to diagnose the disorder. Challenges in diagnosis can include delayed symptom identification, the inadequacy of clinical and diagnostic tools, incorrect clinical judgment, medical co-morbidities, gender differences, and socio-cultural factors (Hus and Segal, 2021). Healthcare professionals use the DSM-5 to guide the diagnosis of ASD. The DSM-5 has specified guidelines for diagnosing ASD, including the requirement of social communication and interactional deficits, the presence of restricted and repetitive behaviours, symptoms present in early development, and symptoms that cause significant impairment and that an intellectual disability does not better explain disturbances. ([DSM-5] American Psychiatric Association, 2013).

The DSM-5 criteria for the diagnosis of ASD emphasizes social communication and social interaction deficits ([DSM-5] American Psychiatric Association, 2013). To better understand the disorder and how autistic people are affected by symptoms, it is important to discuss specific deficits. Difficulties with generalization and imitation, language and communication difficulties, social isolation and social difficulties, peer relationships and friendships and masking are examples of areas in which autistic people struggle. These deficits can affect autistic people differently; some autistic people may be affected by one deficiency more than another and can be affected differently than other autistic people. For this study, it is vital to understand how these deficits affect autistic people and how these deficits might make participating in a social intervention difficult.

Autistic people can experience issues with generalization and the ability to relate new experiences to past experiences (Carruthers, Pickles, Slonims, Howlin & Charman, 2020). Generalization can be applied to social situations and the ability to generalize social skills from one situation to another (Carruthers et al., 2020; Kent, Cordier, Joosten, Wilkes-Gillan, & Bundy, 2020; MacFarland & Fisher, 2021). Like generalization, imitation is another area that autistic people can struggle with. Imitation is the ability to copy others; this is important early in development when a child is learning how to play (Charlop, Lang & Rispoli, 2018; Ingersoll, 2008) and is equally important when learning how to interact socially with peers (Busu & Busu, 2020). Being able to generalize and imitate can also affect the ability to create appropriate gestures when speaking. Some autistic people have a diminished understanding or complete lack of knowledge of the purpose of language as a communicative tool, while other autistic people are highly verbal (Casenhiser, Binns, McGill, Morderer, & Shanker, 2015; Reindal et al., 2021). When interacting socially, using language and communication appropriately is imperative to express opinions and concepts and convey information to others.

Another important topic to consider when discussing social interactions with autistic people is masking. Masking, also called compensating, is a strategy used by autistic people to hide behaviours that can affect their ability to function appropriately in a social situation (Cage & Troxell-Whitman 2019). Autistic people can display completely normal behaviours that are sometimes seen as socially undesirable by neurotypical people and are hidden (Cage & Troxell-Whitman 2019). These are all behaviours that can help autistic people feel like they fit in, help them make friends, avoid being bullied and even help them succeed in work and school (Cage & Troxell-Whitman 2019). Another mechanism that aids in developing peer relationships is masking, typically when autistic people interact with neurotypical peers, but it can also occur around autistic

peers (Cage & Troxell-Whitman 2019). Masking can also explain why autistic people are sometimes viewed as very similar to their neurotypical peers; this will be discussed further in the following section.

When we examine the research around difficulties with generalization, imitation, communication and masking, we see how these factors contribute to functioning normally in social situations and having meaningful relationships with peers. Developing and maintaining peer relationships is essential for developing social, language, and cognitive skills (Chang & Dean, 2022; Hay, Caplan & Nash, 2009; Rodda & Estes, 2018). Inclusive learning environments and adult guidance to initiate peer interactions are one way to encourage peer interaction and possibly develop friendships, improve individual perceptions of popularity, and decrease feelings of loneliness (Frankel et al., 2010; Watkins, Ledbetter-Cho, O'Reilly, Barnard-Brak, & Garcia-Grau, 2019).

Autistic people can appear to be more similar than they are different from their neurotypical peers. Therefore, when conducting research concerning autistic people, it is important to recognize similarities and differences between autistic people and neurotypical people and consider how this can affect the outcome of a study. As autistic children grow and learn through social experiences, they understand what is socially wrong and right, how to interact with other peers and what makes them successful in social situations (Rodda & Estes, 2018; Winchell, Sreckovic, & Schultz, 2018). Autistic children perform similarly to neurotypical children concerning emotional understanding, cooperative behaviour, unfriendly behaviour, and prosocial behaviour (Downs & Smith, 2004; Dunfield, Best, Kelley, & Kuhlmeier, 2019; Taylor, Farmer, Livingston, Callan, & Shah, 2022; Townsend, Robeson, Vonk, & Rohrbeck, 2021). When we take similarities between autistic people and neurotypical people into consideration, along with the idea that therapy, social exposure, and

social learning can be designed to help autistic people navigate the world as independently as possible, we can understand why there may not be noticeable differences in the outcome of certain studies. The following section will further explain what therapies are currently available to autistic people and how these therapies help minimize symptoms of the disorder.

1.3 Therapies Available for the Treatment of ASD Symptoms

As autistic children mature, language becomes a fundamental component of social interaction and developing peer relationships and friendships (Ghanouni et al., 2019; Watkins et al., 2019). Parents play an essential role in developing language and communication through interaction early in the child's life. The treatment of ASD is personalized to fit the needs of the individual. Many treatments can be beneficial in treating the symptoms of ASD. Evidence-based practices are safe and effective interventions for treating ASD through scientific research (Hume et al., 2021; Wong et al., 2015). Currently, twenty-eight focused intervention practices are considered safe and effective (Hume et al., 2021). Through research and growing knowledge of ASD, the safety and effectiveness of treatments can and have changed (Hume et al., 2021; Wong et al., 2015).

Continued research allows for a better understanding of what ASD is and how we can better help autistic people and find treatments that are not only effective but also enjoyable. The current study sought a new way of helping autistic people through a social intervention based on play and play therapy. Play can be integrated into traditional curricula and therapies to create an enjoyable experience (Christie & Johnsen 1983). Play is a natural way for children to develop skills, learn to cooperate, and communicate with other children (Sung & Hwang, 2013). Play therapy is implemented in many forms and executed in different contexts by professionals. Play therapy can be designed to improve social interactions, communication, daily functioning, play skills, and

parent-child interactions and decrease problem behaviours, to name a few (Dijkstra-de Neijs et al., 2021; Kent et al., 2020; O'Keeffe & McNally, 2023). Types of therapy include but are not limited to dramatic play therapy, collaborative or cooperative play therapy, JASPER (a play therapy that teaches social and communication skills to autistic children), Plan-Play-Report, peer play therapy and individualized play therapy (Dijkstra-de Neijs et al., 2021; Kent et al., 2020; O'Keeffe & McNally, 2023). Play therapy can take place in clinics, schools, at the child's home and can be in an individual setting, with peers and with adults such as parents (Dijkstra-de Neijs et al., 2021; Kent et al., 2020; O'Keeffe & McNally, 2023).

Play therapy is not explicitly based on the evidence-based practices published by Hume and Colleagues (2021). However, play therapy can be incorporated into many practices on the list. For example, naturalistic intervention uses strategies and techniques such as play to promote targeted skills and behaviours (Hume et al., 2021). A second example is peer-based instruction and intervention, where peers promote social interactions and learning goals through activities such as play (Hume et al., 2021). A third example is simple reinforcement, which uses consequences following a response that increases the likelihood that the same response will be used in the future; this could include social praise because of successful turn-taking in a board game with peers (Hume et al., 2021). This is only a short list of examples that show how play therapy can be used effectively to treat symptoms of ASD (Dijkstra-de Neijs et al., 2021; Kent et al., 2020; O'Keeffe & McNally, 2023).

When designing and implementing play therapy, it is important to take an individual's interests and enjoyment into consideration when developing a therapeutic program; this makes play therapy, in particular, appealing to children and teens (Alagendran, Hitch, Wadley & Stagnitti, 2019; Bergen & Fromberg, 2009; Lamb & Etopio, 2019). In addition, play therapy is more

effective when the child has a choice and interest in the activity than when an adult asks children to engage in play activity, as children view this as work rather than play. Additionally, higher stress levels are reported when play occurs in unrealistic environments (Alagendran et al., 2019; Bergen & Fromberg, 2009). This information was considered when developing the social intervention implemented in this study, including the decision to utilize cooperative video games.

1.4 Cooperative Video Games and Escape Rooms as Play Therapy

Cooperative video games require that players coordinate their actions with one another throughout the game, either in person or through an online platform (Granic, Lobel & Engels 2014). Video games, to the dismay of some parents (Ferguson et al., 2015; Kutner, Olson, Warner & Hertzog, 2008), are a favourite for children and teenagers. Video games' popularity means they are an enticing way to engage children and teens in therapy (Ceranoglu, 2010; Poole, 2004). Video games can be beneficial in the development of cognitive skills by helping sustain attention, increase the ability to recognize patterns, promote flexibility and control, and improve working memory (Granic et al., 2014; Halbrook, O'Donnell & Msetfi, 2019). Video games can boost motivation to perform everyday tasks as a reward, aid in developing emotional skills and promote social activity, even when played virtually (Granic et al., 2014; Halbrook et al., 2019; Kutner et al., 2008).

In therapeutic settings, video games are an innovative way to help treat the symptoms of depression, anxiety, ADHD, and ASD (Jimenez-Muñoz et al., 2022; Zayeni, Raynaud & Revet, 2020). Video games allow autistic people to improve their social-interactive skills by playing with peers (Banskota & Ng, 2020; Prabavathy, Alex & Sivaranjani, 2023). Video games have the potential to help establish and build relationships through common interests (Ceranoglu, 2010). Cooperative video games have been found to promote positive behaviours and promote positivity

in friendships (Verheijen, Stoltz, van den Berg, & Cillessen, 2019). It has also been found that video game play can promote positive mental health and increase well-being among players (Halbrook et al., 2019; Johannes, Vuorre, & Przybylski, 2021). Even when playing games online, it has been found that video games positively affect emotional recognition, emphasizing the importance of social interaction involved in video game play (Chang, Shih & Kasari, 2016; Kutner et al., 2008).

There is far less research about escape rooms and the potential benefits of escape rooms. Much like video games, escape rooms also come with social benefits and have the potential to be utilized in a therapeutic environment. Escape rooms create a safe context to promote prosocial behaviour while offering a fun and engaging environment (Fotaris & Mastoras, 2019; Veldkamp, Van de Grint, Knippels & Van Joolingen, 2020). Escape rooms can help promote critical thinking, problem-solving, and a motivational environment (Fotaris & Mastoras, 2019; Veldkamp et al., 2020). Escape rooms create an environment that promotes teamwork, group mentality, and relationships and can create a sense of belonging environment (Fotaris & Mastoras, 2019; Veldkamp et al., 2020).

Escape rooms are versatile and can be designed to fit any space, budget, or ability (Fotaris & Mastoras, 2019). There are many ways to design an escape room. There is no right or wrong way to develop an escape room or escape-like games (Nicholson, 2015; Veldkamp et al., 2020). The versatility of escape room designs makes them ideal for therapeutic environments, as they can be designed to fit the target audience's needs. For example, in the current study, the escape rooms (that will be introduced as problem-solving rooms in the methods section) were designed with participant needs in mind and within the confinements of a limited budget and limited space. Using

creativity and research, anyone can create an escape room or escape game (Nicholson, 2015; Veldkamp et al., 2020).

Although it has been shown that video games and escape rooms have the potential to be therapeutic, there are other aspects to consider when examining the use of video games in play therapy. Play engages in an activity for enjoyment and is traditionally self-directed without rules or constraints (Christie & Johnsen, 1983; Sung & Hwang, 2013). Studies have shown that video games and escape rooms can be viewed as an enjoyable experience (Barr & Copeland-Stewart, 2022; Peleg, Yayon, Katchevich, Moria-Shipony, & Blonder, 2019; Veldkamp et al., 2020; Zayeni et al., 2020). However, video games and escape rooms both come with a set of rules. In contrast, these rules can be seen as restrictive and are contrary to the idea that play is to be self-directed and constraint-free. Rules, rather than take away from play, can help provide a script or an idea of what to do. In video games, a script or a story line is provided to help give purpose to the game being played and give the player a directive on what to do. The same can be said with escape rooms; an escape room has rules and a storyline to help guide players.

As the current study looks specifically at cooperative play, these rules and storylines help guide cooperation. Cooperative video games and escape rooms require that all participants work together to complete the given activity. Through the instructions that everyone must work together, players know that their role is to be part of a group, and from that point on, the group can decide how this will work.

Another benefit to the rules provided by video games and escape rooms is that this allows for some control of the environment and over what players are doing. It may be difficult to anticipate a player's next move in free play, but in video games and escape rooms, there is a set list of possible actions. For example, the next task in an escape room is to find a red key, and the

only three options are: 1. Find the key, 2. Ask for a hint, or 3. Give up. These limiting options still allow the player to make a choice and have autonomy, but they also allow the research or therapist to have a plan ready for what will happen next based on the choice made by the player.

Considering this, we can see how playing cooperative video games and escape-like tasks can create a therapeutic environment. This therapeutic environment is not only beneficial in many ways, but it can also be controlled and manipulated by the researcher or therapist to create a therapy tailored to the individual player's needs.

1.5 Hypothesis and Anticipated Results

By helping autistic people develop social skills, they may learn how to navigate social settings and what is and is not socially acceptable. The overall goal of autism research is to learn more about the disorder, increase the rate of early detection and diagnosis, bring awareness to the disorder, and help improve the lives of autistic people so they can thrive (Cremin, Healy, Spirtos, & Quinn, 2021; McDonnell et al., 2019; Sheldrick et al., 2019). Autistic people can be affected by the inability to function typically in social situations ([DSM-5] American Psychiatric Association, 2013), which can result in social isolation and feeling as though they do not fit in (Kaminski, Fisher, Greer, & Akers, 2018). My research problem was developing a social intervention that naturally allows autistic people to develop and improve social skills, while providing a fun experience.

As Autistic teens have lower social skills than neurotypical teens, I hypothesized that test sessions (problem-solving rooms) and practice sessions (video games) would improve their social skills. This increase would be more significant than that in the typically developed group. It was predicted that throughout the three test sessions and four practice sessions, autistic participants would increase their social skills. In addition, it was predicted that all participants would demonstrate better turn-taking in conversation and that there would be an increase in positive

social interactions and a decrease in negative social interactions. Finally, it was also predicted that these changes would be more significant for autistic teens than neurotypical teens.

Chapter 2: Methods

2.1 Sample Description

The test groups consisted of three cohorts of three autistic adolescent males who can act independently and communicate verbally without a communication device. Additional criteria for the study selection included that the participants had been seizure-free for at least one year and had no behavioural concerns such as violent outbursts, self-harm, or a history of running away. The control group consisted of three adolescent males considered neurotypical in their development.

Participants were aged between twelve and seventeen years old, and no one had met one another before the study. Group ASD 1 consisted of fourteen-, fifteen- and sixteen-year-olds, all white. Group ASD 2 consisted of twelve-, fourteen- and fifteen-year-olds, all white. Group ASD 3 consisted of three, twelve-year-olds, all white. The control group consisted of two, fourteen-year-olds and one, fifteen-year-old; the two, fourteen-year-olds were white, and the fifteen-year-old was Blackfoot. Although the control group was not entirely white, as were the ASD groups, the control group is representative of the population in the Lethbridge area.

This thesis project received ethics approval from the Human Participant Research Committee at the University of Lethbridge (HPRC #2019-047). The consent form for guardians can be found in Appendix A, the assent form for participants ages fifteen and under can be found in Appendix B, and the assent form for participants ages 16 and older is in Appendix C.

To ensure that the problem-solving rooms worked as intended, twenty-three University of Lethbridge students, all over eighteen, played through each problem-solving room. They earned

course credit as compensation for their time. Demographics and exact ages of these participants were not collected, all audio recordings were deleted after confirming that audio was recorded, and ethnographic notes were stored but never transcribed or utilized in the final analysis as these participants were used strictly for pre-test and training purposes.

2.2 Research Design and Procedures

Participants met twice weekly for two hours at the University of Lethbridge for seven sessions. In addition, participants, through the course of the study, participated in cooperative activities like cooperative video games and problem-solving rooms. The problem-solving room tasks were completed at the beginning of the study to provide a baseline (problem-solving room 1), halfway through the study (problem-solving room 2), and at the end of the study (problem-solving room 3). Each problem-solving room took thirty minutes to an hour and twenty minutes to complete, including instruction time, time to solve the room, snack breaks, and a debrief at the end. Table 1, provides an overview of the study schedule.

Table 1
Sessions and Tasks

Task	Task Description	Session
Problem-solving Room 1	Part 1: Explanation of the study and participant expectations. Part 2: Problem-solving room – Find Zipper the Rat.	Test
Overcooked	*Overcooked* is a cooperative-style video game involving players working together to run a restaurant (Ghost Town Games, 2016).	Practice
Sports Video Game	*NHL 18* is a hockey-based game where players work together on the same team (Electronic Arts, 2017b).	Practice
Problem-solving Room 2	Problem-solving room – The Magician Lost his Magic Rabbit.	Test
Sports Video Game	*FIFA 18* is a soccer-based game where players work together on the same team (Electronic Arts, 2017a).	Practice
Tiny Brains	*Tiny Brains* is a cooperative-style video game involving players working together to escape a mad scientist's laboratory (Spearhead Games, 2013).	Practice
Problem-solving Room 3	Part 1: Problem-solving room – The Teacher Lost Your Gift Cards! Part 2: Debrief	Test

Note: This table provides an overview of the task schedule, task description and if the session was a test session (behaviours were measured and analyzed) or a practice session (where participants engaged cooperatively but behaviours were not measured or analyzed).

2.2.1 Cooperative Video Games.

There was a total of four video game sessions. The video games were intended to be practice sessions that allowed participants to work together cooperatively while playing video games. The video games are practice sessions. Behaviours were not measured or analyzed during these sessions.

The following video games were played: Overcooked (Ghost Town Games, 2016), Tiny Brains (Spearhead Games, 2013), *NHL 18*, and *FIFA 18* (Electronic Arts, 2017). These video games were played in a regular classroom at the University of Lethbridge. Comfortable leather

chairs were set up in the classroom, and the PlayStation screen was projected onto a projection screen (Figure 1). Each participant was given a PlayStation controller; each controller was a different colour and would light up in a different colour during gameplay to prevent arguments among the group members. Drinks and snacks were provided during video game sessions, and snacks were typically consumed during gameplay. The doors to the classroom were left open for participants to take a break as needed. Each video game required that all participants worked together, and each had its own style, storyline, and objective.

Overcooked is a cooperative-style video game that can be played singularly or with a group of people (Ghost Town Games, 2016). The game's platform is played interactively from one console, and all players must play cooperatively to continue through the game. As a result, the game is easier to play with a group of people, and levels get increasingly more complex as the game continues. The game is set in a kitchen, and the overall goal is to put together a dish to serve guests in the restaurant promptly and without burning the food. Roles in the game are interchangeable among participants; roles include cooking, chopping up food, cleaning dishes, serving food, and even putting out fires when the food starts to burn (Ghost Town Games, 2016).

Tiny Brains is rated E for everyone and can be played with one to four players (Spearhead Games, 2013). Tiny Brains is a cooperative action game set in a scientist's lab. All participants must work together to solve puzzles and escape the mad scientists' experiments. The game is easier to play with more players, and the levels become more challenging to solve as the game goes on. The puzzles that need to be solved vary throughout the game, allowing all players to work together to outsmart the scientist and escape from the lab (Spearhead Games, 2013).

FIFA 18 and NHL 18 are sports-based games rated E for everyone; they can be played with one to four players (Electronic Arts, 2017a & 2017b). These games are where players can

play against each other or as a team, against the video game console. The difficulty level can be adjusted according to the player's skill level. The game is played as a team, allowing this task to be cooperative. The goal is that all participants play together in different positions on the sports team, such as the forward position and defence position, and work together to score goals (Electronic Arts, 2017a & 2017b).

These four video games were chosen because they required all players to work together and could be played in person. These were video games that were best played with other people. The games could be played alone when put in single-player mode, but in this case, the gaming console would act as the other player to assist with game play. For this study, instructions were provided that all participants had to play the game together cooperatively, and the games were each set to three-person mode. As the games were played in person, the participants could engage socially and interact with one another.

Figure 1: Video game set up in the University of Lethbridge classroom TH241

2.2.2 Problem-solving Rooms

A problem-solving room is essentially an escape room. However, where traditional escape rooms tend to be dark and scary, this was a bright, safe, and non-sensory overloading environment. There was a total of three uniquely designed problem-solving rooms utilized in this study. The problem-solving rooms were the tested sessions. Behaviours were measured and analyzed during these sessions.

The problem-solving room portion of this study occurred at the University of Lethbridge in various classrooms and breakout rooms (Figure 2). The participants had to search for clues, solve riddles, and open combination locks that helped them get to the next clue and eventually solve all the tasks to complete the problem-solving room. The researcher guided the problem-solving room sessions, and hints were given as the participants requested. The researcher designed and set up these problem-solving rooms to be a challenge that all participants had to work together to solve. The room design was mapped out, including a description of the problem-solving room design and a flow chart showing the order in which the problem-solving room was completed. This map was created to ensure consistent room setup and assist research assistants in running the session if the researcher had to step out.

Tasks varied in order and type for each of the three problem-solving rooms. One of the simplest and most frequent tasks was to find a key colour-coded to a lock that would unlock a room (Figure 3). The keys were hidden in lockers, under tables or chairs. Solving or finding the code to combination locks was also common, with clues in riddles, math questions, numbers, and letters written on props. Once combination clues were found, they would need to be ordered correctly to open the locks successfully; this could be tedious as some locks had up to twenty-five combinations. To make this process less frustrating, whiteboard cards and dry-erase markers

were provided (Figure 4). Other tasks included finding puzzle pieces, as those seen in Figure 5 and Figure 6, which were hidden under tables and chairs and had cutouts to make solving the task easier. When this task was initially tested with four University students, it wasn't easy to solve; as a result, shape punch-outs were added to make the puzzle easier to solve. Some clues were visible and easy to find throughout the problem-solving rooms, while others were hidden in invisible ink that was only visible using a UV light source (Figure 7). As the study was limited to the use of classrooms and study rooms within the University of Lethbridge, I wanted to utilize the space to the best of my ability, and this included using the entire area and making the problem-solving rooms as interactive as possible by hiding items in various places (Figure 8 and 9). Each problem-solving room concluded with participants finding the last locked box and a prize inside (Figure 10). Most of the time, participants actively searched for clues and ran back and forth from one room to the next rather than sitting in one space. The tasks in the problem-solving rooms were designed to make the group work together; some rooms were large, and there were many places to search for clues and keys, this was easier to complete with three people. Other tasks, such as math problems and riddles, were given in multiples at a time so each group member would have something to work on, rather than one individual working on that task while the others had nothing to do.

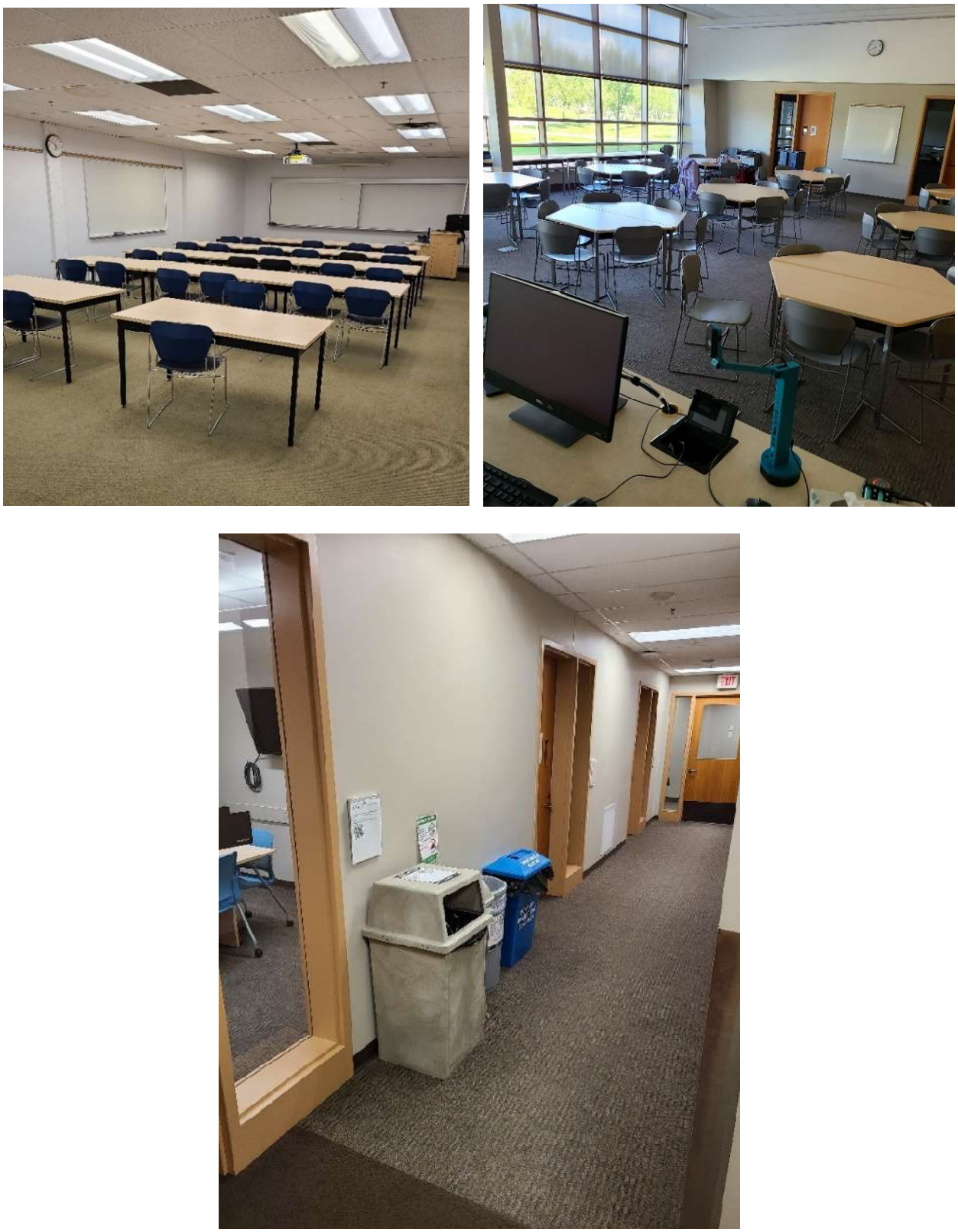


Figure 2: Classrooms Transformed into Problem-solving Rooms. Classrooms, breakout rooms and study rooms were utilized to create problem-solving rooms.

Figure 3: Lock on Doors. Finding keys to unlock rooms was also a common task. As rooms could not be locked, colour-coded padlocks were placed on door handles to simulate a locked room.

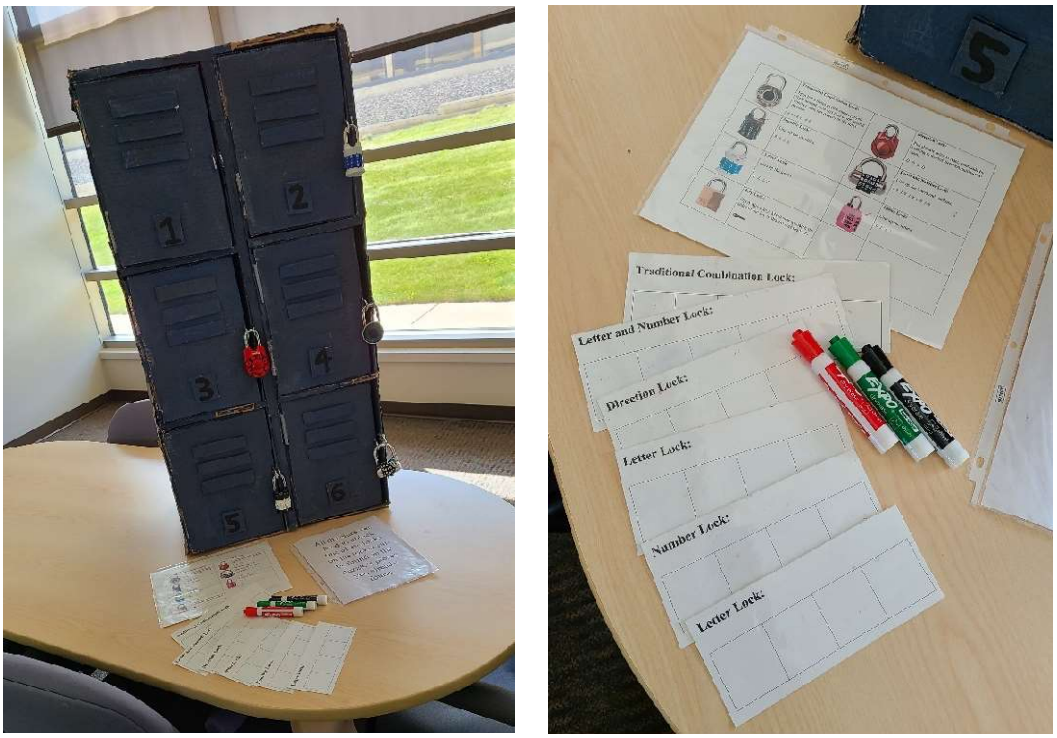


Figure 4: Lockers and Locks. Most tasks focused on finding the combinations for locks on the cardboard locker; instructions on how to open the different locks, dry-erase boards, and markers were provided as a visual aid for brainstorming combinations.

Figure 5: Items Found in Lockers. Inside the lockers, many clues could be found in the form of props, riddles, hints, keys, and books. However, sometimes, items were irrelevant to throw off participants.

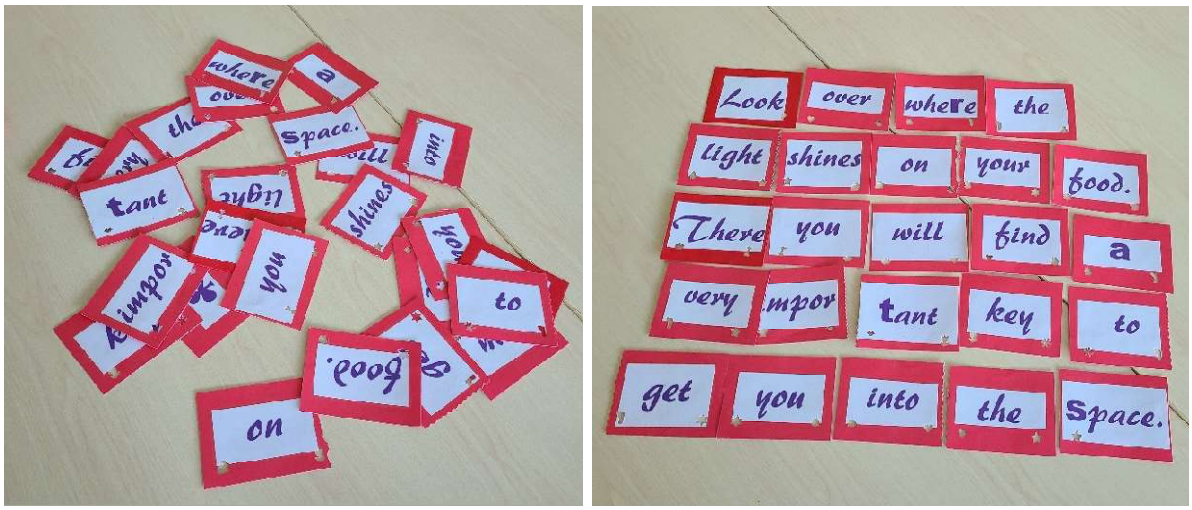


Figure 6: Find and Sort Tasks. Twenty-four envelopes were hidden; once found, the cards had to be sorted and arranged correctly to reveal a clue.

Figure 7: Hidden Clues in Invisible Ink and Visible Ink. Numbers corresponding to various combinations were written in different ink on different mediums.

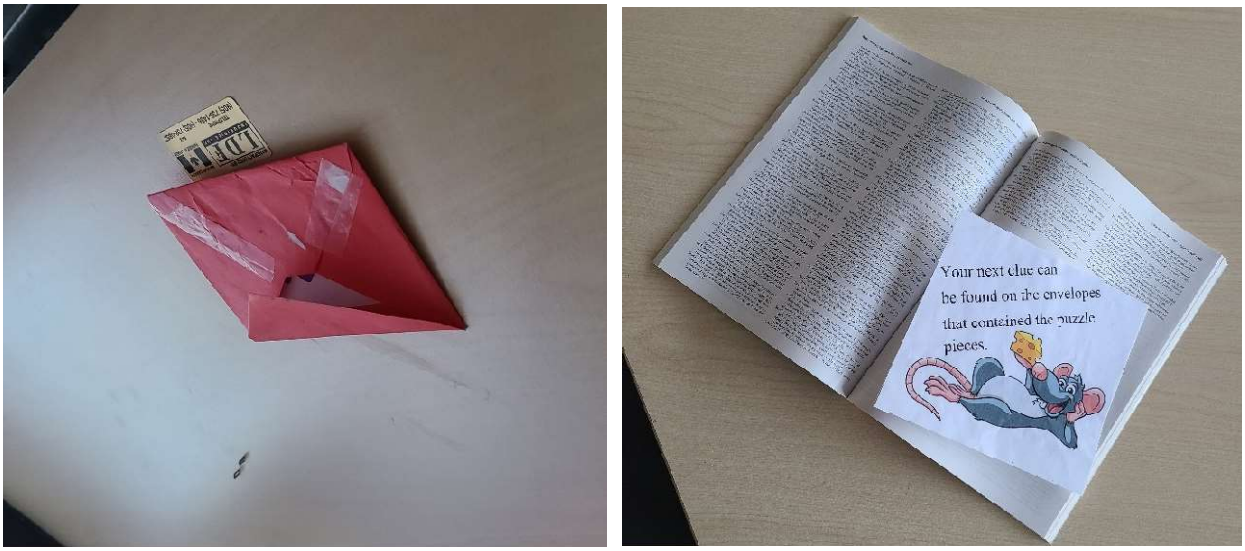


Figure 8: Clues are Hidden in Various Places. Clues were hidden under desks and chairs, behind doors and in books for example.

Figure 9: Classroom Space. The classrooms were fully utilized to make the problem-solving rooms interactive, engaging, and challenging. In addition, using the classrooms fully encouraged active participation and cooperation as there was a larger area to cover.

Figure 10. The Final Task. The final task of each problem-solving room was finding the combination of the lock on the treasure chest or finding a key.

As previously mentioned, before the research participants participated in the problem-solving rooms, university students tested them. This allowed not only for all problems to be worked out, such as finding that a puzzle was too difficult to solve, but it also helped ensure that all tasks made logical sense and that the problem-solving rooms could be solved and completed. The rationale was that if four university students cannot solve a task, then a group of twelve-year-olds may be unable to. These test runs also allowed research assistants to practice taking ethnographic notes and show them how the problem-solving rooms worked if the researcher had to step out.

When participants first entered each problem-solving room, they were given general instructions on what a problem-solving room is and instructions on the different kinds of locks found throughout the escape room. Unlimited hints were allowed on the condition that the group agreed to ask for a hint; if a participant did not agree, a hint was not provided. If needed,

participants were allowed up to two hours to complete the problem-solving room. Although, instead of using a countdown timer as traditional escape rooms do, a stopwatch was used to indicate how much time had passed so participants would not feel constrained or stressed by a timer, the recorded run time of each room included time taken for breaks and for the time taken for off-topic socializing.

Problem-solving room 1 was titled “Find the Professor’s Prize Rat Zipper.” A layout of the room is provided in Figure 11. The average run time of the room was sixty-two minutes and thirty seconds. This problem-solving room contained one main room and seven smaller breakout rooms. The first task was to find twenty-four envelopes hidden under chairs and tables in the main room. The envelopes had puzzle pieces that needed to be put together correctly to reveal a clue in the form of a message. The message provided a hint that helped find the blue key under the snack table. The blue key opened room two with a set of lockers. In room two, a hint stated, “All the clues you need to unlock one of the locks can be found on the puzzle pieces you already found.” This clue would lead them back to the puzzle, where they would see the letter R, A, T, S written in a font that differed from the font on the rest of the puzzle. The word RATS unlocked locker door number two, which had a red key and instructions for room four. A math problem must be solved in room four to get into locker three. Once in locker three, a clue stated, “If you return to the red envelopes that you found before, you will find your next clue.” The envelopes contained letters, numbers and symbols that spelled L05T! this was the combination of locker six. Once in locker six, the next clue stated, “The next combination will be found on the back of a door you have already opened,” The combination was found on the back of the door to the main room. This gave the combination 49-16-49 and opened locker four. In locker four, there were four cards with medium to tricky riddles; when the riddles were answered correctly, the

combination given was 8909 and opened locker five. Locker five contained a note stating, “Go back to room four and search well.” Room four had a small teal box with three UV flashlights and a note saying, “Shine the light at the back of the red locker.” The inside of locker one was painted red with a message written in invisible ink that said, “Go to room one and look up.” In room one, there was a note above the door that said, “Ask Brittany for the key,” this key was the purple key and would unlock room six. In room six, a locked box and a hint said, “You have one more search ahead of you.” When searching room six, a pink key unlocked the final chest containing a plush toy rat and a note that said, “Congratulations!”

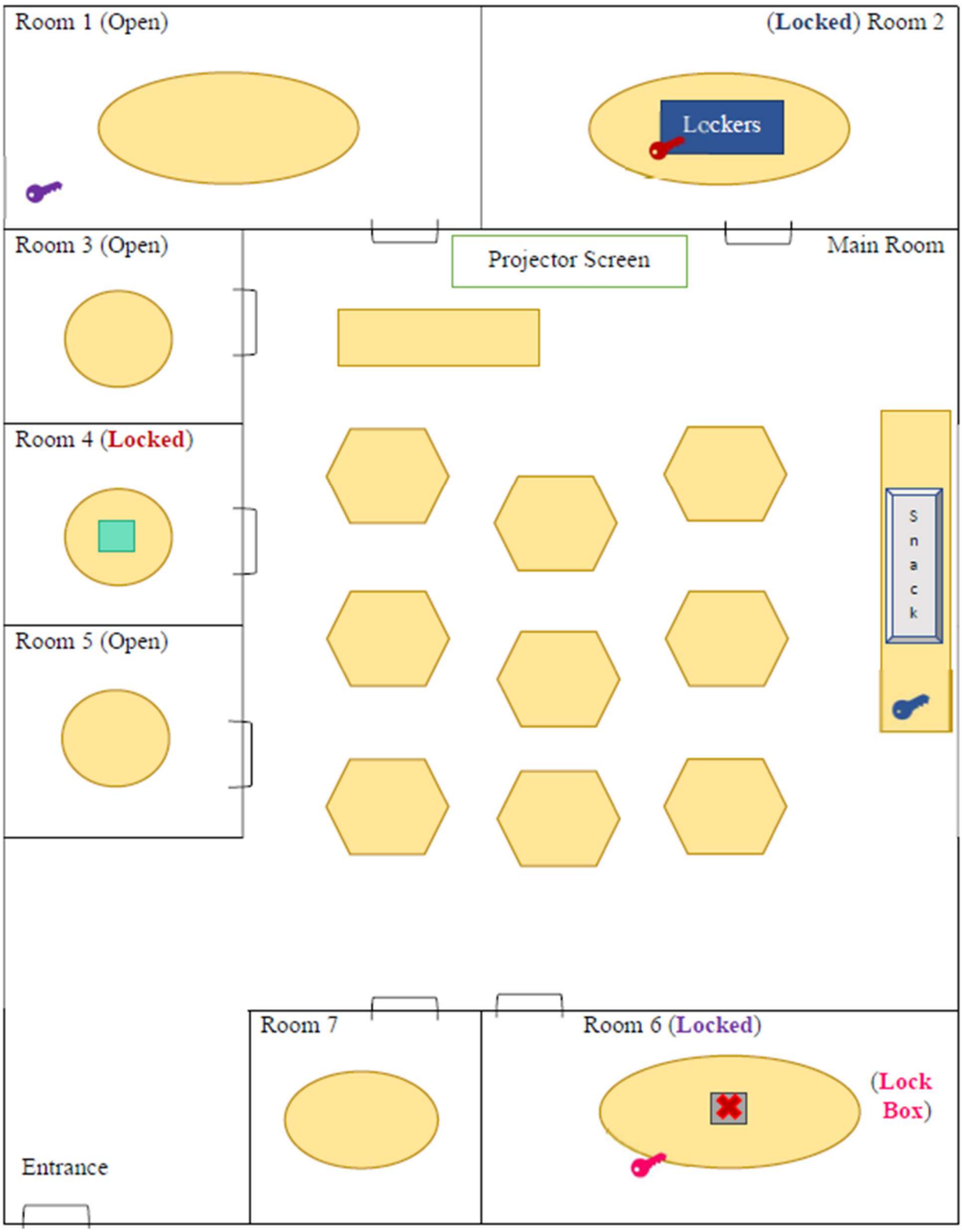


Figure 11: Problem-solving Room 1 Layout. Problem-solving room 1 was in classroom M1035 and linked to breakout rooms at the University of Lethbridge.

Problem-solving room 2 was titled “Find the Magic Rabbit!” A layout of the room is provided in Figure 12. The average run time of the room was fifty-one minutes and fifteen seconds. This problem-solving room contained eight study rooms and the hallway area between the study rooms. This problem-solving room started in room four, and instructions were given to search all the open and unlocked rooms to find the first clue. The unlocked rooms were room six, room seven, and room eight. In room six, there was a deck of red playing cards. In room seven, four dice were found that had one side of each dice purposefully painted with green dots that would give the combination 5413 for locker two. In room eight, a blue key was found to open room five, where the lockers were. Once in room eight, locker five was open and contained three UV flashlights; these flashlights could be used to check the deck of red playing cards that would give a hint that “The combination for locker two starts in five and ends in three,” using this hint and the four dice they found, locker two was open. The deck of red cards also included the following cards: ace of Clubs, two of Spades, three of Clubs and four of Diamonds circled in invisible ink with “LOCKER THREE” written on each of these cards. This hint would open locker three; once in locker three, a pink key would open room two and a note that stated, “Search room two” was found. A purple key was found in room two that would open room one. That room had a deck of blue playing cards and pictures of magicians on the back of the door. The blue deck of cards contained six cards with the numbers 4 9 1 6 4 9 circled in black ink. On the reverse of the cards clues to the combination order were given using invisible ink; for example, combination 49-16-49 opens locker one, in locker six there were five envelopes that contained riddles and math problems. When correctly solved, the combination 4 3 6 2 opened locker six. In locker six, there were ten neuroscience journals; in one of the journals, there is a hint that stated, “Go look at the back of the door in room one.” The back of the door in room one had four pictures of famous

magicians. The names of the magicians were written under the pictures, and each word had one letter that looks different than the others. Decoded it provided the word code STAR, which opened locker four; in locker four, there was a red key. The red key opened room three with the final locked box and a note to, “Check the back of locker two.” At the back of locker two was the word LITE written in invisible ink; this was the combination of the final lock box. The lost plush toy rabbit and a note of congratulations were in the last lockbox.

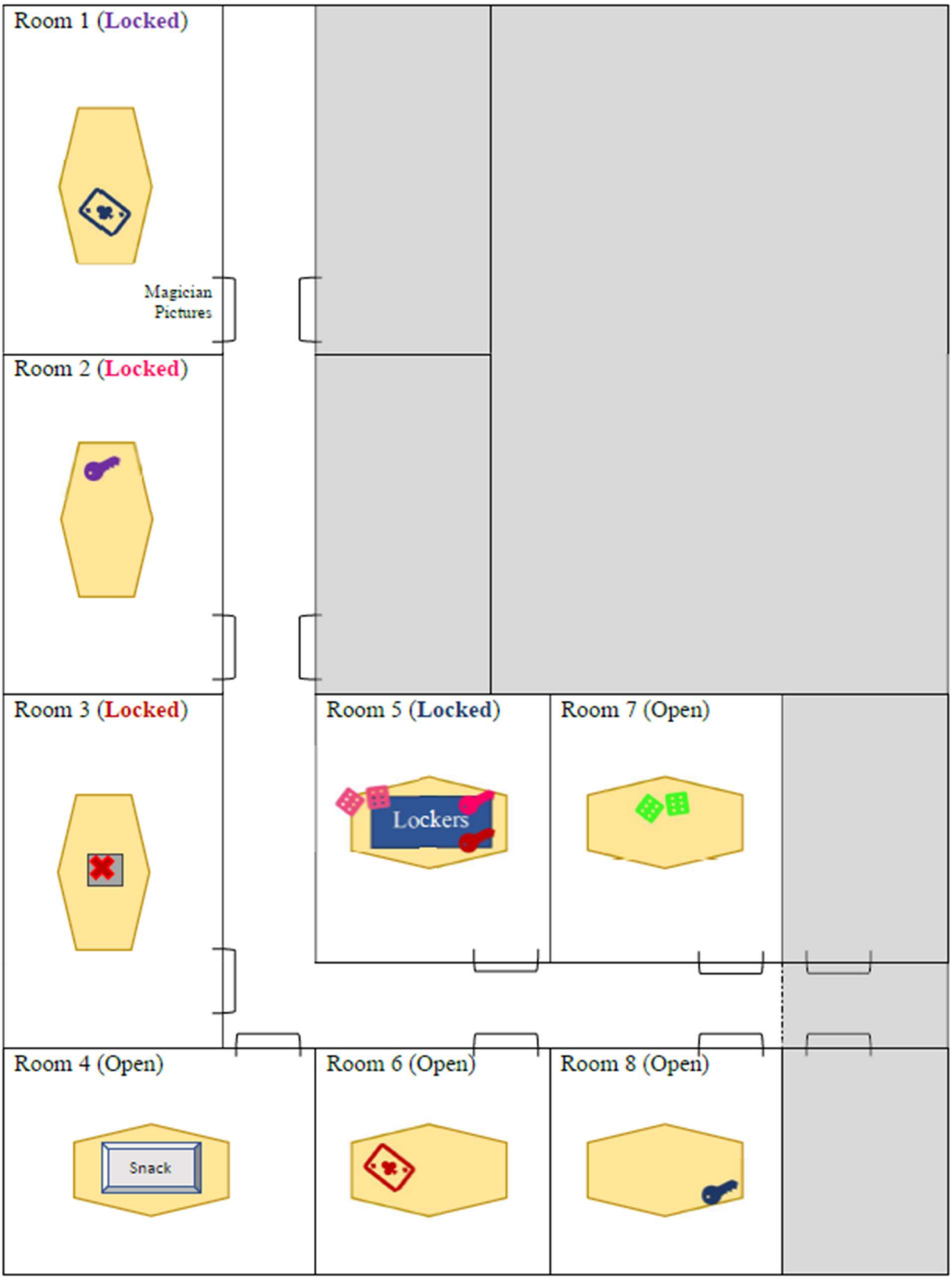


Figure 12: Problem-solving Room 2 Layout**.** Study rooms M1062, M1064, M1068, M1070, M1072, M1073, M1074, & M1075 at the University of Lethbridge.

Problem-solving room 3 was titled, “The Teacher Misplaced the Key to the Safe with Our Gift Cards!” A layout of the room is provided in Figure 13. The average run time of the room was thirty-five minutes and zero seconds. This problem-solving room contained two large-sized classrooms and the hallway area between the classrooms. This problem-solving room began in the first classroom with a hint to search the room. In the first room, there were two keys hidden along with props, including toy dinosaurs and large erasers with clues that would be useful later. The red key opened room two, which contained the lockers, and the blue key opened locker four. Once in locker four, there was a word-shaped eraser and a clue that stated, “look at the alphabet.” In room two, there was an elementary school alphabet board on the wall. On the alphabet board, hints were written on the letters that gave the combination MGBO to open locker one. In locker one, there was another word-shaped eraser and a toy dinosaur. There were now three word-shaped erasers, two found in lockers and one found in the classroom; these gave the combination !PN3A which opened locker two. In locker two, there were three UV flashlights and a hint that directed the participants to look at the dinosaur poster. The dinosaur poster was found in room one and gave the combination BELL that opened locker six. Once in locker six, four envelopes contained questions that could be answered using the large periodic table on the whiteboard in room one. When answered correctly, combination 7126 opened locker four. Once in locker four, a third dinosaur was found. The belly of each dinosaur contained a number; these numbers gave the combination 59-34-19 to open locker five. Locker five had the pink key, which opened the final lock box; in the last lock box, participants found a thank you card and a fifty dollar gift card for Mastercard.

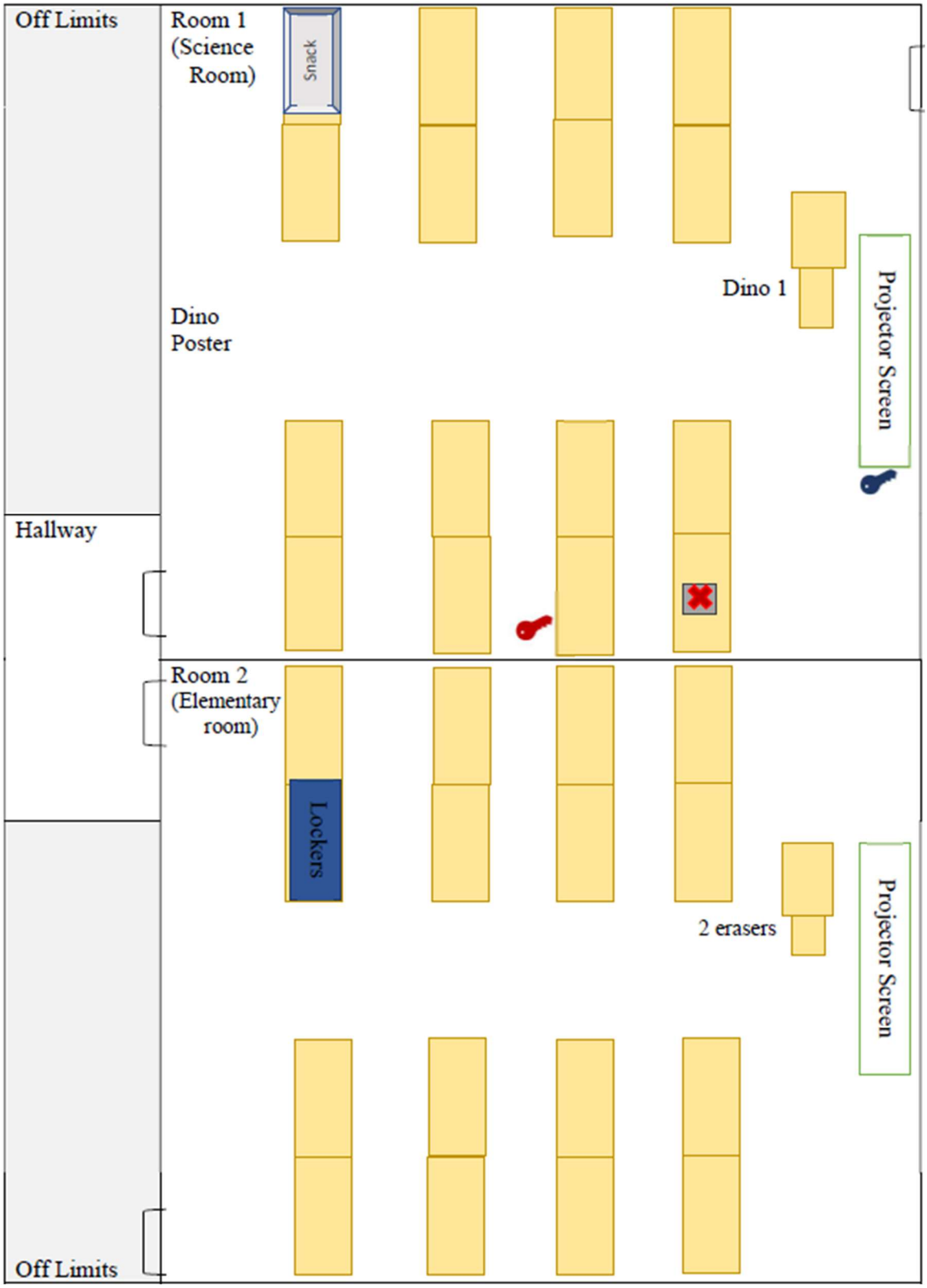


Figure 13: Problem-solving Room 3 Layout. Classrooms PE020 & PE040 at the University of Lethbridge.

2.3 Measurements

The audio was recorded from each participant and from the researcher. Ethnographic notes were taken for all problem-solving room sessions. The audio recordings were collected using handheld audio recorders with lapel microphones and then transcribed into Excel documents to show the time progression and overlap of the conversation. An example of the formatting of the audio transcripts can be found in Table 2. In Table 2, the first column indicates the time; time was recorded in one-minute increments. Columns two through four represent the participant, and the fifth represents the researcher (or research assistant). Each row represents a person speaking; when more than one statement is in a line, two participants spoke simultaneously, while a statement in the next row represents turn-taking in speech. The ethnographic records were directly handwritten onto paper containing tables divided into five-minute increments and later typed into an Excel document; an example can be found in Figure 14. For example, in Figure 14, time was indicated in five-minute increments on the left column, and notes were directly handwritten into the right column.

Table 2
Format of Audio Transcripts

Time	**Participant One**	**Participant Two**	**Participant Three**	**Researcher**
1 minute	Statement one	Statement two		
			Statement three	
		Statement four		
				Statement five

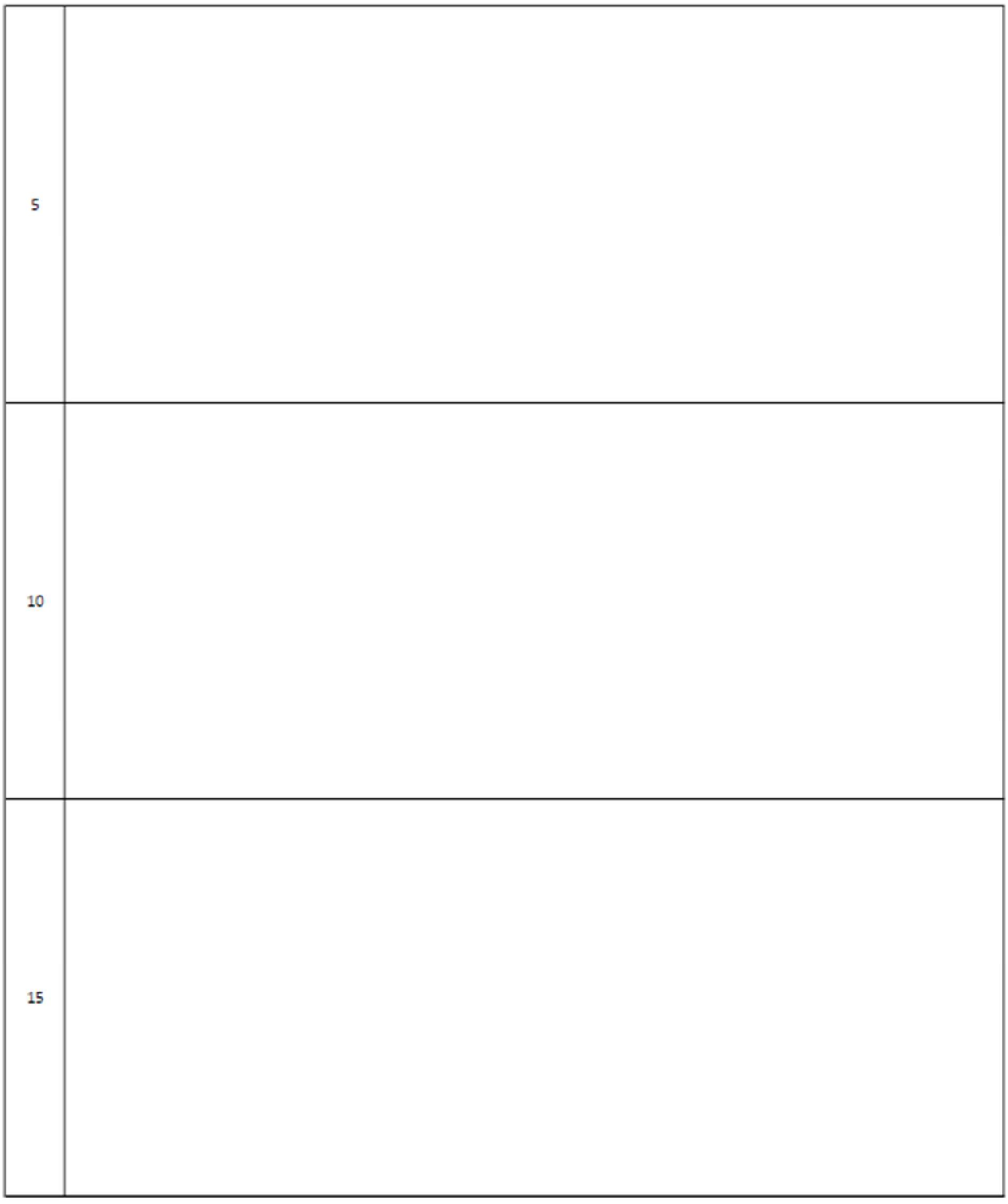


Figure 14: Sample of a Sheet Used to Record Ethnographic Notes.

2.3.1 Audio Recordings

All participants wore lapel microphones during the test sessions, and everything said was recorded. The audio recordings were transcribed by research assistants and checked over by the researcher. Ninety-eight percent of the audio recordings were audible and able to be transcribed; for the two percent that were inaudible, this was due to a sound made by a participant that was not understandable. All sessions and all participant audios were successfully recorded. Where audio was missing from a participant due to a shirt being rubbed against the microphone lapel or for some other reason, the conversation was picked up on another participant's microphone and transcribed.

The researcher completed a microphone check every five minutes; this could be done visually by ensuring the microphone jack was still inserted and the red recording light was on. When the recording indicator light could not be seen, the researcher would ask to see the recorder. The researcher also had a recorder attached to a clipboard to catch any audio that was possibly missed. The researcher's audio recorder was used to keep time; when the session began, the recorder was started, and when the session ended, the recorder was shut off, providing a record of the time it took to complete the problem-solving room.

The video game sessions were not audio recorded as the study focused on measuring what happened in the problem-solving tasks. The video game sessions were to allow for exposure to cooperative play and were intended to be practice sessions where participants would socially engage with one another.

2.3.2 Ethnographic Notes

A total of six research assistants were trained to take ethnographic notes. This training included a lesson in ethnography, ethnographic note-taking practice from online videos, and

training using university student participants in the actual problem-solving rooms. These notes were taken by hand using a clipboard, pen and a paper divided into five-minute increments. As a result, research assistants reported feeling well prepared for the ethnographic note-taking of the study participants, and ethnographic notes were detailed and representative of participant behaviour.

The ethnographic notes were used during transcription to help verify who was talking to whom in cases where the audio was difficult to hear. For example, if Participants 1 and 2 were in the room and Participant 3 was in the bathroom, there was only communication between Participants 1 and 2 at that specific time in the recording. The ethnographic notes were also used when looking at participant interactions, for example, social network analysis requires that we know which participant is talking to another participant and which participant is responding to another participant. The ethnographic notes allowed the researcher to understand where the participants were physically located and what they were physically doing at any given time to confirm the information needed to complete the social network analysis.

2.4 Analytic Techniques

Three techniques were used to analyze the collected data: time comparisons, interactional analysis, and social network analysis. The time comparison and interactional analysis were quantitative methods that used repeated measures, one-way ANOVA statistical test and post-hoc paired T-tests. The social network analysis was a qualitative analysis that used Social Network Visualizer V3.0.4 (Kalamaras, 2022) to identify patterns within group dynamics.

2.4.1 Time Comparisons

Time comparisons were completed by analyzing the time it took for each problem-solving room to be completed. This was further broken down into the time it took to complete

each task. As each problem-solving room remained the same throughout the study, a time comparison was conducted to see how each group performed. From the time comparison, the mean and standard deviation were determined. All calculations were completed using Microsoft Excel, and tabulated graphs were generated to present the data. The data in the table was gathered from the ethnographic notes taken; the ethnographic notes are made with time stamps of five minutes, meaning that all task completion times happened within five minutes and were recorded as such. As means and standard deviation can only provide a limited view of the data, the data were further analyzed using repeated measures of one-way ANOVA, which will be discussed in the following section.

2.4.2 Interactional Analysis

Participants' interactions were analyzed using an adapted version of the analysis conducted by Bauminger (2002). In that study, Bauminger (2002) evaluated the effectiveness of a three-hour-a-week, seven-month-long cognitive behavioural intervention program. The intervention consisted of social education, emotional education and social-interpersonal problem-solving that addressed thirteen social skills. Bauminger (2002) defined five main social behaviours: social initiation, social response, positive social interaction, negative social interaction, and low-level interaction. These definitions were adapted and used to code participants' behaviours in the current study.

The social behaviours utilized from Bauminger (2002) included: affection, a call to attention, and giving help. I added the following social behaviours: success of an event, questions (asked by a participant to another participant), social response, social communication and a sixth category to account for communication made with the researcher. The completed version of the social behaviours key was extensively developed to cover the full spectrum of all

participant behaviours presented during the study. The development of the social behaviours key took place while analyzing the audio transcripts, with terms and definitions changed during initial analysis as needed to incorporate all behaviours exhibited appropriately. After the social behaviours key was fully developed, all data were analyzed from scratch using the completed version of the key as it is in Appendix D to ensure validity or accuracy and reliability or consistency of the measure.

2.4.3 Repeated Measures One-way ANOVA

A repeated measures one-way ANOVA was used to analyze the time to complete each problem-solving room and each behaviour recorded in the interactional analysis. In this study, we had four groups and variables measured at three other points in time (problem-solving room 1, problem-solving room 2 and problem-solving room 3) (Healey, 2015). The dependent variable was the total time to completion or the specified behaviours measured using the interactional analysis. Figure 15, provides a schematic diagram showing the relationship between levels, the measured variables and time. For example, in Figure 15, the circles represent the three problem-solving rooms, the arrow below the circles shows where the problem-solving rooms are measured through time, and the four coloured boxes represent the groups that remain consistent throughout the measure. Although these elements comprise one level, this schematic has three levels representing each of the three problem-solving rooms.

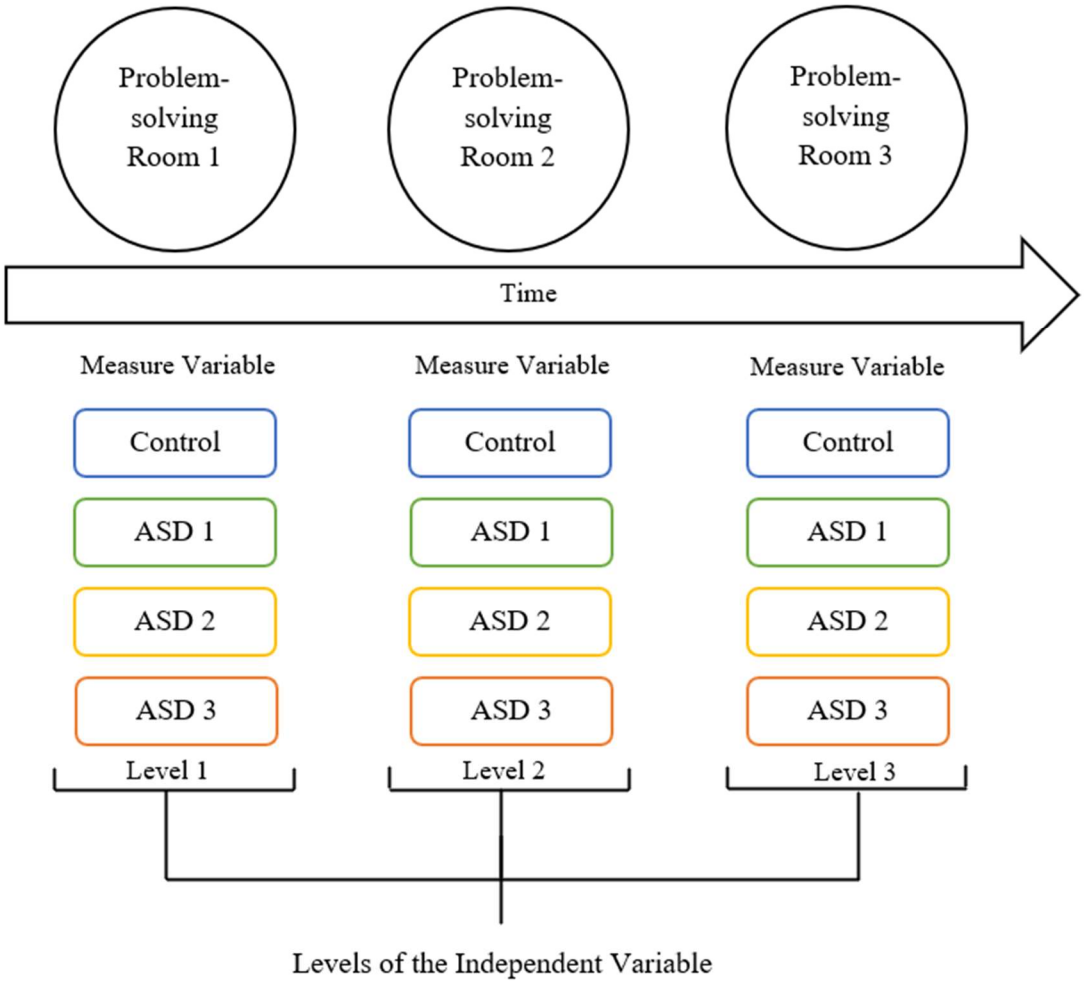


Figure 15: Schematic of Repeated Measure Design Over Time. Figure adapted from Lund Research, 2018.

The repeated measures one-way ANOVA was used to analyze the overall completion time of the problem-solving rooms. Each problem-solving room was different, consisting of different puzzles and differing numbers of puzzles and locks, and was in various classrooms throughout the University of Lethbridge campus (the order of tasks in each escape room can be found in Figure 16). Although the differences in these three problem-solving rooms represent differences in established escape rooms, no escape room is the same. Therefore, comparing the total completion times for each problem-solving room was essential.

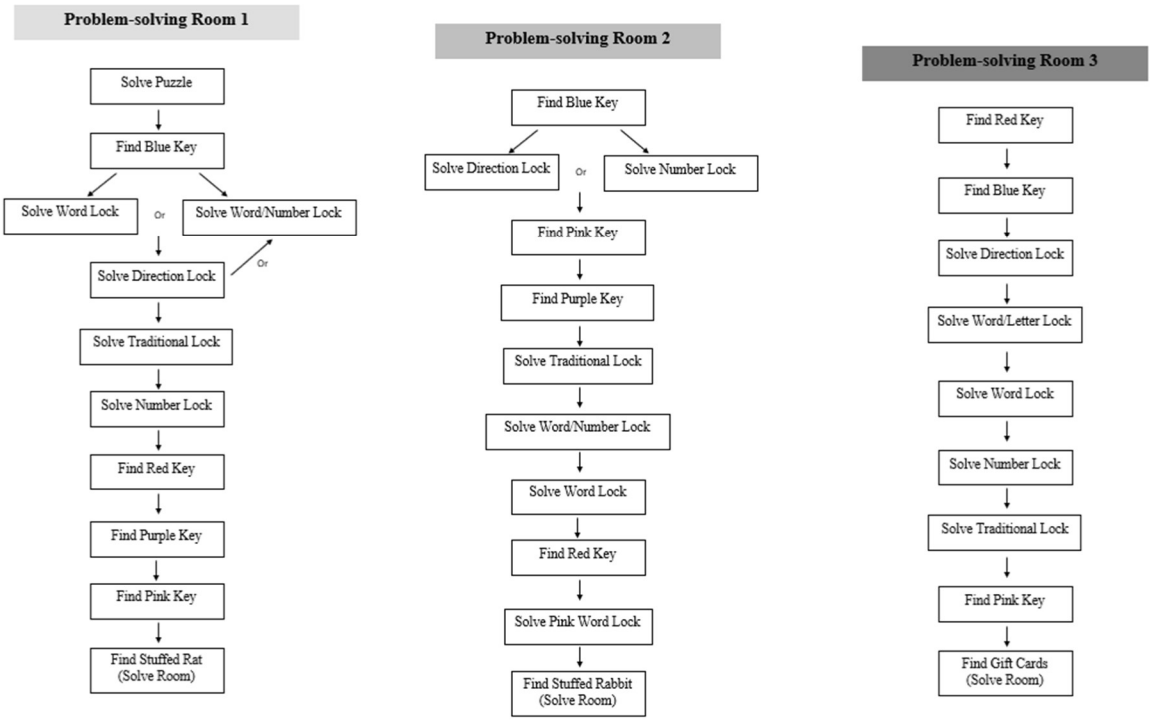


Figure 16: Flow Chart of Tasks in Each Problem-solving Room. Order of tasks in each problem-solving room.

For the behaviours measured in the interactional analysis, all thirty behaviours in the interactional analysis were statistically tested to see if there were any significant differences. For the statistical tests, total counts of each behaviour were used. For example, if a hint was asked six times in problem-solving room 1, then a score of six was assigned. The data was tabulated and tested against all other groups' counts for the measured behaviour. For example, if we are looking at the behaviour of asking for a hint, the number of hints was entered for all groups across all three categories. Using the statistical test, all group and level counts were calculated to get the mean; the means were then calculated to generate a grand mean. Table 3 provides an example of how the counts were tabulated and how the means were calculated. In Table 3, the first row indicates the measured variable and the number of hints in this example. The first column shows the group, and the second through fourth columns indicate the problem-solving

room. The seventh row and fifth column contain the count means, and the last cell in the table includes the grand mean.

Table 3
Example of Tabulated Data and Mean Calculations for Repeated Measures One-way ANOVA

Variable Measured: Number of Hints				
Group	**Problem-solving Room 1**	**Problem-solving Room 2**	**Problem-solving Room 3**	**Group Means:**
Control	3	7	4	**4.67**
ASD 1	7	5	4	**5.33**
ASD 2	3	6	6	**5**
ASD 3	4	6	3	**4.33**
Problem-solving Room Means:	**4.25**	**6**	**4.25**	
			Grand Mean:	**4.83**

Note: Table adapted from Lund Research, 2018.

The current research utilized a repeated measures ANOVA and a paired T-test post-hoc using IBM SPSS statistics software Version 27.0 (IBM, 2020). Sphericity was calculated using Mauchly's test of sphericity, which yields a p-value; if the p-value is less than 0.05, then the assumption has been violated. When this violation happens, the Greenhouse-Geisser correlation corrects for lack of sphericity. Normality was checked using the Shapiro-Wilk test; this test uses an alpha value of 0.05 and compares it to the p-value. No normal distribution is present if the p-value is lower than the alpha value. There was a total of eleven degrees of freedom. Between subjects (rows), there were three degrees of freedom, and between treatments, there were two degrees of freedom. Outliers were detected using Tukey Fence for multiple comparisons, k=1.5.

2.4.4 Social Network Analysis

Social network analyses can involve thousands of connected points representing anything from interactions in a group of friends to political parties to characters in your favourite movie

(Yang et al. 2017). Social networks are created using an adjacency matrix. The adjacency matrix organizes the numerical data representing each actor's total interactions. This numerical data can represent various information, for example, how many likes are sent on social media, how many times your mother tells you to clean your room or how many seconds you spoke to a friend. From the adjacency matrix, a social network can be created to show us the relationship between the data. A social network comprises nodes representing an actor and ties representing the connection between nodes.

In the current study, each group comprised three participants, so ties interconnected three nodes. The data used to create these social networks was the time each participant spent talking to one another measured in seconds. The data for each problem-solving room was placed into an adjacency matrix to perform statistical analysis using Social Network Visualizer v3.0.4 (Kalamaras, 2022). Figure 17 shows an example of an adjacency matrix. A number in this example represents the actor but can also be represented by a name. The numbers or elements in the inner part of the table represent actors' connections; in this example, the numbers represent seconds spoken but can represent other data dependent on the study. An adjacency matrix of a social network is an $N \times N$ matrix, where N represents the number of actors; in the current research, this is 3 x 3, representing three participants speaking to one another (Kalamaras, 2015). The matrix comprises elements (i, j), the value from actor to actor, representing the seconds each participant spoke to one another (Kalamaras, 2015).

In an adjacency matrix, the actor column is representative of the “in-node,” while the actor row is representative of the “out-node.” The “in-node” represents the amount of time an actor in the column spoke to an actor in a row, while the “out-node” represents the amount of time an actor in the row was spoken to by an actor in a column. Misreading an adjacency matrix

would result in misinterpretation of the results. Figure 17 provides a visual representation and instructions on how to read an adjacency matrix.

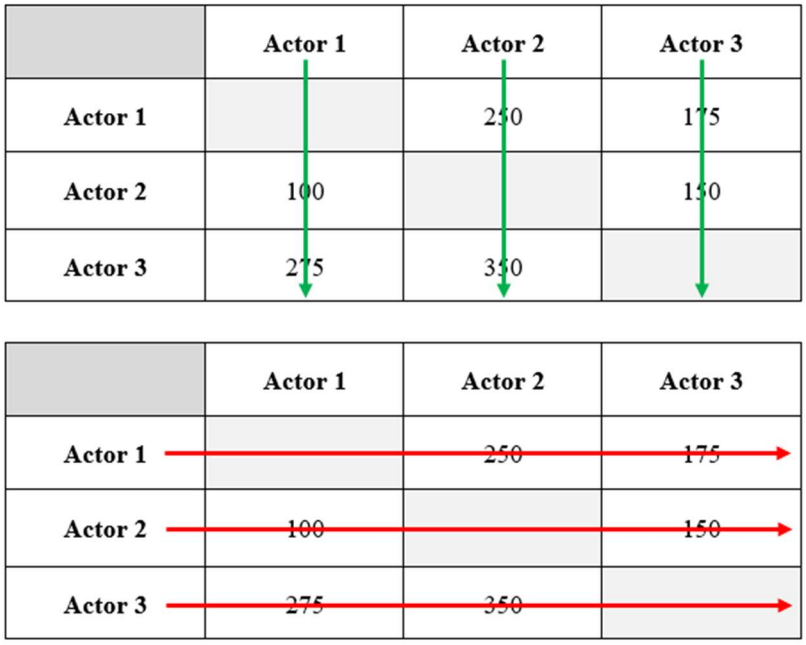


Figure 17: How to Read an Adjacency Matrix. The first table shows the actor column, or "in-node," represented by green arrows. The second table shows the actor row, or "out-node," represented by red arrows. An adjacency matrix can be read one of two ways. The first is from the "in-node," for example, "Actor 1(column) spoke to Actor 2(row) for one hundred seconds". The second is from the "out-node," for example, "Actor 2(row) was spoken to for one hundred seconds by Actor 1(column)". The way we read and interpret an adjacency matrix is important; for example, "Actor 2(row) spoke to Actor 1(column) for one hundred seconds" is incorrect and would create an incorrect representation of the data collected.

I ran degree centrality and closeness centrality analysis using an adjacency matrix from these matrices. Degree centrality is how many ties a node has to another node in a network; this is calculated using Freeman's Formula in Figure 18 (Kalamaras, 2015). Degree centrality is presented in raw numbers but can be converted into a percentage by dividing each actor's group degree centrality (GDC) by the group sum (Kalamaras, 2015). The degree centrality percentage shows the distribution of conversation between the three participants.

$$GDC = \frac{\sum (maxDC' - DC')}{(N-1) \cdot (N-2)/(2 \cdot N - 1)}$$

Figure 18: Freeman's Formula for Degree Centrality (Kalamaras, 2015) calculates degree centrality. *DC'* is degree centrality, and N is the number of the node; in the current research, this is the number of seconds an actor has spoken. This is calculated by Social Network Visualizer v3.0.4 (Kalamaras, 2022).

Social network theory does not define the idea of an "ideal" cooperative conversation; rather, this concept fits well with the current research. A deep literature search into social networks did not find any reference to the "ideal" cooperative conversation. Therefore, this is important to define as it will be referenced when discussing the results of this study. Linguists and philosophers have discussed the concept of cooperative conversation in a different way that applies to the current research. Meaningful conversation is characterized by cooperation with a common purpose (Grice, 1975); in the current research, the common purpose is the cooperative task at hand. Another example of this is the expectation of communication to be reciprocated by everyone in the conversation, and that effort is facilitated by all members involved (Kecakes, 2014). Working through a cooperative task such as the problem-solving rooms in this study requires a conversation to be reciprocated, or completing the task at hand would be difficult and completed individually.

For this study, the ideal cooperative conversation was defined as a conversation that is shared and reciprocated equally by all members of the conversating group. As all groups in this study have three participants, an ideal cooperative conversation would be shared in three ways: 33.33%-degree centrality per actor or participant. Any deviation from this number would suggest the conversation is not the ideal cooperative conversation. Depending on the percent degree centrality, we can see which participant(s) is dominating the conversation and which is

contributing less. There is no statistical method to determine how significant a deviation from the "ideal" cooperative conversation needs to be before the deviation is considered significant. As a result, the analysis is qualitative, and future empirical testing would be required to examine geometric relationships in cooperative interactions.

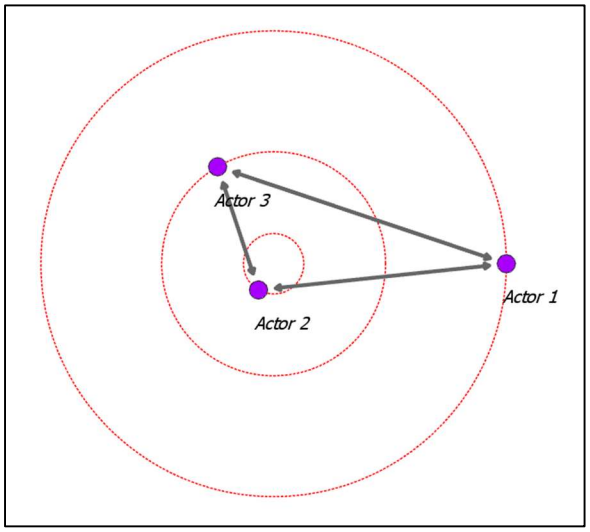
Closeness centrality is how close, geographically, each node is to all other nodes in the network (Kalamaras, 2015). This is calculated using the directed path of conversation and the equation in Figure 19. Closeness centrality is presented in raw numbers but can be converted into percentages by dividing closeness centrality (CC) for each actor by the group sum (Kalamaras, 2015). The closeness centrality percentage shows how close each node or actor is to one another. For example, if Actor 1 has a closeness centrality of 37%, Actor 2 has a closeness centrality of 70%, and Actor 3 has a closeness centrality of 39%. We know Actor 1 and 3 are "closer" to each other than they are to Actor 2.

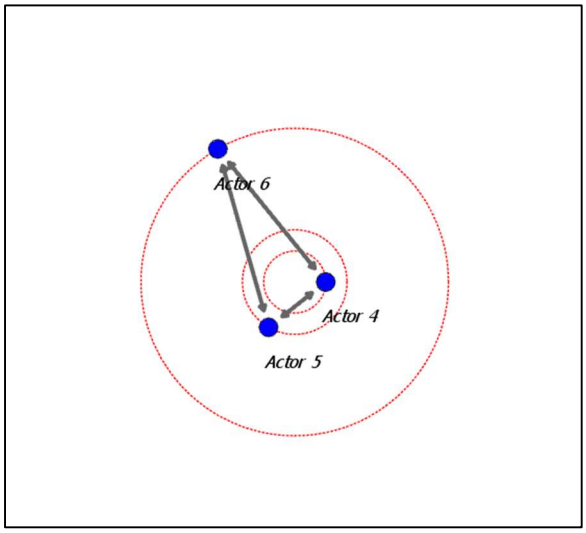
$$CC_u = \frac{1}{\sum_{v \in E} d(u, v)}$$

Figure 19: Closeness Centrality is used to calculate closeness centrality for strongly connected graphs (Kalamaras, 2015). *d* is the distance of the node being analyzed, *u* is the node being analyzed, and *v* is all other nodes. This is calculated by Social Network Visualizer v3.0.4 (Kalamaras, 2022).

Degree and closeness centrality can be graphically presented in a social network generated using Social Network Visualizer v3.0.4 (Kalamaras, 2022). Social networks can be graphed radially or on levels. Social networks graphed radially place the social network in a circle; this creates a visual representation that is easy to compare to another social network. The size of the social networks for degree centrality and closeness centrality ultimately depends on how many seconds each group spoke; groups that spoke more will have a closer social network

than those who spoke less. This is also reflected in the tabulated data when looking at the raw DC or CC value.



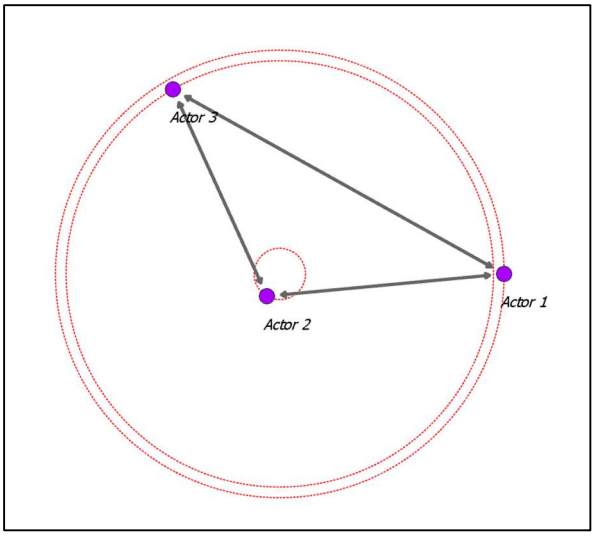


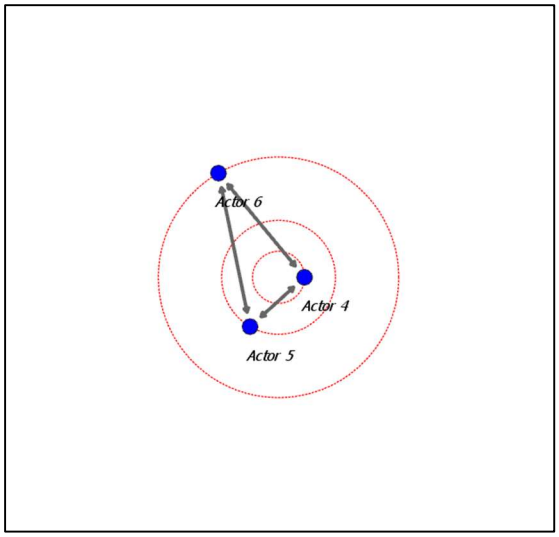
Node	Label	DC	DC'	%DC'
1	Actor 1	1010.000000	0.245503	24.550316
2	Actor 2	1689.000000	0.410549	41.054934
3	Actor 3	1415.000000	0.343947	34.394750

Node	Label	DC	DC'	%DC'
1	Actor 4	2750.000000	0.367401	36.740147
2	Actor 5	2637.000000	0.352305	35.230461
3	Actor 6	2098.000000	0.280294	28.029392

Figure 20: Degree Centrality is represented radially and tabularly using Social Network Visualizer v3.0.4 (Kalamaras, 2022). These radial graphs show degree centrality; each social network's size is directly related to the total number of seconds spoken by the group. All images were sized to 709 x 709 pixels for comparison.

The social networks are more straightforward to compare for closeness centrality than the tabulated data, as illustrated in Figure 21. When looking at closeness centrality, the %CC shows how close one actor is to another, and the social network visually represents this closeness. The social network on the left indicates that Actor 1 and Actor 3 are closer to each other than they are to Actor 2. While the social network on the right shows that Actor 4 and Actor 5 are close to each other but not as close as Actors 1 and 3.





Node	Label	CC	CC'	%CC'
1	Actor 1	215.236634	0.379606	37.960606
2	Actor 2	400.763766	0.706814	70.681440
3	Actor 3	225.197173	0.397173	39.717314

Node	Label	CC	CC'	%CC'
1	Actor 4	664.407636	0.804368	80.436760
2	Actor 5	617.072431	0.747061	74.706105
3	Actor 6	520.107245	0.629670	62.966979

Figure 21: Closeness Centrality is represented radially using Social Network Visualizer v3.0.4 (Kalamaras, 2022). These radial graphs show closeness centrality; each social network's size is directly related to the total number of seconds spoken by the group. All images were sized to 709 x 709 pixels for comparison.

An alternative way to present social networks is to display them as levels, as shown in Figures 22 and 23, for both degree centrality and closeness centrality networks. Figure 22 shows how the information in Figure 20 would look presented on levels, and Figure 23 shows how the data in Figure 21 would look presented on levels. The size of each social network is directly related to the total number of seconds spoken by the group.

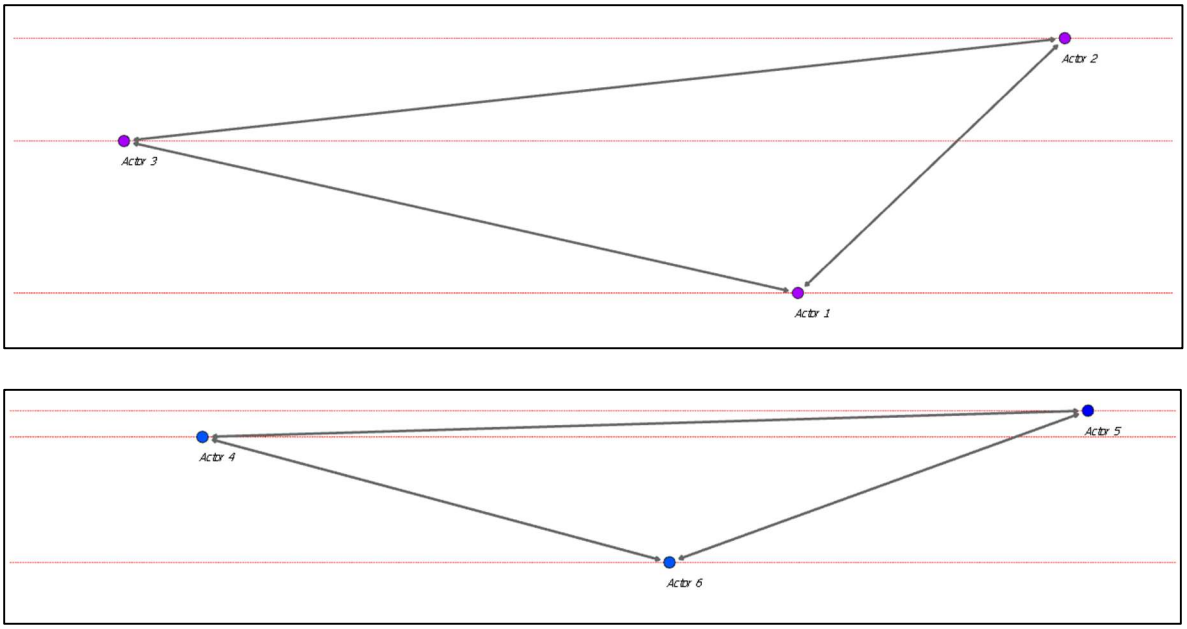


Figure 22: Degree Centrality is represented on levels using Social Network Visualizer v3.0.4 (Kalamaras, 2022).

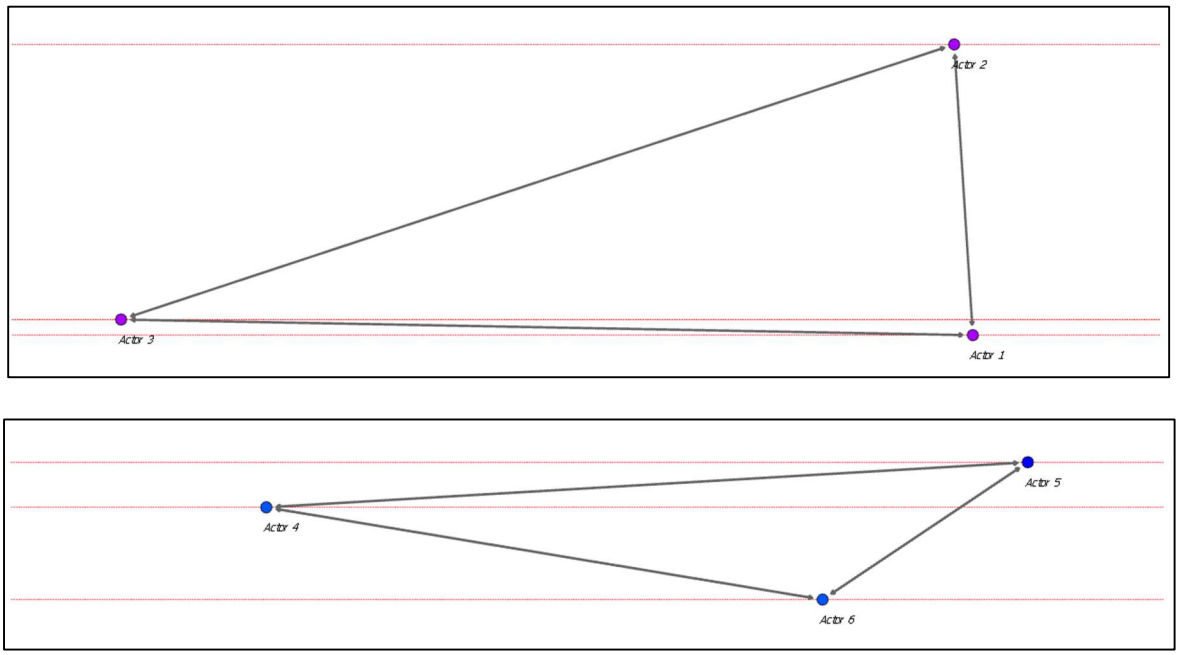


Figure 23: Closeness Centrality is represented on levels using Social Network Visualizer v3.0.4 (Kalamaras, 2022).

A final point to consider when examining the results of social network analysis is the dynamics of a three-person group or a triad. Group size is an important factor; initially, the current study was intended to have groups of four, but due to a lack of participants for the control group, groups of three were established. Group size can determine group dynamics and member relationships; smaller groups have more intense interactions and social bonds, whereas larger groups tend to be more stable (Barkan, 2012). In a triad, the three individuals share a close relationship and are more stable than in a dyad, a group of two (Barkan, 2012). In triads, the third individual can act as a mediator and help provide compromise when the other two members disagree; on the other hand, the third person can become the outsider in the group as the other two members form a closer relationship (Barkan, 2012).

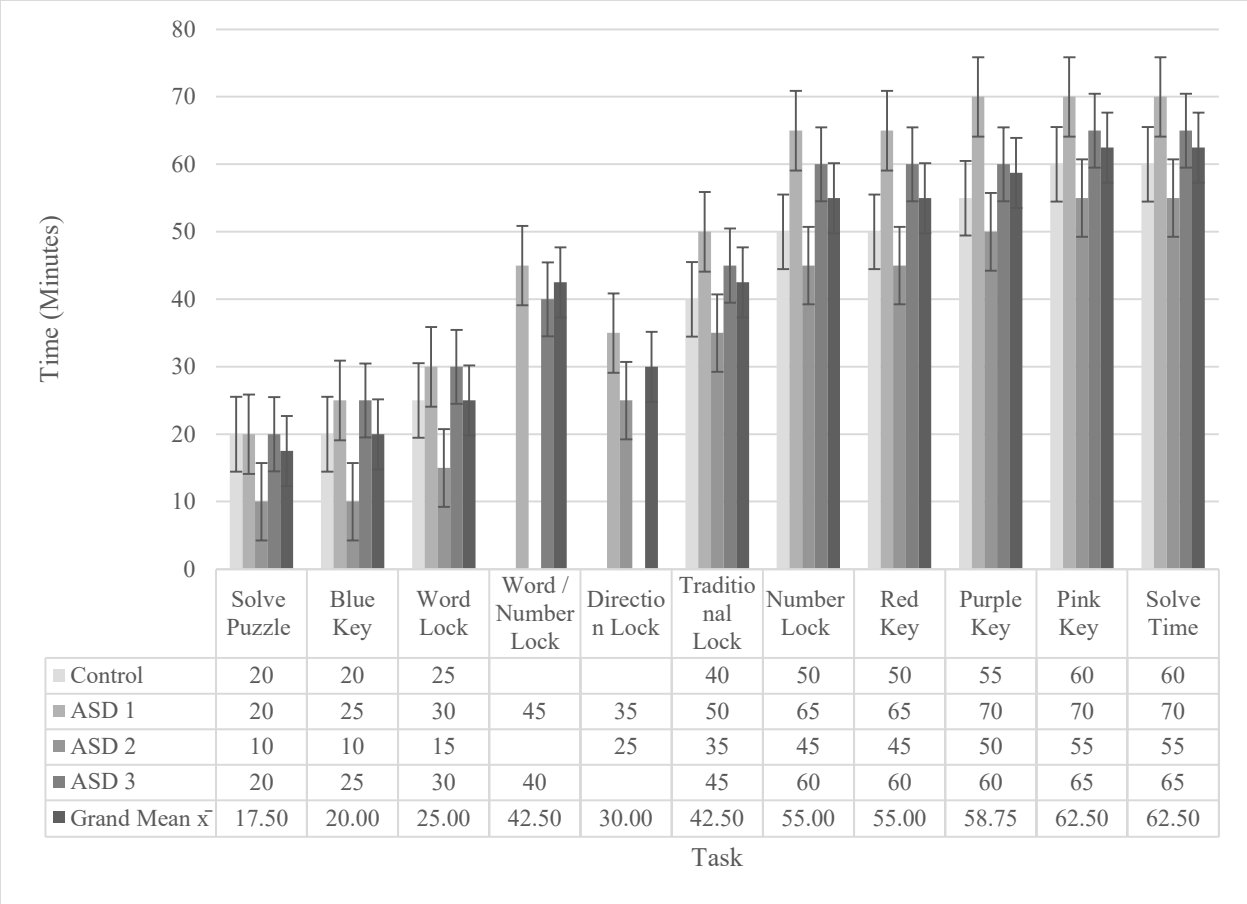
In a dyad, only two members share a relationship; in a triad, this relationship is shared in three ways but is not always shared equally as the amount of time each member can interact declines (Barkan, 2012). This means that in a triad, the group has three different relationships: Participant One and Participant Two, Participant One and Participant Three, and Participant Two and Participant Three. Returning to the previously defined "ideal" cooperative conversation, we can see how a group of three sharing their relationship equally gives a percentage of 33.33% and how this can be applied to social network theory. However, the concept of an "ideal" cooperative conversation is not typically what we see in triads. In groups, leaders can be appointed or established naturally (Barkan, 2012). In the current research, participants had no previous relationship established, and a leader within the group arose naturally through repeated interactions. When looking at the different relationships within the triad, degree centrality reveals the group's leader, while closeness centrality reveals which participants have the closest

relationship. Both degree centrality and closeness centrality will be discussed for each group individually, followed by a comparison of all findings for the four research groups.

Chapter 3: Results

3.1 Time Comparison

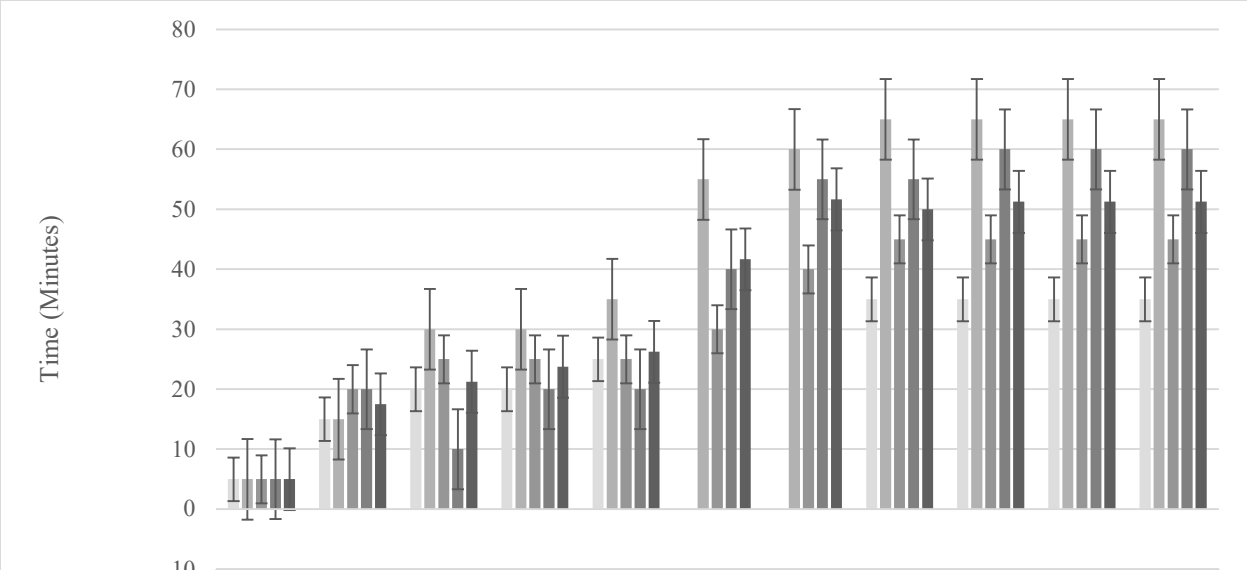
All groups completed all problem-solving rooms. The mean time to complete the first problem-solving room was 62.50 minutes, and the standard deviation was 5.59 minutes. The relatively small standard deviation suggests that all groups finished roughly within the same time frame. There were some differences in performance between the groups; the control group skipped over solving the word/number lock and the directional lock due to finding other clues earlier without needing the hints found in the lockers with those locks. ASD 1 could not skip opening these locks, ASD 2 skipped the word/number lock, and ASD 3 skipped the directional lock. No locks were skipped in the first problem-solving room during testing with the groups of University students. This could have happened for several reasons, including that the teens were more competitive, that the University students felt they had to comply and finish all aspects of the room, or that there were design flaws, which will be discussed further in section 6.9. Figure 24 contains a graph that shows the time, in minutes, that it took each group to complete each task and the average time to complete each component of room 1.



	Solve Puzzle	Blue Key	Word Lock	Word / Number Lock	Direction Lock	Traditional Lock	Number Lock	Red Key	Purple Key	Pink Key	Solve Time
Control	20	20	25			40	50	50	55	60	60
ASD 1	20	25	30	45	35	50	65	65	70	70	70
ASD 2	10	10	15		25	35	45	45	50	55	55
ASD 3	20	25	30	40		45	60	60	60	65	65
Grand Mean $\bar{x}$	17.50	20.00	25.00	42.50	30.00	42.50	55.00	55.00	58.75	62.50	62.50

Figure 24: Time Comparison for Problem-solving Room 1. Time is displayed in minutes on the y-axis, and the task name is displayed on the x-axis for the bar graphs and is quantitatively shown in the table below the graph.

The mean time to complete problem-solving room 2 was 51.25 minutes, and the standard deviation was 11.92 minutes. This higher standard deviation suggests more significant variance across groups in solving this room. We can see again that the control group skipped solving two locks, a traditional lock and a directional lock; this allowed them to complete the problem-solving room 16.25 minutes before the average completion time. In this problem-solving room, no other group skipped opening any locks (Figure 25). Due to the control group completing the room within thirty-five minutes, the standard deviation for the total solve time and the last five tasks is higher.

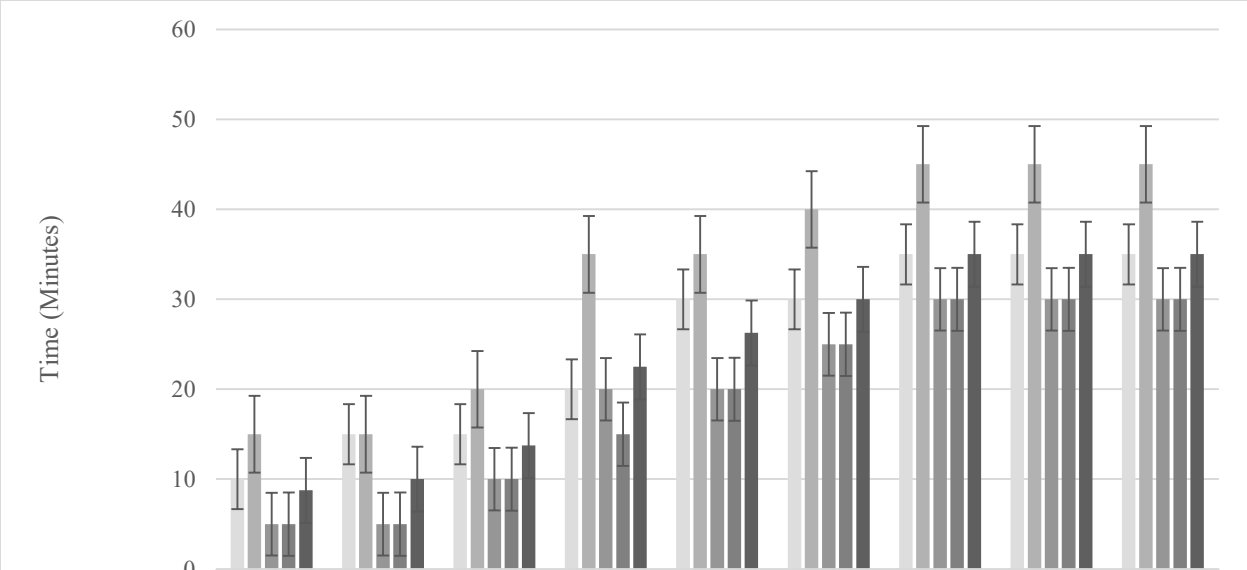


	Blue Key	Number Lock	Direction Lock	Pink Key	Purple Key	Traditional Lock	Word / Number Lock	Word Lock	Red Key	Pink Letter Lock	Solve Time
Control	5	15	20	20	25			35	35	35	35
ASD 1	5	15	30	30	35	55	60	65	65	65	65
ASD 2	5	20	25	25	25	30	40	45	45	45	45
ASD 3	5	20	10	20	20	40	55	55	60	60	60
Grand Mean $\bar{x}$	5.00	17.50	21.25	23.75	26.25	41.67	51.67	50.00	51.25	51.25	51.25

Task

Figure 25. Time Comparison for Problem-solving Room 2. Time is displayed in minutes on the y-axis, and the task name is displayed on the x-axis for the bar graphs and is quantitatively shown in the table below the graph.

The mean time to complete the third problem-solving room is thirty-five minutes, with a standard deviation of 6.12. Due to space limitations, this problem-solving room had fewer tasks than the previous rooms, but completion was more variable across groups than in the other two rooms. In this problem-solving room, no tasks were skipped by any groups, and the standard deviation shows that all groups finished within the same period. From Figure 26, there are no apparent differences between the four groups.



	Red Key	Blue Key	Direction Lock	Letter / Number Lock	Word Lock	Number Lock	Traditional Lock	Pink Key	Solve Time
Control	10	15	15	20	30	30	35	35	35
ASD 1	15	15	20	35	35	40	45	45	45
ASD 2	5	5	10	20	20	25	30	30	30
ASD 3	5	5	10	15	20	25	30	30	30
Grand Mean $\bar{x}$	8.75	10.00	13.75	22.50	26.25	30.00	35.00	35.00	35.00

Figure 26: Time Comparison for Problem-solving Room 3. Time is displayed in minutes on the y-axis, and the task name is displayed on the x-axis for the bar graphs and is quantitatively shown in the table below the graph.

Figures 24, 25, and 26 show the completion times for each room component to be solved recorded to the five-minute mark because exact times were not recorded for each task completed. The ethnographic notes were used to calculate these values, which were recorded in five-minute increments. The total completion times for each problem-solving room were recorded to the second. The total completion time was entered in seconds for the repeated measures one-way ANOVA. The data for the repeated measures one-way ANOVA statistical tests are shown in Table 4. Table 4 provides the total time in seconds it took to complete each room; this data was used for the repeated measures one-way ANOVA statistical test. The first row indicates the measured variable; this table shows the seconds it took to complete each problem-solving room.

The first column indicates the group, and the second through fourth columns indicate the problem-solving room. The seventh row and fifth column contain the count means, and the last cell in the table includes the grand mean.

Table 4

Total Completion Times in Seconds

The variable measured: Total completion time in seconds				
Group	**Problem-solving Room 1**	**Problem-solving Room 2**	**Problem-solving Room 3**	**Group Means:**
Control	3752	2125	2184	**2687.00**
ASD 1	4192	4077	2856	**3708.34**
ASD 2	3225	2657	1932	**2604.67**
ASD 3	4067	3777	2006	**3283.34**
Problem-solving Room Means:	**3809.00**	**3159.00**	**2244.50**	
			Grand Mean:	**3070.84**

Note: Table adapted from Lund Research, 2018.

The following method of analysis used was a repeated measure one-way ANOVA. The ANOVA indicated that there is a significant difference in the dependent variable between the different groups, $F(2, 6) = 12.49$, $p = .007$, with a mean of 3809 for problem-solving room 1, 3159 for problem-solving room 2, 2244.5 for problem-solving room 3. Mauchly's test of sphericity indicated that the assumption of sphericity could not be rejected and, therefore, indicates that the data has a normal distribution. There were no outliers found. A post-hoc paired T-test using a Bonferroni corrected $\alpha = .017$ indicated that problem-solving rooms 1 and 3 varied significantly.

In other words, the null hypothesis was rejected, accepting the alternative hypothesis that at least two means were significantly different. A statistically significant difference was found in

the completion times across the three problem-solving rooms and four groups of participants. Specifically, this difference is seen between problem-solving rooms 1 and 3, with no significant difference between problem-solving rooms 1 and 2 or problem-solving rooms 2 and 3. However, this difference may not be due to improvement in performance over time but instead to the design of problem-solving room 3, which was limited to two rooms; the limited space resulted in a limited place to hide objects and so fewer steps or "puzzles" than the previous two problem-solving rooms, making the room easier to solve. Supporting this possibility is that problem-solving room 3 took less time to complete than the other two problem-solving rooms (Table 4).

3.2 Interactional Analysis

The data collected from the interactional analysis is presented as a percentage distribution to show the behaviours present for each group in the three problem-solving rooms. Figures 32, 33 and 34 visually represent the interactional analysis performed; these figures do not tell us much overall but are included to show the behavioural distribution.

In problem-solving room 1, most interactions for all four groups were in the positive social interaction and functional communication categories, suggesting that the groups effectively interact socially with peers. However, we also see some low-level and negative social interactions that indicate behavioural issues, such as disagreements and interactions that did not contribute to completing the problem-solving room (Figure 27).

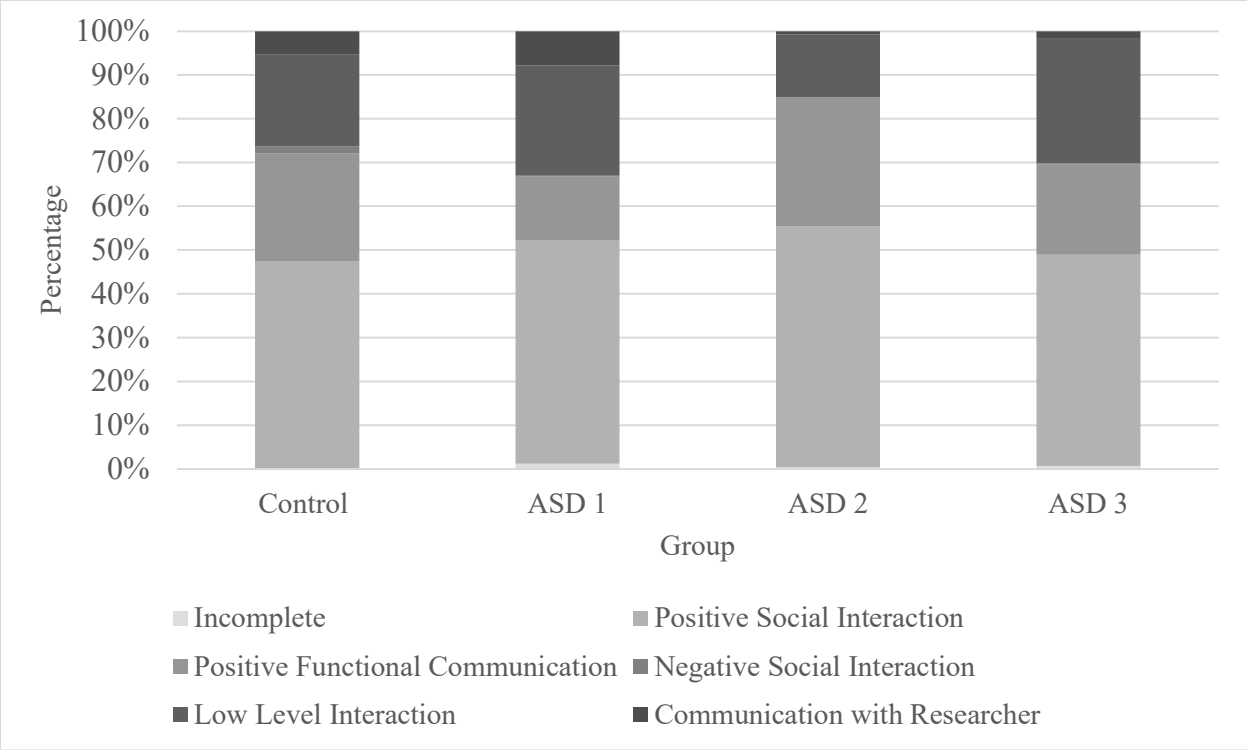


Figure 27: Interactional Analysis for Problem-solving Room 1**.** This graph shows team interactions for each category as a percentage distribution. The percentage is on the y-axis, and the group's name is displayed on the x-axis.

In problem-solving room 2, most interactions were in the positive social interaction and functional communication categories. However, there are also some low-level interactions and negative social interactions present. The less positive interactions decreased, relative to problem-solving room 1, for the control group, ASD 1 and ASD 2, but increased for ASD 3 (Figure 28).

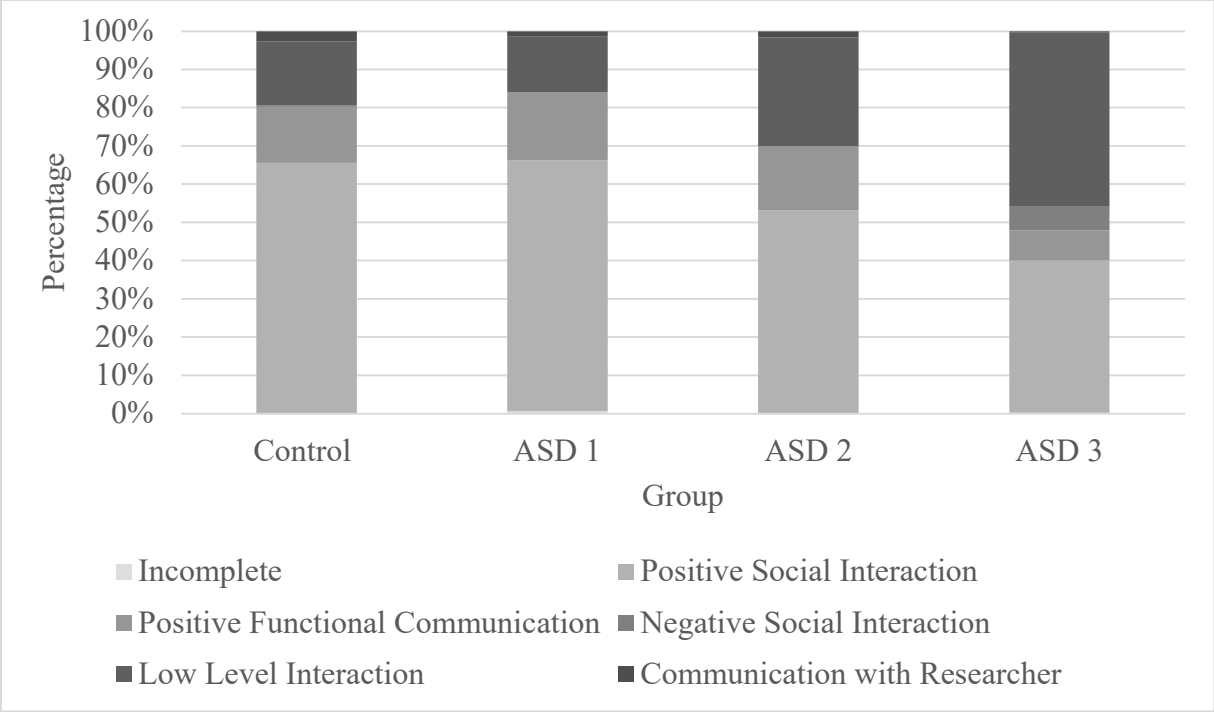


Figure 28: Interactional Analysis for Problem-solving Room 2**.** The percentage is on the y-axis, and the group's name is displayed on the x-axis.

In problem-solving room 3, the overall pattern is repeated. Again, the ASD 3 group has more negative-type interactions. However, as shown later, the repeated measures one-way ANOVA statistical test did not find the number of low-level interactions significantly different from the other group (Figure 29).

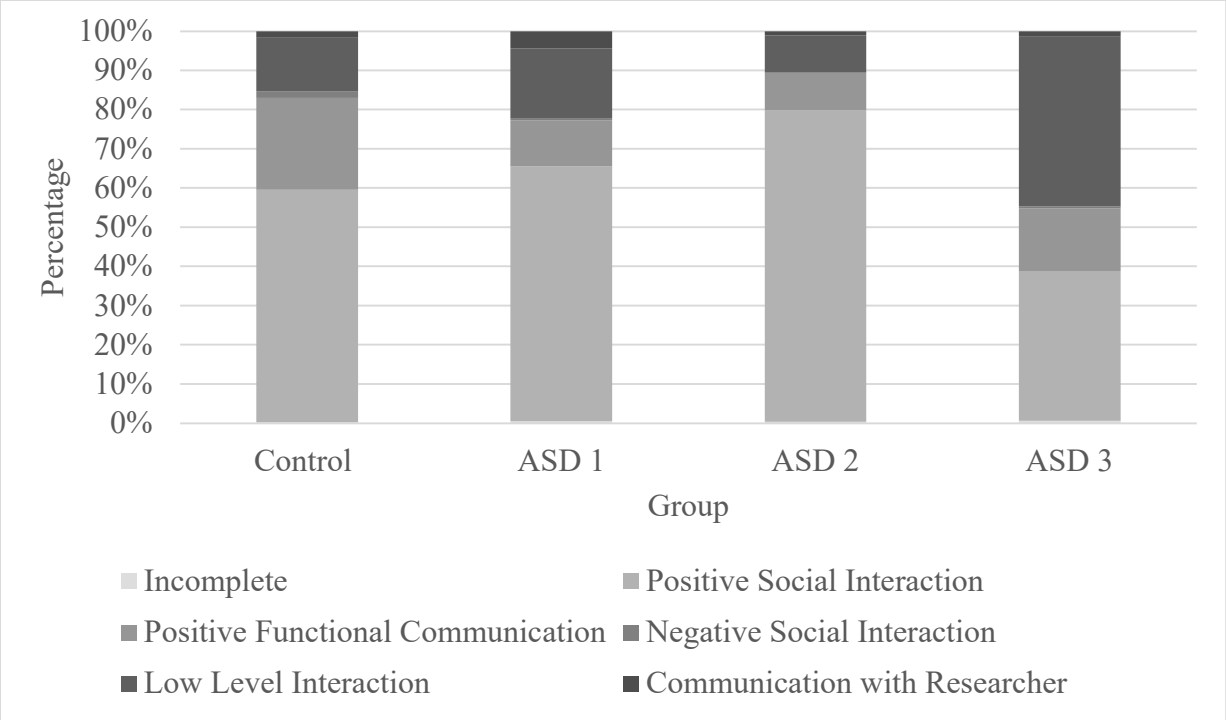


Figure 29: Interactional Analysis for Problem-solving Room 3. The percentage is on the y-axis, and the group's name is displayed on the x-axis.

Repeated measures one-way ANOVAs were used to evaluate all thirty behaviours recorded in the interactional analysis. The results are presented in Table 5, with only two significantly different behaviours.

Table 5

Repeated Measures One-way ANOVA for Behaviours Found in the Interactional Analysis

Behaviour	P-value	F Test Statistic	Effect Size	Outliers	Normality	Sphericity Assumption
1. Incomplete	0.3	1.46	0.25	0	Yes	It cannot be rejected.
2A. Affection	0.82	0.2	0.2	1	Yes	It cannot be rejected.
2B. Call of attention	0.3	1.47	0.21	0	Yes	It cannot be rejected.
2C. Giving help	0.25	2.04	0.16	0	Yes	Violated.
2D. Success of event	0.81	0.22	0.045	0	No	It cannot be rejected.
2E. Questions	0.37	1.16	0.28	0	Yes	It can not be rejected.
2F. Social response	0.39	1.1	0.19	0	Yes	It cannot be rejected.
2G. Social communication	0.17	2.46	0.41	0	Yes	It cannot be rejected.
3A. Reading clue/question	0.035	6.18	0.64	0	Yes	It cannot be rejected.
3B. Repeating	0.43	0.97	0.14	0	Yes	It cannot be rejected.
3C. Counting	0.4	1.08	0.23	0	Yes	It cannot be rejected.
3D. Trying lock combination	0.32	1.4	0.25	0	Yes	It cannot be rejected.
3E. Brainstorming	0.28	1.6	0.29	0	Yes	It cannot be rejected.
4A. Verbal aggressiveness	0.39	1	0.16	0	Yes	Violated.
4B. Temper tantrum	0.42	1	0.18	1	No	It cannot be rejected.
4C. Teasing	0.67	0.43	0.034	0	Yes	It cannot be rejected.

4D. Controlling	0.42	1	1	1	No	It cannot be rejected.
4E. Avoidance	0.42	1	0.18	1	No	It cannot be rejected.
4. F Refusal to hint	0.48	0.84	0.14	0	Yes	It cannot be rejected.
4G. Put yourself down verbally	0.23	1.88	0.14	0	Yes	It cannot be rejected.
5A. Simple words	0.16	3.42	0.48	0	Yes	Violated.
5B. Imitation	0.42	1	0.18	1	No	It cannot be rejected.
5C. Idiosyncratic language	0.42	1	0.18	1	No	It cannot be rejected.
5D. Repetitive behaviour	0.39	1	0.067	0	Yes	It could not be run.
5E. Functional communication	0.42	1	0.18	1	No	It cannot be rejected.
5F. Off-topic	0.44	0.81	0.076	1	Yes	Violated.
5G. Laughing	0.77	0.27	0.064	0	Yes	It cannot be rejected.
6A. Asks a question	0.39	1.12	0.14	0	Yes	It cannot be rejected.
6B. Asks for a hint	0.29	1.54	0.3	0	Yes	It cannot be rejected.
6C. Agree to a hint	0.0015	23.17	0.8	0	Yes	It cannot be rejected.

Note: The data input for this statistical test consisted of the total counts of each behaviour displayed by the four groups to complete each of the three problem-solving rooms. The highlighted rows show which behaviours are significantly different.

The first behaviour found to be significantly different is 3A. reading clue/question. The repeated measures one-way ANOVA test indicated that there was a significant difference in the

dependent variable between the different groups, F (2, 6) = 6.18, p = .035, with a mean of 129.5 for problem-solving room 1, 44.5 for problem-solving room 2, 31.75 for problem-solving room 3. Mauchly's test of sphericity indicated that the assumption of sphericity could not be rejected and, therefore, indicates that the data has a normal distribution. There were no outliers found. The post-hoc paired T-test using a Bonferroni corrected $\alpha = .017$ indicated that the means of the following pair are significantly different: problem-solving rooms 1 and 3.

The second behaviour found to be significantly different is 6C. agree to a hint. The repeated measures one-way ANOVA test indicated that there is a significant difference in the dependent variable between the different groups, F (2, 6) = 23.17, p = .002, with a mean of 5.75 for problem-solving room 1, 2.75 for problem-solving room 2, 12.5 for problem-solving room 3. Mauchly's test of sphericity indicated that the assumption of sphericity could not be rejected, indicating that the data has a normal distribution. There were no outliers found. The post-hoc paired t-test using a Bonferroni corrected $\alpha = .017$ indicated that the means of the following pair were significantly different: problem-solving rooms 2 and 3.

No significant differences were found for the rest of the behaviours in the interactional analysis.

3.3 Social Network Analysis

When we examine the group dynamic of the control group, we see that across all three problem-solving rooms, Leo is the dominant participant in the group (see Figure 30). Consistently, Leo provides more verbal communication than the other two participants in the group, Eric is the second most dominant person, and Trevor talks the least. The “ideal” cooperative conversation is not seen in the control group throughout all three problem-solving rooms. Figure 31, visually represents the group dynamic, showing that Eric and Trevor have a

closer relationship than Eric and Leo or Trevor and Leo. We can also see that the relationship between Eric and Trevor revolves around the relationship with Leo, the dominant character in the triad. We can also see that the relationship, or the three different sessions, got "closer over time." This closeness is represented by the size of the diagram shrinking from problem-solving room 1 to problem-solving room 3 (Figure 31). Another interesting finding is that in problem-solving room 3, we see a shift in the group dynamic, where Eric and Trevor are still in a close relationship, but also that Eric has developed a closer relationship with Leo. This suggests that the group grew closer throughout the study and was more cooperative in the final problem-solving room. However, this is a marginal effect at best.

Problem-solving Room 1:

Node	Label	DC	DC'	%DC'
1	Trevor	1010.000000	0.245503	24.550316
2	Leo	1689.000000	0.410549	41.054934
3	Eric	1415.000000	0.343947	34.394750

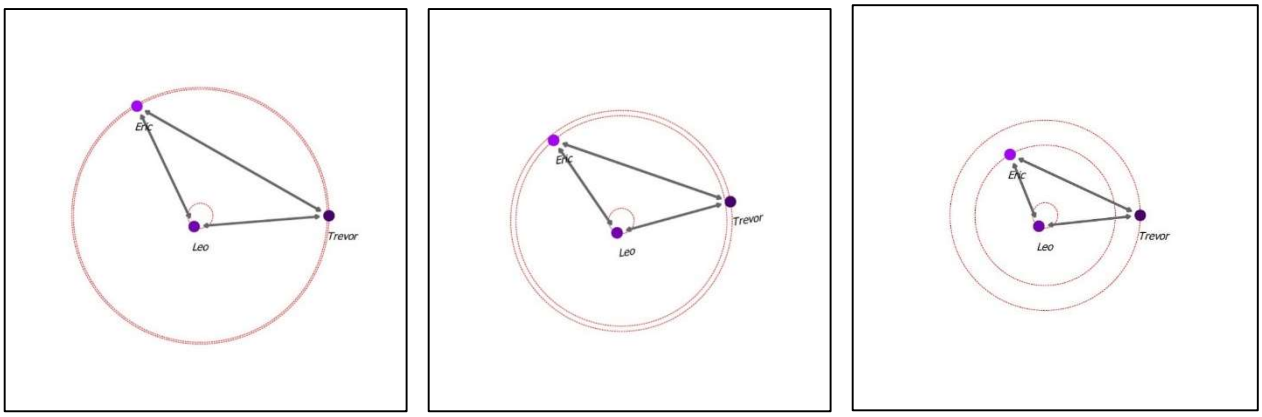
Problem-solving Room 2:

Node	Label	DC	DC'	%DC'
1	Trevor	749.000000	0.224790	22.478992
2	Leo	1460.000000	0.438175	43.817527
3	Eric	1123.000000	0.337035	33.703481

Problem-solving Room 3:

Node	Label	DC	DC'	%DC'
1	Trevor	645.000000	0.241935	24.193548
2	Leo	1044.000000	0.391598	39.159790
3	Eric	977.000000	0.366467	36.646662

Figure 30: Control Group Degree Centrality Tabulated Data Generated using Social Network Visualizer v3.0.4 (Kalamaras, 2022). These three tables show the degree of centrality for the control group in problem-solving rooms 1, 2 and 3. These tables are generated using the matrix data uploaded to Social Network Visualizer v3.0.4 (Kalamaras, 2022).



Problem-solving room 1 Problem-solving room 2 Problem-solving room 3

Figure 31: Control Group Closeness Centrality, Social Network Diagrams, generated using Social Network Visualizer v3.0.4 (Kalamaras, 2022). These social networks show the relationship between the three participants in the control group and how closeness centrality is visually represented across problem-solving rooms 1, 2 and 3. All images are size 709 x 709 pixels for comparison.

ASD group 1 had a clear leader throughout the three problem-solving rooms. Casey was the dominant participant throughout the group's interactions, more so than the dominant participant in the control group. Casey consistently dominated the conversation by more than fifty degrees of centrality, leaving Jesse and Jason to share the rest. Jason was the least dominant during the first and second problem-solving rooms, while Jessie was the least prevalent in the third problem-solving room (Figure 32). Again, no "ideal" cooperative conversation is seen in this group, but a strong leader emerges. Jesse and Jason share the closest relationship in the group; this relationship gets stronger as the study progresses (Figure 33). However, as this relationship between the pair gets more substantial, the group's overall strength decreases, and we can see this as the size of the diagram increases. This finding aligns with what we know about group dynamics in triads; as a pair relationship strengthens, the relationship with the third group member is weakened. This tells us that the group grew further apart during the study and cooperated less.

Problem-solving Room 1:

Node	Label	DC	DC'	%DC'
1	Jason	753.000000	0.234506	23.450638
2	Jessie	792.000000	0.246652	24.665213
3	Casey	1666.000000	0.518841	51.884148

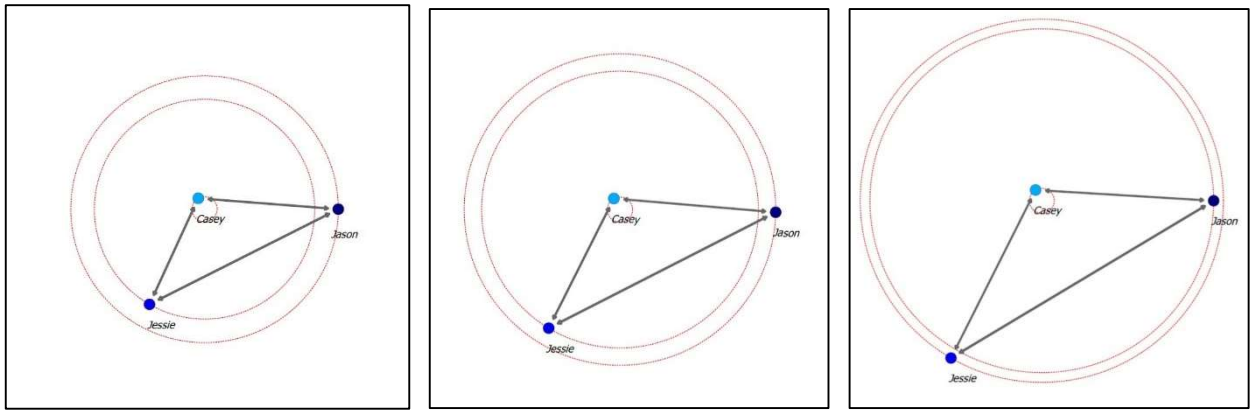
Problem-solving Room 2:

Node	Label	DC	DC'	%DC'
1	Jason	572.000000	0.176871	17.687075
2	Jessie	723.000000	0.223562	22.356215
3	Casey	1939.000000	0.599567	59.956710

Problem-solving Room 3:

Node	Label	DC	DC'	%DC'
1	Jason	704.000000	0.347826	34.782609
2	Jessie	265.000000	0.130929	13.092885
3	Casey	1055.000000	0.521245	52.124506

Figure 32: ASD 1 Group Degree Centrality Tabulated Data Generated using Social Network Visualizer v3.0.4 (Kalamaras, 2022). These three tables show degree centrality for the ASD 1 group in problem-solving rooms 1, 2 and 3. These tables are generated using the matrix data uploaded to Social Network Visualizer v3.0.4 (Kalamaras, 2022).



Problem-solving room 1 Problem-solving room 2 Problem-solving room 3

Figure 33: ASD 1 Group Closeness Centrality Social Network Diagrams. These social networks show the relationship between the three participants in the ASD 1 group and how closeness centrality is visually represented across problem-solving rooms 1, 2 and 3. All images are size 709 x 709 pixels for comparison.

ASD group 2 was closer to having an "ideal" cooperative relationship within their triad, but there is still an apparent leader. Steve is the dominant leader throughout all three problem-solving rooms, Alex is in the middle, and Martin is the least dominant participant in the group (Figure 34). These positions within the triad remain the same throughout all three problem-solving rooms. In Figure 35, Martin and Alex have the closest relationship throughout all three problem-solving room tasks. When we examine the results for closeness centrality, the results vary across the three problem-solving room tasks. We can see that the group was off to a strong start and relatively close. This closeness increased in the second problem-solving room, but there was a change in this group dynamic in the third problem-solving room. We can see that the relationship between Alex and Martin grew closer, resulting in overall group closeness dropping, suggesting there was less cooperation. This is visually represented in Figure 35.

Problem-solving Room 1:

Node	Label	DC	DC'	%DC'
1	Alex	2034.000000	0.353739	35.373913
2	Martin	1451.000000	0.252348	25.234783
3	Steve	2265.000000	0.393913	39.391304

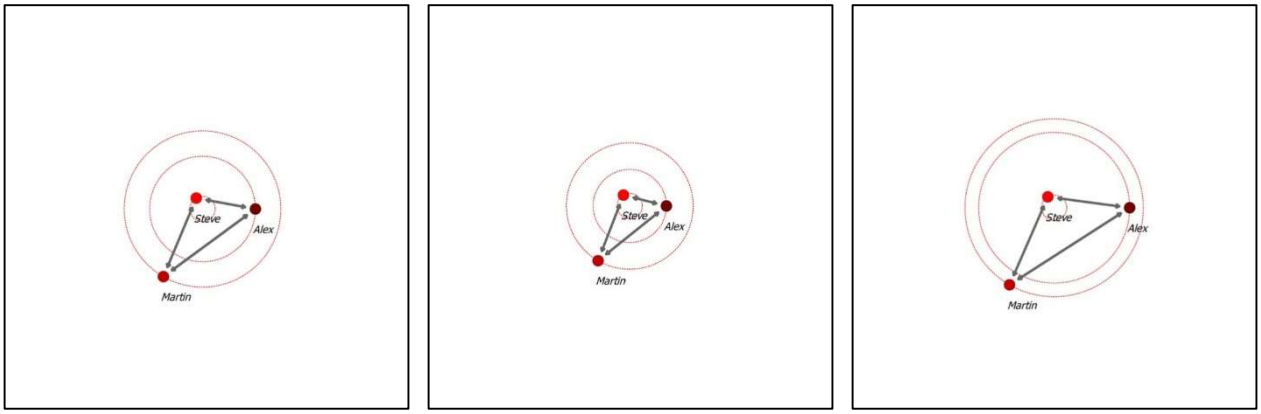
Problem-solving Room 2:

Node	Label	DC	DC'	%DC'
1	Alex	1419.000000	0.327638	32.763796
2	Martin	1176.000000	0.271531	27.153082
3	Steve	1736.000000	0.400831	40.083122

Problem-solving Room 3:

Node	Label	DC	DC'	%DC'
1	Alex	1141.000000	0.350538	35.053763
2	Martin	890.000000	0.273425	27.342550
3	Steve	1224.000000	0.376037	37.603687

Figure 34: ASD 2 Group Degree Centrality Tabulated Data generated using Social Network Visualizer v3.0.4 (Kalamaras, 2022). These three tables show degree centrality for the ASD 2 group in problem-solving rooms 1, 2 and 3. These tables are generated using the matrix data uploaded to Social Network Visualizer v3.0.4 (Kalamaras, 2022).



Problem-solving room 1 Problem-solving room 2 Problem-solving room 3

Figure 35: ASD 2 Group Closeness Centrality Social Network Diagrams. These social networks show the relationship between the three participants in the ASD 2 group and how closeness centrality is visually represented across problem-solving rooms 1, 2 and 3. All images are size 709 x 709 pixels for comparison.

The final group, ASD 3, showed results closest to the "ideal" cooperative group. Figure 36 shows that during problem-solving room 1, all three participants were within a few percent of 33.33%, numbers that were even closer in relation to the final problem-solving room. In problem-solving rooms 1 and 3, Roy was the dominant leader but not by much; in the second problem-solving room, they were the least dominant participants. Gage was consistent in their participation throughout all three problem-solving rooms, remaining around 34-35%. Due to Roy's disengagement, Luke engaged the least overall but contributed more to problem-solving in room 2. In Figure 37, group closeness increased over the three problem-solving rooms, with the third problem-solving room resulting in the closest relationship in the study. This is also represented by the numbers in Figure 36, being the closest to the ideal 33.33% representative of a cooperative conversation. This suggests that ASD 3 was the most cooperative group of the four groups.

Problem-solving Room 1:

Node	Label	DC	DC'	%DC'
1	Roy	2750.000000	0.367401	36.740147
2	Gage	2637.000000	0.352305	35.230461
3	Luke	2098.000000	0.280294	28.029392

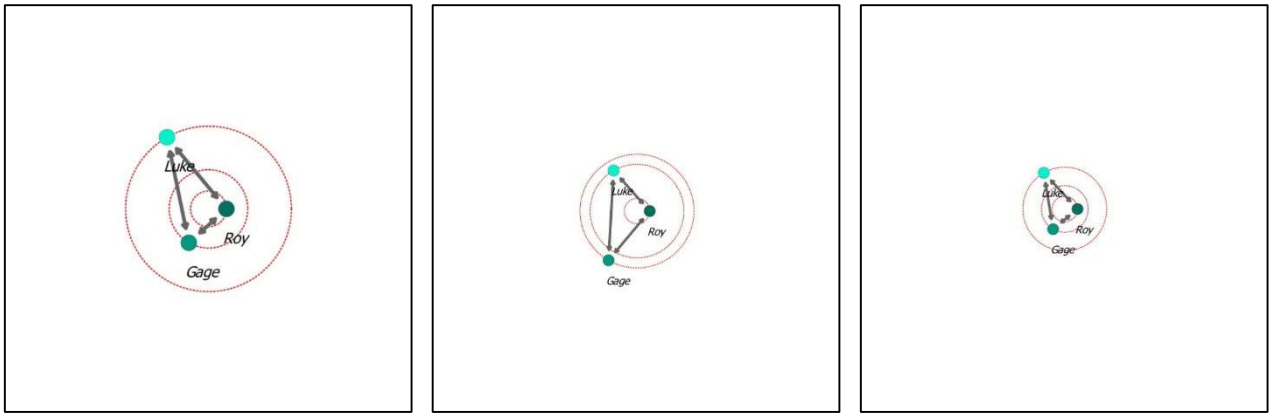
Problem-solving Room 2:

Node	Label	DC	DC'	%DC'
1	Roy	949.000000	0.216025	21.602550
2	Gage	1539.000000	0.350330	35.033007
3	Luke	1905.000000	0.433644	43.364443

Problem-solving Room 3:

Node	Label	DC	DC'	%DC'
1	Roy	1189.000000	0.355988	35.598802
2	Gage	1142.000000	0.341916	34.191617
3	Luke	1009.000000	0.302096	30.209581

Figure 36: ASD 3 Group Degree Centrality Tabulated Data Generated using Social Network Visualizer v3.0.4 (Kalamaras, 2022). These three tables show degree centrality for the ASD 3 group in problem-solving rooms 1, 2 and 3. These tables are generated using the matrix data uploaded to Social Network Visualizer v3.0.4 (Kalamaras, 2022).



Problem-solving Room 1 Problem-solving Room 2 Problem-solving Room 3

Figure 37: ASD 3 Group Closeness Centrality Social Network Diagrams. These social networks show the relationship between the three participants in the ASD 3 group and how closeness centrality is visually represented across problem-solving rooms 1, 2 and 3. All images are size 709 x 709 pixels for comparison.

There were trends seen throughout all four groups that are consistent with what we know about triad dynamics. First, we see that in all groups, across all three problem-solving rooms, there was always a pair of participants forming a closer relationship, leaving the third individual as an outlier to the group. Second, in instances where we see that these pairs are closer, we also see that the overall closeness of the group is low. On the contrary, when the group pair does not share as close of a relationship, we see that the overall group closeness is higher. Third, although each group had a pair that had a closer relationship, we see an apparent leader in the group; this is consistent across all groups and all three problem-solving rooms. Finally, the last pattern is that the groups considered closer spoke more.

This study was initially designed to examine cooperative play in autistic teens. When we look at the social network of the control group and ASD 3, we can see that they have a similar pattern of increased closeness, while ASD 1 and ASD 2 do not show a pattern of increased group closeness and cooperation throughout the study. It is also important to note that the ASD 3 group had a greater group closeness than the control group, suggesting that they were the more

cooperative group overall. Using social network theory and the defined “ideal” cooperative conversation being 33.33% in a triad, we can see that there is only one instance, in the ASD 3 group in problem-solving room 3, that the division of communication is near 33.33%.

Chapter 4: Discussion

4.1 Summary

Autism spectrum disorder (ASD) is a developmental disability caused by differences in the brain. These differences in the brain are described as neuro divergences, a non-medical term used to describe brains that learn and think differently. According to the Centers for Disease Control and Prevention (2022), one in forty-four children is diagnosed with ASD. The Centers for Disease Control and Prevention (2019) reported this number as one in fifty-nine children. The increase in diagnosis, however, does not mean that there are necessarily more individuals with the disorder; instead, this is due to ongoing research into diagnosis and treatment as well as increased awareness of the disorder among parents, healthcare professionals and within our school systems (Centers for Disease Control and Prevention, 2022). Furthermore, early recognition, diagnosis and treatment have been shown to have long-term positive effects on symptoms of the disorder and the development of social and life skills (Centers for Disease Control and Prevention, 2022). For this reason, research into different ways to recognize and treat symptoms of ASD is fundamental.

The current research hypothesized that the three test sessions (problem-solving rooms) and four practice sessions (video games) would improve social skills. This increase would be more significant than that in the typically developed group. My analysis of the data collected led me to reject the study hypothesis that practice sessions would improve social skills in the test groups and that the increase would be more significant than that recorded in the control group. The time comparison provided no evidence to support the hypothesis either way, as the time differences could be explained by design differences in the problem-solving rooms. The next analysis was an interactional analysis that looked at the behaviours of individuals in each group.

Each of the thirty behaviours was analyzed using repeated measures one-way ANOVA statistical test; only two behaviours were found to be statistically significant, but both had alternative explanations. The remaining twenty-eight behaviours were not found to be statistically significant. Therefore, the interactional analysis also did not support the hypothesis. The final method of analysis looked at group dynamics using social network theory. The social network analysis provided trends seen in all groups but did not provide evidence that supported the hypothesis.

The lack of evidence supporting the hypothesis can be due to several reasons and factors. The first is the sample size; this study had a relatively small sample size that was limited by location. A small sample size can undermine a study's internal and external validity, reducing the ability to generalize findings. However, sample size did not affect the repeated measures one-way ANOVA statistical test as this test works well with small numbers and equal group sizes (Healey, 2015).

4.2 Reliability and Validity of Analysis

When collecting and analyzing data, human error is always potential. Therefore, several precautions were taken to ensure reliability and validity in the data collection and analysis. The primary data collection method was lapel audio recorders, with 98% of all recorded audio recorded and transcribed. Although recorders were checked every five minutes to ensure they were on and recording, on a few occasions, the microphone would cut out, be muffled, or the recorder was turned off. When this happened, audio was picked up on the recorder of another participant, the audio recorder or the researcher's clipboard. No audio was lost, meaning this data collection method was reliable and valid. The secondary data collection method used ethnographic notes recorded by research assistants. This method has the opportunity for human

error, but this was mitigated by training that involved practice and introductory guidelines, such as recording only what is seen and heard and the importance of recording data truthfully. With human error in mind, ethnographic note-taking is not entirely reliable or valid and was only used as a supplementary form of data. The ethnographic notes were used during the social network analysis to help determine who was speaking to whom and what was happening when participants were not talking to each other.

4.3 Unexpected & Unplanned Situations

A few unplanned situations came up with the ASD 3 group, which is interesting as this is contrary to the findings that the ASD 3 group appeared to be the most cooperative. On the first occasion, the behavioural problems escalated to the point where we had to separate participants to prevent a physical altercation over a plush toy rat. This event occurred after problem-solving room 1 was completed, and as such, this did not affect the data collected. On multiple occasions, we encountered behavioural problems with the participants in this group and verbal confrontations between participants. We also had an incident where one of the participants walked out of the research area during problem-solving room 2 and was wandering around the university for approximately ten minutes; during this time, I followed behind him from a distance to ensure he would not run off, get lost or hurt while the other two members of the group continued to work through the problem-solving room task. These behaviours were recorded and included in the interactional analysis under “negative social interaction” and found not significantly different when the ANOVA was run; therefore, the decision was made to include this group in the results. There were no other incidents or unexpected occurrences during the study.

4.4 Limitations of the Study Method

The sample size for this study was limited due to factors such as the prevalence of the disorder being one-in-forty-four children (Centers for Disease Control and Prevention, 2022) and that only one-third of autistic people can act and communicate independently (Centers for Disease Control and Prevention, 2019). In addition, population size is a limiting factor. Lethbridge has a population of around 100,000 people. Considering these three factors, the available and willing autistic people that met the selection criteria were low, limiting the current study.

Another limitation is the demographics of the control group. While the control group is representative of the population, it has features that can affect the results. For example, the Blackfoot share traditions through storytelling; consequently, they are a culture where people are taught to listen and be respectful towards the speaker (Stout, 2012). This is reflected by the Blackfoot participant listening rather than talking over the other two participants and may account for the number of words spoken by this individual. This pattern was confirmed by the ethnographic notes, which describe how this participant actively listened to the other participants and used their suggestions to solve the task. Therefore, it would be wrong to interpret the data to conclude that this individual was cooperating less because they were speaking less.

4.5 Consideration of the Results

The current research was designed to take key aspects of play and cooperative play to create a play therapy incorporating fun tasks and video games that participants would enjoy. As previously discussed, creating a task that is not forced, does not feel like work and is enjoyable is essential when designing a therapy concerning play (Alagendran et al., 2019; Bergen & Fromberg,

2009; Lamb & Etopio, 2019). The problem-solving room tasks and video game play were intended to help promote the benefits of play and cooperative play, such as improving communication skills, social skills, emotional regulation, teamwork, and problem-solving skills, to name a few (Fotaris & Mastoras 2019; Granic et al., 2014; Halbrook et al., 2019; Kutner et al., 2008; Veldkamp et al., 2020).

This play therapy was designed to help autistic people who experience deficits in social communication and social interactions practice these skills ([DSM-5] American Psychiatric Association, 2013). Creating a play therapy that puts peers together in the same room and provides them with tasks that must be completed together cooperatively promotes social behaviour that can help improve social-emotional reciprocity, interactions and initiations, and reciprocal conversation (Bottema-Beutel et al., 2018; Szumski, Smogorzewska, Grygiel, & Orlando, 2019; Schiltz et al., 2018; Wolstencroft et al., 2018).

The autistic teens in this study went to public schools. They were in classrooms with typically developed peers, meaning they had been previously exposed to social normalcy and learned to be social beings in mainstream society. Working together in a group was not a new activity to the individuals in the study; instead, they were using the skills they already had to work their way through the cooperative tasks. Therefore, this study's findings align with what we know about autistic people and how they can function as social beings and work together cooperatively (Downs & Smith, 2004; Townsend et al., 2021).

Group dynamics further explain how the results found in this study are consistent with what we already know about interactions in a triad. In a triad, we know there is typically a leader in the group, a strong pair and a single member that is often left out (Barkan, 2012). When we consider group dynamics and the fact that autistic people are more like neurotypical people than

they are different, we can see why we did not find any differences between the control group and ASD groups.

As this study showed that our control group and three ASD groups were very similar in overall performance in the problem-solving rooms and in terms of behaviors, it would be easy to conclude that there are no differences between them. However, there is another possibility we must consider that could account for the lack of difference seen. Masking is used to hide some behaviours seen as undesirable in a social situation and typically happens when autistic people interact with typically developed peers (Cage & Troxell-Whitman 2019). In this study, the test groups consisted only of autistic people, and all participants knew they were in a peer group of autistic people. Therefore, there may have been masking and assimilating behaviours in the groups; however, there is no way to tell if this is the case through listening to the audio recordings. In the future, a possible way to account for masking would be to administer a self-report survey asking each participant about masking behaviour while completing the task. If no masking occurred among the peers in the ASD groups, this could explain why there were no significant differences between the three test groups and the control group. If participants felt comfortable in the group and didn't have to hide anything, they could better focus on the task. However, this is just speculation, but I thought it was important to mention it as a possible explanation for the lack of differences between the control and test groups.

A final consideration is that order effects may be present. Order effects can occur when the conditions influence participant performance, such as the practice effect that leads to an increase or decrease in a certain behaviour (Healey, 2015). For example, in this study, there were three problem-solving rooms; after completing the first, the participants understood the task, which influenced their future performance. It is important to remember that the data used for this

statistical test was verbal only, which could mean that participants may have still been reading the clues and questions but not out loud.

4.6 Recommendations for Future Study

In the current study, as the researcher, I did not address any behavioural concerns or help guide participants through the room other than to provide hints when requested. I only intervened when participants became physically aggressive or displayed emotional expression. However, behavioural concerns likely would have been addressed in a different setting, such as a classroom or therapeutic program (Dijkstra-de Neijs et al., 2021; Kent et al., 2020; O'Keeffe & McNally, 2023). I acknowledge that behavioural interventions could have been beneficial to participants and that utilizing what we know about evidence-based practices could be used in an escape room setting (Hume et al., 2021; Wong et al., 2015). For example, the escape room would be the play environment, and a trained professional could implement evidence-based practices such as prompting, reinforcement, peer-based instructions, and intervention (Hume et al., 2021; Wong et al., 2015).

I would reconsider incorporating video game play with escape rooms or consider the benefits of cooperative video game play independently. The video games were used as practice sessions, and no aspects of the video gameplay were recorded and analyzed. Therefore, it is impossible to determine if playing video games was valuable, considering no improvement was found throughout the study. In a future study, I recommend recording gameplay and performing the same analysis used to examine behaviours in the escape rooms. This would provide further insight into what is said during video game play and could allow a comparison between the two activities. Research has shown that video games, specifically cooperative, have social benefits (Chang et al., 2016; Halbrook et al., 2019; Johannes et al., 2021; Kutner et al., 2008; Verheijen et

al., 2019). The cooperative video games used in this study should be examined further to determine whether they produce the same results as seen in other studies on video gameplay.

Another suggestion would be to look at the longevity of the peer relationships established in the study and see if peer relationships continue given the opportunity. Peer relationships and friendships are important for neurotypical and autistic people (Ghanouni et al., 2019; Watkins et al., 2019; Verheijen et al., 2019). Cooperative tasks such as video game play can help promote social interactions and encourage peer relationships (Ceranoglu, 2010; Verheijen et al., 2019). Future research could better consider the long-term impact of playing cooperative video games together in person or over the Internet to understand the relationship between cooperative play and friendship.

My last suggestion is regarding escape rooms. As very few studies look at escape rooms, our understanding of the benefits of the use of escape rooms is limited. However, the studies that have been conducted provide valuable insight into the potential benefits of escape rooms and escape room-style games. The first example is a game called AScapeD, a multiplayer virtual escape room explicitly developed for autistic children (Terlouw, Kuipers, van 't Veer, Prins, & Pierie, 2021). It was found that the AScapeD game successfully initiated social connection and interaction through play (Terlouw et al., 2021). A second study that also utilized a virtual escape room that required a pair of participants to work together to escape found through self-reporting of participants that the game promoted collaboration and discussion and that the experience was fun (Knoll, Liaqat & Monroy-Hernández, 2023).

Further studies have integrated learning into the theme of the escape room. For example, an escape game was created using nursing knowledge to create an integrative learning environment for nursing students. The participants reported that the escape game promoted

teamwork and enhanced their learning experience (Brown, Darby & Coronel, 2019). Another study set up escape games for new radiology residents and found that the task helped emulate real-world skills such as communication, dexterity and multi-tasking (Jambhekar, Pahls & Deloney, 2020). It has also been found through systematic reviews that education escape rooms have found escape activities to promote learning, engagement, teamwork, collaboration, critical thinking, problem-solving skills, creativity and enjoyment (Fotaris & Mastoras, 2019; Veldkamp et al., 2020). With all this considered, escape rooms appear to have the potential to aid in the development and promotion of social skills of autistic people while providing a fun experience.

To further this suggestion, since the start of the current research, I have learned a lot about escape rooms from working as a game master and room designer. Applying my knowledge in hindsight, there are things I would do differently moving forward. Some of the changes I would make would include creating more complex games, as some of them were easier than I anticipated and at times, the players were looking for more of a challenge. Going into the study, I did not want the rooms to be too difficult; however, after working with the public and building rooms for the public, I feel I did not give the participants enough credit regarding their ability to solve problems. I also did not know there was a whole world of premade props, some of which have electronics and are not overly expensive. Adding premade props would have made the rooms more exciting and provided a different difficulty level. With this in mind, I would have also considered working with pre-established escape rooms to run the study.

There are very few studies looking at pre-established escape rooms. A future study should examine the benefits of escape rooms using pre-established escape rooms that are privately operated. This would allow a game master to be an outside source that the researcher or participants do not influence, as their role would be the same as it typically is. Pre-established

escape rooms would come with a higher research cost but would offer rooms that have been tried and tested, eliminating my concerns with my research about the spaces I created and how the study was executed. Pre-established escape rooms would also have surveillance systems to record participants' behaviours, eliminating the need to purchase or borrow video equipment and utilize audio recordings and ethnographic note-taking. Finally, using pre-established escape rooms would provide a real-world experience for participants and data collected from facilities that are accessible to the public, thus making the research outcomes more generalizable to broader populations.

In conclusion, from the literature, my own research and work experience in an escape room, I believe that escape rooms have the potential to help autistic people learn and practice social skills in a fun environment. Through my experiences working as a game master, I have created a guide to help autistic people navigate escape rooms. This guide is available in Appendix E and contains information about the basics of escape rooms, what to expect at an escape room and provides a general guide to navigating escape rooms as an autistic person.

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Chapter 6: Appendix

Appendix A: Guardian Consent Form.

Guardian Consent Form

University of Lethbridge

Dr. Sergio Pellis (Supervisor)
Dr. Jeffrey MacCormack (Supervisor)

Brittany Davidson
Master of Science, Neuroscience Candidate
University of Lethbridge
780-970-1188
Brittany.davidson@uleth.ca

April 10, 2019

Dear Guardians,

My name is Brittany Davidson. I am a graduate student and researcher at the University of Lethbridge under the supervision of Dr. Sergio Pellis and Dr. Jeffery MacCormack. Your teen is being invited to participate in a research study looking at how cooperative play can help in building social skills in teens who have autism. The purpose of this research is to gain a better understanding of how playing video games and interacting cooperatively can help teens with autism develop and strengthen social skills. Your teen will play four cooperative style video games that are rated E for Everyone on a Play Station 4. Your teen will also work through three problem-solving rooms that require cooperation to find clues and solve riddles and puzzles.

This research will require two hours of your teen's time, twice a week for a total of fourteen hours or seven sessions. The sessions will be held on either Mondays and Wednesdays, or Tuesdays and Thursdays, in the months of June, July or August. During this time, your teen will be audio recorded and observed by myself and two trained research assistants. Your teen will be compensated with a $50 Visa gift card at the conclusion of the study for his or her participation.

There are few anticipated risks and discomforts related to this research. Your teen will be introduced to new peers and placed in social situations that require them to work with these new peers, as such this may be cause for anxiety. If your teen feels overwhelmed or anxious during the study, he or she can call Wood's Homes at (403)-299-9699 or text (587)-315-5000 for support. Wood's Homes also has a clinic located in Lethbridge that offers counseling services. Alternatively, you or your teen can speak to me at any time and I can help with directions to appropriate resources.

If your teen is participating in my study and begins to show signs of mild anxiety or discomfort, I will check in with him or her and ask if a break is needed or if there is anything, I can do. If your teen starts to demonstrate signs of moderate anxiety, I will get the entire group to take a break and discretely ask if your teen would like to give you a call or go home for the day. While your teen is in my study, his or her wellbeing and safety is of utmost importance.

University of Lethbridge

Several steps will be taken to protect your teens's anonymity and confidentiality. Written notes and behavioural logs will not mention your teen's name. Notes and behavioural logs will be kept in a locked filing cabinet in Dr. Sergio Pellis' lab where only he and myself will have access to them. Audio recordings will be stored on a hard drive in Dr. Sergio Pellis' lab where they will be password protected and only, he and myself will have access to the recordings. The recordings will also be kept on a portable external hard drive, that only I have access to and is password protected. The recordings will be transcribed, and names of all participants will be changed. Research assistants will be required to sign confidentiality agreements. All data collected will be retained for 5 years, after that all written material will be shredded and all digital material will be deleted.

Participation in this research is completely voluntary. Your teen may choose to not participate. You may also withdraw your teen from the study at any time for any reason simply by notifying me. If your teen stops participating, it will not be possible to withdraw your teen's data due to the group activity used for data collection.

The results from this study will be presented in a master's thesis, and in other scholarly presentations and publications. Before submitting the master's thesis for review, you and your teen will have the opportunity to review an executive summary of the research. This will include feedback for the entire study, feedback for the peer group your teen was a part of as well as individual feedback for your teen. At no time will your teen's name be used, or any identifying information revealed.

If you require any additional information about this study, please contact me at 780-970-1188 or email Brittany.davidson@uleth.ca. You may also contact my supervisor Dr. Sergio Pellis at 403-329-2078 or by email at Sergio.pellis@uleth.ca. Questions regarding your teen's rights as a participant in this research may be addressed to the Office of Research Ethics, University of Lethbridge at 403-329-2747 or by email at research.services@uleth.ca.

This research study has been reviewed for ethical acceptability and approved by the University of Lethbridge Human Subject Research Committee.

A copy of this consent form will be given to you to keep for your records and reference.

I have read (or have been read) the above information regarding this research study on cooperative play and autism and consent for my teen to participate in this study.

_____ _____

Printed Name of Teen Participant Date

Guardian Consent Form

University of Lethbridge

Printed Name of Guardian	Date
Signature of Guardian	Date
Printed Name of Researcher	Date
Signature of Researcher	Date

I agree to allow **Brittany Davidson** to use the anonymous transcription of the audio-recording of our session for one or more of the following purposes:

Publication in a Journal Parent/guardian Signature: _____

Presentation at a Conference Parent/guardian Signature: _____

Date: _____

I would like **Brittany Davidson** to send me feedback regarding the study to my email. I understand that the email will not state my teen's name or disclose that they were a part of the study.

Email: _____

Parent/guardian Signature: _____

Appendix B: Assent Form 15 and Under

University of Lethbridge

Assent Form

Dr. Sergio Pellis (Supervisor)
Dr. Jeffrey MacCormack (Supervisor)

Brittany Davidson
Master of Science, Neuroscience Candidate
University of Lethbridge
780-970-1188
Brittany.davidson@uleth.ca

Why are you Here?
My name is Brittany, I am a student and researcher at the University of Lethbridge. I want to see if you would like to be in my study. I want to research how play can help develop social skills in teens with Autism.

What is expected of you?
If you agree to be in my study, you will get to work through 3 problem solving rooms and get to play 4 different video games on 4 different days with a group of teens just like yourself. This will require 2 hours of your time twice a week for three and a half weeks for a total commitment time of 14 hours. You will be audio recorded during the study and observed by the researcher and two research assistants.

Who will know you are in my study?
Your parents/guardians will know you are in my study. The other three participants you will be with in the study will also know you are in the study. However, when I tell other people about my research, I will not use your name.

Where will the study take place?
The study will take place at the University of Lethbridge in different classrooms.

Do I have to be in the study?
No. Your parent/guardians have to agree for you to be in my study and then you get to decide if you want to be in my study. If you do not want to be in my study, you do not have to be. If you want to be in my study and change your mind later that is okay. You can stop being in my study at any time by telling me.

Will the study help me?
The study will introduce you to other teens, you will have the opportunity to play games with these other teens. You will also have an opportunity to practice your social skills.

What if I start feeling anxious during the study?
If you ever feel anxious or uncomfortable you can speak to me or to your guardian. If you feel overwhelmed and want support, you can also contact Wood's Homes, they are a teen mental health center and can be called at (403)-299-9699 or you can send a text to (587)-315-5000. I

University of Lethbridge

will also be with you while you are taking part in my study and I will make sure you feel comfortable and safe. If I notice you look anxious or if something looks wrong, I will check in on you.

What do I get for being in this study?
You will receive a $50 gift card at the end of the study.

How will I get feedback about the study?
Before I submit the study results to the University, I will provide you with feedback for the entire study, feedback for the peer group you were apart of as well as individual feedback. I will email this information to your parent/guardian.

What if I have questions?
You can ask me questions at anytime. My phone number and email address are at the top of this page. You can also ask your parents/guardians if you have any questions because the study has been explained to them. If you want, you can also contact the Office of Research Ethics at the University of Lethbridge at 403-329-2747 or research.services@uleth.ca to ask questions.

I will give you a copy of this form in case you want to ask questions later.

Agreement

I have decided to be in the study even though I know that I don't have to do it. Brittany has answered all my questions.

Printed Name of Participant	Date
Printed Name of Researcher	Date
Signature Name of Researcher	Date

Appendix C: Assent Form 16+

University of Lethbridge

Assent Form

Dr. Sergio Pellis (Supervisor)
Dr. Jeffrey MacCormack (Supervisor)

Brittany Davidson
Master of Science, Neuroscience Candidate
University of Lethbridge
780-970-1188
Brittany.davidson@uleth.ca

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University of Lethbridge

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How will I get feedback about the study?
Before I submit the study results to the University, I will provide you with feedback for the entire study, feedback for the peer group you were apart of as well as individual feedback. I will email this information to you and your parent/guardian.

What if I have questions?
You can ask me questions at anytime. My phone number and email address are at the top of this page. You can also ask your parents/guardians if you have any questions because the study has been explained to them. If you want, you can also contact the Office of Research Ethics at the University of Lethbridge at 403-329-2747 or research.services@uleth.ca to ask questions.

I will give you a copy of this form in case you want to ask questions later.

Agreement

I have decided to be in the study even though I know that I don't have to do it. Brittany has answered all my questions.

_____	_____
Printed Name of Participant	Date
_____	_____
Signature of Participant	Date
_____	_____
Printed Name of Researcher	Date
_____	_____
Signature Name of Researcher	Date

University of Lethbridge

Assent Form

I agree to allow **Brittany Davidson** to use the anonymous transcription of the audio-recording of our session for one or more of the following purposes:

Publication in a Journal Participant Signature: _____

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Date: _____

I would like **Brittany Davidson** to send me feedback regarding the study to my email. I understand that the email will not state my name or disclose that I was a part of the study.

Email: _____

Participant Signature: _____

Appendix D: Social Behaviours Key. Adapted from Bauminger (2002).

1. Incomplete: Sentences, thoughts and phrases that were dropped or not finished by the participant.

2. Positive Social Interaction: The participant exhibits verbal and nonverbal social behaviours that lead to an effective social process with peers. Behaviours that serve to start or maintain social interaction.
    A. Affection – The participant expresses affection toward another participant verbally (e.g., a complement)
    B. Call of attention – The participant approaches another participant to gain their attention. (e.g., Calls for someone's attention).
    C. Giving help – The participant offers help to another participant.
    D. Success of event – A task was solved, and a participant verbally expressed success.
    E. Questions – A question is asked to another participant regarding the current or another task.
    F. Social response – The participant responds verbally to social stimuli directed toward them by another participant (e.g., The participant is asked something or a statement is referred to them to which they reply).
    G. Social communication – Communicates socially for benefit/relation to problem-solving room (communication that does not fall into the above categories).

3. Positive Functional Communication – The participant says something about the problem-solving room task.
    A. Reading clue/question – The participant reads a clue or question that is a part of the problem-solving room.
    B. Repeating – The participant repeats something another participant has said that is relevant to the task.
    C. Counting – The participant counts (counting is relevant to the task).
    D. Trying lock combination – The participant tries to open a lock and verbally express the task.
    E. Brainstorming – The participant is brainstorming an idea or answer verbally.

4. Negative Social Interaction: The participant exhibits unpleasant social behaviours that operate to stop or decrease the likelihood of developing adequate social interaction.
    A. Verbal aggressiveness – The participant behaves in malicious intrusive ways toward peers (e.g., yells, screams).
    B. Temper tantrum – The participant throws a fit/storms off.
    C. Teasing – The participant makes fun of another participant.

D. Controlling – The participant verbally dominates other children without respecting their needs.
E. Avoidance – The participant avoids social overtures made toward them by another participant.
F. Refusal to hint – The participant refused a hint.
G. Put self down verbally – The participant says something negative about themselves.

5. Low-level Interaction: The participant exhibits behaviours that indicate social intention but with minimal social enactment, such as proximity to children without initiating a positive social interaction. It also includes behaviours typical of the autistic syndrome (e.g., echolalia, idiosyncratic language).
    A. Simple words – The participant says words without meaningful connection to the task or social interaction with other participants (e.g., yes, no, ohh, umm, hmm, so, okay).
    B. Imitation – The participant imitates another participant's talk.
    C. Idiosyncratic language – The participant uses utterances with no clear meaning.
    D. Repetitive Behavior – The participant behaves repetitively with no apparent communication intent but with proximity to another participant.
    E. Functional communication – The participant approaches or responds to another participant to fulfill their needs with no social intention (e.g., “It’s my turn on the computer now”).
    F. Off-topic – The participant talks about something unrelated to the task. (e.g., lunch talks or cracks a joke).
    G. Laughing – The participant is laughing.

6. Communication with the Researcher: The participant talks to the researcher.
    A. Asks a question – The participant asks a question of the researcher.
    B. Asks for a hint – The participant asks the researcher for a hint.
    C. Agree to a hint – Participant agrees to a hint.

Appendix E: Guide

Autistic People and Escape Rooms

A guide to navigating a new and unknown environment.

Brittany Davidson B.A. Psychology and Sociology M.Sc.. Behavioural Neuroscience

What is an Escape Room?

An escape room is typically a physical room in which a group of at least two people are locked in. To escape the room, players must work together to solve a series of puzzles and games within a time limit and ultimately escape the room.

What are the benefits of escape rooms?

Escape rooms have many benefits. Escape rooms promote teamwork; when in an escape room, everyone must work together to escape. Having to work together increases cooperation, communication, and social skills. Escape rooms also provide an environment that tests problem-solving skills and promotes working memory. Escape rooms are a fun and interactive way to increase cognitive and social skills.

How can escape rooms benefit individuals diagnosed with ASD?

Autistic people struggle in social situations and learn to interact with peers appropriately. Social interventions and behavioural programming teach and promote appropriate social behaviour. These social interventions vary depending on how the facilitator runs the program but often involve including peers. Escape Rooms can be like other interventions that promote social engagement. Escape rooms require all players to work together to solve all puzzles and escape the room. Escape rooms are often designed to be completed one task at a time. This forces everyone to work together on the same task and provides structure and order that autistic people may appreciate, as it's easy for players to follow. While working together to solve the escape room, players will have to use the skills they already know about teamwork and social constructs, further strengthening their skills. Escape rooms will also be beneficial to those who are still trying to develop social skills, as everyone in the room is required to work together.

How can I be best prepared for an escape room?

Escape rooms can sometimes be overwhelming, especially if it's your first time. Not all escape rooms will be accommodating, and others may be extremely accommodating. When I worked in an escape room, I would do what I could to make the experience more enjoyable, and so would my coworkers and the owner was very understanding. Please don't be scared to ask questions or ask for help; as a former game master, I would rather know how to help before a group starts a room over a group having a bad experience.

Another important way to be prepared is to work with the group you are playing with. Cooperation and communication are very important when playing in an escape room. From my experience, groups that work together are more successful than those that do not. For example, groups that spend more time arguing than problem-solving have a lower success rate. Likewise, my research demonstrated that groups who communicated more were closer than those who communicated less.

What does an escape room look like?

Escape rooms can look like anything. Escape rooms are often themed and provide a story. For example, an escape room can look like a pirate ship, a magical castle, like the inside of a bank vault, or even look like a video game such as Minecraft. The best way to find out what escape rooms look like is to google "escape rooms," which will provide you with photos of escape rooms worldwide.

To see what local escape rooms look like, it is best to go to their website or social media accounts where they may post photos of the room. Another good source is local review sights such as TripAdvisor or local news media sites where they have sent someone to review the room. Alternatively, you can also ask the escape room if they can provide photos of the room.

Are there alternatives to in-person escape rooms?

Escape rooms are also available in an "at home" format; these can be purchased as board games or printable games. In addition, many free versions of printable games are available online with a quick google search or paid versions on websites such as Etsy.

There are also escape room games that can be played online or escape room apps that can be downloaded from an app store on your phone or tablet.

These are excellent resources for first-time escape room players as they can be played in the comfort of your home and show you what an escape room is like before going to one in person.

When booking an escape room, here is a list of questions you can consider asking:

- "What is the room theme, and is it appropriate for X age group? If not, is there a different room you can suggest?"
- "Will the room be dark? If so, can we turn lights on or bring in flashlights?"
- "Will there be loud music playing? Can we turn down the music or keep it off?"
- "Are there flashing lights? If so, can we have them covered or turned off?" This question is particularly important for individuals diagnosed with epilepsy or sensitive to flashing lights.
- "Will there be jump scares?" Jump scares are something that occurs suddenly without warning to frighten someone. Not all escape rooms have jump scares.
- "Can we leave the room anytime to take a break?"
- "Is there a quiet place where a person can take a break, such as a lobby?"
- "Can we bring a chair into the room?" Sometimes escape rooms can take an hour or more, and you may want a chair for comfort.
- "If a participant has an assistant, will the assistant have to pay an entry fee?" Some businesses will waive the fee for assistants or aids.
- "Can we bring outside items into the room?" For example, tablets for communication or comfort items.
- "If we don't escape on time, do we get extra time?" Some escape rooms will give you an extra 5 or 10 minutes, depending on their schedule.
- "Can we do a quick walk-through of the escape room before starting? This would benefit us as we will know what our environment looks like and what to expect." Some escape rooms may say no as they view this as cheating; however, some may allow it.

What can I expect when I go to an escape room?

No one escape room is the same. They each have different themes and games. They each have unique props that create an experience for players. They have different levels of difficulty. Some rooms can be small and crowded, while others can be larger. Rooms may have a variety of electronic props, combination locks, key locks, and other items.

Anecdote: an escape room story

My friends have told me how much fun an escape room is, and I've been wanting to go, but I'm nervous. I sometimes get scared with loud noises and small dark rooms, but I think I'll be okay. Today is the day I'm going to get to play my first escape room with my friends! It's a "harry potter" theme, and I loved the books and movies! I go to open the door to the escape room place, and I'm anxious. The staff greeted us and asked if we'd ever played before; I said no and told them I was a bit nervous. The staff member said that's a normal feeling and that they would explain how everything works to me and tell me a story to help me play the game. I go to the washroom first, worrying I may miss out on the fun if I leave halfway through the game. I'm ready to go now, I walk into the escape room, but it's a bit dark. I ask for a flashlight, and the game master gives me one. The game master explains the rules of the game, what not to pull on or touch, where the hint button is and most importantly, how I can leave the room if I need a break. I felt a bit better knowing I could leave the room anytime. As the game master talked, I panicked because I forgot to ask about jump scares. Luckily, there were none in the room. The game master seems understanding, which I appreciate as not everyone always is. But I know that the people I am with are supportive even when others are not. So I feel safe. The game master closes the door and starts the timer; this is it now; here we go. At first, I was a bit unsure, but I looked around and took note of my surroundings. My friends are already picking up the carpet, so I go and look under the table, find our first clue, and am so excited. My friends find three other puzzle pieces, and we put them together. It's a clue; we all scream in excitement! The next few steps were a bit of a blur because we were all having so much fun. I completely forgot how nervous I was until the door to the next room opened. The door scared me a little, but now we have more puzzles and doors to solve. It's getting intense now, my friends and I are having a bit of a disagreement, but the game master said that's normal and we need to remember to work together. We ask for a hint and feel silly that we couldn't figure it out alone, but that doesn't discourage us. Puzzle by puzzle, we keep getting closer, and then suddenly, we find the magic wand, and now we need the spell to open the door. We scream, "Witches, warlocks, and wolves. Witches, warlocks, and wolves. Witches, warlocks, and wolves." The door opens, and we are out! What a journey, how much fun was that? I'm glad I didn't skip out on this, and I had so much fun working

Terms you might hear at an escape room:

Actor: some escape rooms might have a paid actor; the actor may or may not be in costume and is there to enhance the game experience.

Cipher: a text written in code that often requires a key or a guide to solve.

Easter Egg: an unexpected feature in an escape room that is included as a joke or a bonus but serves no functional purpose.

Game Master: A person who works at an escape room and guides a group through an escape room by providing a story and giving hints or clues.

Jump Scare: something that occurs suddenly without warning to frighten someone.

Red Herring: an item or information that doesn't contribute to a puzzle solution can confuse players and waste time. This can sometimes be called a ghost puzzle and may be remnants of an old puzzle.

About my graduate research:

My graduate research was conducted at the University of Lethbridge, using classrooms set up as escape rooms (in my thesis, these are problem-solving rooms) and a classroom for video game play. Twelve local boys, ages 12 to 17, participated in my study. The participants were in groups of three. Three groups were test groups made up of autistic teens, and one group was a control group consisting of neurotypical teens. Three escape rooms were played, and four cooperative-style video games (Overcooked, Tiny Brains, Fifa 18 and NHL 18). I wanted to see if cooperative play would have a meaningful impact on the social behaviours of participants and if we would see a more significant improvement in the test groups compared to the control group. The study used social network theory to analyze participant interactions with one another. What was found is that there was no significant difference between the three test groups, nor between the test groups and control group. What was found is that there were commonalities among all groups. I discovered that in each group of three, there was always an apparent leader, a closed pair within the group, which would sometimes leave the third person out and that groups with a higher level of communication had a closer group dynamic. This means there are two critical takeaways: autistic teens aren't all that different from neurotypical teens, and the second is that communication is vital when working together cooperatively.

About the Author:

My graduate research focus was on autistic teens and cooperative play. The core of my research focused on cooperative play in escape rooms, cooperative play with video games and their potential social benefits. During my undergraduate degree, I was a behavioural interventionist working with autistic people in group and community programs. During my graduate research, I worked as a private respite worker for autistic people, and I also worked at an escape room as a gamemaster and as a room designer/builder. Between my research experience and work experience, I wanted to take what I learned about ASD, cooperative play, and escape rooms to create a guide to help autistic people navigate escape rooms. This guide was created to provide a complete overview of escape rooms, including questions to ask before playing an escape room, what the experience will be like, the benefits of escape rooms and other alternatives to in-person escape rooms. My entire thesis is available on the University of Lethbridge website using the following link:

Questions can be sent to Brittany.Davidson@uleth.ca

What is Cooperative Play?

Cooperative play is a form of social play that involves peers working together to achieve a common goal (Sung & Wang, 2013). Engaging in cooperative play aids in establishing and building social relationships (Sung & Wang, 2013).

What is a Social Network?

A social network comprises nodes and ties; in this research, a node represents a single person, and a link represents another person's connection (Yang et al., 2017). First, social networks are created using an adjacency matrix that counts the interactions between each participant (Yang et al., 2017). Then, these interactions can be analyzed to tell us more about individual and group dynamics (Yang et al., 2017).

References:

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