SIDES: A Cooperative Tabletop Computer Game for Social Skills Development

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ABSTRACT
This paper presents a design case study of SIDES: Shared Interfaces to Develop Effective Social Skills. SIDES is a tool designed to help adolescents in social group therapy, specifically individuals with Asperger's Syndrome, practice effective group work skills using a four-player cooperative computer game that runs on tabletop technology. We present the design process and evaluation of SIDES conducted over a period of six months with a middle school social group therapy class. Our findings indicate that tabletop computer games provide a motivating experience to help our target audience learn effective group work skills in a supportive environment.

Author Keywords
Tabletop groupware, CSCW, computer games, Asperger's Syndrome, social skills development.

ACM Classification Keywords
H5.3. Information interfaces and presentation (e.g., HCI): Group and Organization Interfaces – computer-supported cooperative work.

INTRODUCTION
Asperger's Syndrome (AS) is a Pervasive Developmental Disorder and is considered an Autism Spectrum Disorder. Statistical data on the prevalence of AS is unclear, as many cases go undiagnosed or are misdiagnosed. It is estimated that AS occurs in 3.6 to 7.1 of 1000 children [6]. Individuals with AS are often of normal intelligence, but have difficulty understanding accepted social conventions, reading facial expressions, interpreting body language, and understanding social protocols. These social deficits can lead to challenges in learning effective group work skills, including negotiation, perspective taking, active listening, and use of pragmatic language.

Most computer programs for social skills development are designed for one user working directly with the application and lack the face-to-face interaction found in authentic social situations [2, 16]. Social skills therapy groups help adolescents with AS learn strategies to navigate social situations. Mental health therapists who lead these groups often use card and board games to help adolescents practice appropriate social interaction techniques with peers. These traditional games, however, may not sustain interest or motivate students enough to overcome challenges in social interaction. Traditional board games can be inflexible and may not specifically support current classroom topics and learning goals.

On the other hand, tabletop technology is a unique platform for multi-player gaming that combines the benefits of computer games with the affordance of face-to-face interaction. Tabletop computer games have recently been explored for general audiences [8, 9], but have yet to be designed for a special needs population who would especially benefit from social computer games.

This paper explores how interactive table technologies, specifically cooperative tabletop computer games, can help mental health therapists facilitate adolescent social skills development in a comfortable and motivating way. Tabletop technology encourages face-to-face interaction around one computer in a way other computer workstations and video gaming systems do not. Adolescents with AS often describe the computer as a comfortable and motivating medium. Through our approach we leverage the comfort of working with a computer to help these individuals practice effective listening, negotiation, and group work skills.

RELATED WORK
There are currently a number of single-user computer programs to help with social skills development. These existing applications typically focus on rote memorization of facial expressions and emotions (e.g., Mind Reading: The Interactive Guide to Emotions [2] and Gaining Face [16]). Memorization of social cues may be helpful to some adolescents, but this isolated activity lacks a supportive and authentic context for application of these skills. Teaching appropriate social protocols with virtual reality has also been explored as in [4]. Despite advances in facial imaging,

it is difficult for computers to completely replicate the nuances of human social behavior. Though social cue memorization and virtual reality applications are valuable, neither of these approaches provides a fully supportive and authentic means of practicing effective group work skills.

The goal of our application is not to teach skills explicitly, but rather to provide a motivating experience through which adolescents may practice social and group work skills discussed in group therapy sessions. The pedagogical design of SIDES stems from Piaget's constructivist learning theories; we wanted to create a tool where learners could be active participants in the task and construct their own knowledge, based on experiences with others in the world [11]. We also draw on Vygotsky's theory that learning is a social process and has its roots in social interaction [17]. Collaborative activities and cooperative games have been shown to benefit individuals with AS [7]. SIDES leverages these educational theories to provide an authentic and engaging activity to supplement current group therapy techniques for teaching social and group work skills.

The term "single display groupware" (SDG) refers to systems that support co-located, computer-supported cooperative activity around a single, shared display [15]. Interactive tables, such as the DiamondTouch table [5] are a form of SDG that promote face-to-face interaction (rather than the shoulder-to-shoulder interaction style promoted by vertical, wall-mounted displays). Studies comparing face-to-face and shoulder-to-shoulder work styles [12] have found that around-the-table style interaction promotes more communication and participation from group members, which can be especially beneficial for individuals with AS. Researchers have explored the benefits of tabletop displays for educational activities [1] and games [8, 9], but have not explored how tabletop interfaces and games might be designed to maximize educational benefits for populations with special needs.

DESIGN PROCESS

We conducted observations, interviews, and paper and digital prototype tests over a period of six months with middle school students (12-14 years old) and therapists from a social cognitive therapy group. Twelve students and their school-designated mental health therapist were involved in this study. While the majority of students in our study have a primary diagnosis of AS, other students from this class who participated in the study have social skills challenges stemming from other disorders, including diagnoses of High-Functioning Autism, Attention Deficit Hyperactivity Disorder, Apraxia, and Klinefelter's Syndrome. Our methodology for understanding the needs and learning goals of this population included participant observation as well as group and individual interviews. We focused on participatory design, involving students and adults with AS, mental health therapists, and parents of children with AS in all aspects of design and evaluation.

Design Goals

Our goal was to develop a cooperative, multi-player tabletop computer game that encourages meaningful application of group work skills such as negotiation, turn-taking, active listening, and perspective-taking for students in social group therapy. We intentionally designed SIDES to leverage the cognitive strengths and interests of individuals with AS. Interviews with children and adults with AS revealed an interest in highly visual games such as puzzles and a fascination with systems; as a result, we created a puzzle-style game. AS occurs in only one female for every four males [6], so we chose a game theme of frogs and insects in order to appeal to our predominately male, adolescent audience. For students with AS, the challenge in playing SIDES is learning to work cooperatively with each other.

Field Studies and Observations

As participant observers in a middle school social skills therapy class, we sat with the students and participated in the group discussion of topics such as listening, turn-taking, and leadership. We attended seven sessions, each lasting approximately one hour, to investigate current approaches to teaching social skills as well as student interests in and out of the classroom. We conducted six interviews with school mental health therapists and a speech pathologist to understand current teaching methods and classroom techniques and to identify potential solutions for teaching group work skills. The mental health therapist who leads this social therapy group stated:

"Some of my kids go into mainstream classes and they just can't work with other people. We have to find the right mainstream kids that will have the patience and tolerance to deal with our kids' behaviors. Then some of our kids just flat out refuse to work in groups because they don't want to give up their power and control. Control for these kids is not something they have a lot of so they try to control their environment."

It was challenging to interview students from this class in a one-on-one setting. One student, for example, "shut down" during her interview. She would not make eye contact and only provided one-word answers to open-ended discussion prompts. Instead of one-on-one interviews, we found that

Figure 1: Our design process (left to right) included brainstorming sessions with experts, interaction storyboards, paper prototype tests, interface mockups, and DiamondTouch implementation and evaluation.

group interviews with four or five students from the class were more productive. Interviews with students from this class revealed discontent with current group therapy activities such as discussing emotions and reporting on weekend activities. We found that "game day" (therapy sessions where students play board games) was one of the few interview topics that elicited positive and excited responses from students. One seventh grade girl from this social group therapy class pointed out that the challenge in designing a motivating and exciting game is to avoid creating a game that appears overtly educational. This student is an avid gamer and is currently designing her own computer game. When asked how she would design a game to teach the social skills topics addressed in group therapy, she replied, "I don't know. I don't really like those types of games. I don't *do* educational games." She then explained that "entertainment games are just when you're doing them for fun" and educational games "start teaching you stuff and they get away from all the entertainment and fun." We realized that the challenge in designing a compelling cooperative game would be to create an engaging yet educational experience without directly focusing on traditional content from social skills therapy sessions.

Games are a prominent theme that emerged from our observations and interviews. Students in this class frequently play online games and video games at home. We found that board games are often used as a tool during therapy sessions. The students' mental health therapist commented, "With these kids we have to be on alert when they are playing board games in class. We jump at the first sound of voices raised. Other kids would be fine and could work out a disagreement, but with our kids we have to monitor behavior very closely and know when it's time to intervene." We realized that regardless of our game design, an adult may have to monitor game play for behavioral purposes.

Game Design

We decided to create a highly visual puzzle game and designed the rules so as to increase collaboration and decrease competition. At the beginning of a round, each player receives nine square tiles with arrows (three copies of three unique game pieces) (Figure 2). Arrows are divided among participants. There is a limited supply of each arrow type, thus encouraging students to cooperatively build an optimal path to win the most points. Students are asked to work together to build a path with their pieces to allow a "frog" to travel from the start lily pad to the finish lily pad. To gain points, the path must intersect with insect game pieces on the board. The insects are worth various point values (e.g., each dragonfly is worth 20 points). The group of students must agree on one path that collects the most points with their given amount of resources. Once all players agree with the solution, the frog will travel along the path and collect points by the eating all insects it encounters.

Paper Prototype

We tested a paper prototype of SIDES to finalize the rules, check for game balance, and determine whether the theme would appeal to our audience. The paper version of SIDES is ideally suited for four-players, but more people can play with minor adjustment. We tested the prototype with two five-student groups from the social skills therapy class. After playing multiple rounds, we held a group interview and brainstorming session about the gaming experience. The students were positive about the game design and flow of game play. Students gave positive feedback on the frog and insect theme and offered numerous thematic suggestions. After observing both groups play the prototype, the students' mental health therapist commented, "I was impressed with how they all shared the responsibility and actually played collaboratively rather than one person dominating… even those who are normally the least active in the groups were active and engaged the entire time." The paper version was successful in that it provided proof of concept for a cooperative game design. However, there are still significant advantages of a computer version for these adolescents. A computer game can enforce rules without the therapist having to police game play, thus freeing up his/her time to attend to higher-level group work issues. Adolescents within our target user group find comfort in controlled and structured interactions with a computer, thus making a computer version even more promising.

DiamondTouch Implementation

After successful testing with the paper prototype, we implemented a computer version of the game in Java for the DiamondTouch table [5], a multi-user touch sensitive tabletop with a top-projected display. We wrote our application using the DiamondSpin tabletop user interface toolkit [14]. As with the paper version, players seated around the table receive game pieces to place on the board

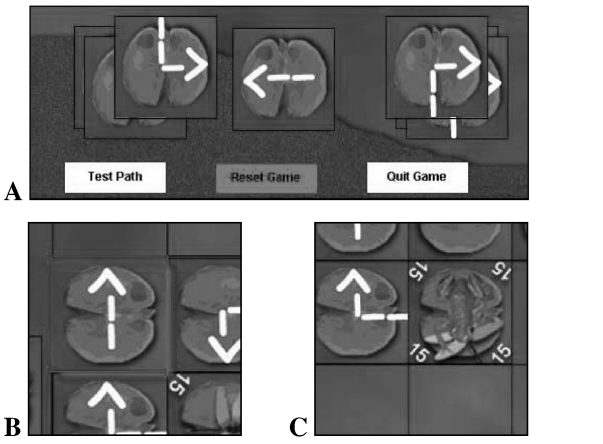

Figure 2: Interface components: A) Each player has a control panel with voting buttons located along the border of the table nearest each user's seat. B) Arrow pieces highlight with the player's color when touched. C) The frog "hops" along the path and eats insects to win points.

and create an optimal path from the start to finish. Game pieces with different types of arrows (as in Figure 2) are divided among players and are initially located in piles directly in front of each of the four users. We chose this distributed initial configuration of game pieces based on findings from [13], where the center area of the table is perceived as a group space and areas directly in front of each person are considered spaces for personal items. We did not incorporate a timer or impose any time limits on the game, to prevent students from feeling rushed and forgoing collaboration just to reach a solution. The computer version gives each player a control panel in the region of the interface closest to his or her chair (see Figure 2A). In each player's control panel are round and point indicators as well as voting buttons to test the path, reset, or quit the game. The voting buttons allow the group to "vote" unanimously in order to change the state of the game. For instance, players must vote unanimously to test their path once a solution is reached by all simultaneously pressing the "Test Path" button. This feature was implemented to ensure that no one player had more control over the state of the game than another player, and to encourage social interaction by necessitating communication and coordination with other members of the group. The first version of the computer game did not enforce rules such as turn taking or piece ownership. This design decision was made so that the game remained more open-ended and we could investigate the minimal amount of structure necessary for encouraging effective group work.

EVALUATION

Play Testing Session 1

The primary research questions that guided Session 1 include:

- Are tabletop computer games an appropriate and feasible tool for facilitating social skills development for this audience?
- Do any sensory or motor issues specific to this audience affect interaction with tabletop technology?

Method

We tested this initial design with five students from the same social cognitive therapy class we observed and with whom we tested the paper prototype (Figure 3). The game is ideally suited for four players, so students rotated in and out after each round of play. These students were all male (mean age of 12.8 years) and in the same social cognitive therapy class. The students' parents and mental health therapist from school came to the lab at our university to oversee the testing session. We had students play for two half-hour blocks of time. Following each half-hour playing session, students discussed their experience with the therapist and participated in a group brainstorming session about improvements to the game. The students' mental health therapist facilitated the game playing and discussion. The students played a total of six rounds. Students were given a brief tutorial on how to use the DiamondTouch

Figure 3: Four students playing SIDES during Play Testing Session 1.

table and then instructed to work together to come up with one solution while playing SIDES. In this version of SIDES, the computer did not enforce rules. The therapist monitored student behavior and encouraged discussion of strategy. Leaving the game open-ended made the activity more challenging, as it forced students to negotiate leadership and turn taking on their own. Game playing and discussion was videotaped for later analysis. All interactions with the interface were logged by the computer. Students individually completed a questionnaire after playing SIDES.

Findings (Session 1)

We found that students remained engaged in the activity the entire time and were excited by the novelty of the technology. However, the students' excitement around playing a computer game on new technology in a new environment provided additional behavioral challenges. The students' therapist commented, "Even though their behavior was very positive, they were still talking over each other and not taking turns like we discuss in group therapy… they were really enthusiastic and had difficulty navigating back-and-forth conversation."

Individual Behavior

Some students exhibited a high level of control over their behavior and made positive contributions to the group without dominating the activity. Drew, a seventh grader with AS, suggested several strategic moves to the group but was repeatedly ignored. Later he commented on the group's final solution, "It's not exactly like my planned route, but it's close enough." Drew's comment illustrates *perspective taking*, realizing that other people have different ideas, a topic that is frequently discussed in group therapy. Drew's mother also observed the testing session and explained, "I've actually found it rather interesting watching my son because he tends to be decisive about things and be more of a leader, but he's not forcing his will on anyone else here at all. He's listening and seemingly much more socially conscious than I think of him in terms of trying to be

involved, but not trying to take over or get angry. So I'm actually quite pleased to see that."

In contrast, some non-cooperative behaviors indicate that additional structure could have helped other adolescents control their impulse to dominate the activity. Several rounds of play were chaotic with kids pushing each other's hands off the interface and yelling loudly. One outspoken student often took control of the game, reaching across the table to move other player's pieces without asking and telling others which piece to play next without eliciting input. This student's father observed the testing session and commented, "With [my son], tact and making other people feel good about what they're doing doesn't even enter the equation… he'll try to get the ideal result of whatever problem is in front of him and how that impacts other people doesn't even occur to him. That's what he needs to learn more of. Games like this give him more practice."

Need for Order

In the debrief immediately following the gaming session, the students gave an overwhelming response regarding the need for order while playing. One commented, "There always has to be a leader; otherwise it will be wild and nobody will get anything from it." In response to this comment, Brad, a seventh grade student, stated, "We're supposed to work together. We're supposed to be equals." Brad was the quietest participant during the testing session and quickly became agitated and covered his ears when his peers spoke loudly at each other. During a follow-up conversation several weeks later, Brad explained, "Last time it was chaos." He looked at the ground and paced back and forth, "yeah, it was really chaotic until I got to be the leader." By "leader" Brad is referring to a point in the session where the therapist closely monitored the students and gave each a chance to make decisions for the group.

Sensory and Motor Issues

In this first round of testing, we also wanted to assess the appropriateness of tabletop technology for this audience. Our primary concern was whether these adolescents could learn sufficient control over the interface given the tactile input required by most tabletop surfaces. Participants answered "How hard was it to move the pieces around on the table?" with a mean of 2.2 (stdev = 0.45) on a five point Likert scale (1 = "not at all difficult" and 5 = "extremely difficult"). This response indicates that the participants found the mechanics of using the touch-sensitive tabletop technology manageable.

Providing private audio through headphones during a tabletop computer activity enhances the user's experience and is an interesting way to provide personalized feedback to users [10]. Some individuals with an Autistic Spectrum Disorder, however, may experience extreme discomfort when wearing headphones and/or be hypersensitive to noise. These adolescents may become disengaged and unmotivated to participate in the group activity if they become uncomfortable working with the technology. For the first half of the testing session we played game sounds over a shared set of speakers. During the second half of testing, we asked students to wear individual headsets so they could hear game sounds that only pertained to their piece movement. We wanted to determine if wearing headsets would be too intrusive for these students and if hearing personalized game sounds when the player moves or plays a game piece would add to the gaming experience. Brad is highly sensitive to noise. He only wore his headphones for approximately five minutes before removing them. Another student said he did not want to wear them and also took his off, followed minutes later by the last two students. According to the students' therapist and our observations, the headphones and our choice of game sounds did not cause extreme discomfort to any students in this session. The headphones, however, were intrusive enough for all students to remove them prior to completing the activity.

Overall Impact

Overall, the students found SIDES to be a highly motivating and challenging experience. After playing, one eighth grade student remarked, "Are we going to play again? I want to play it in the classroom." According to the students' therapist, this excitement carried over into the classroom and spurred discussion about the gaming experience, allowing him to tie the experience back into current classroom social skills topics. Session 1 demonstrated the promise of tabletop computer games as a tool for facilitating social skills learning, as these adolescents were highly engaged with each other during the game and motivated by performance.

Product Iteration

Play Testing Session 1 revealed that SIDES was motivating for this audience. Session 1 also indicated that explicit game rules such as turn taking and piece ownership might help reduce controlling behaviors of some students and encourage other less engaged members to feel ownership over the activity. We revised the game to include computer-enforced turn taking and restricted access to game pieces, as per our observations and feedback from the students' therapist. The therapist suggested, "Whoever's turn it is should be the only one who can manipulate the pieces. You can see that the kids can't keep their hands off. They will reach over and if some kid is too slow or taking in more information, they might not be able to wait and will break the rules by stealing another person's piece." The computer provides hard, fast, and consistent rules in a way that the therapist as a human facilitator cannot. The rule enforcement was enabled by the DiamondTouch table's ability to distinguish between four distinct users and to associate a user identity with each touch input.

We also redesigned the control panel in front of each player to include a "turn taking" button (Figure 4). Each player's "turn taking" button indicates whether or not it is that player's turn. A player may make as many moves with their own pieces during their turn as they like. The player whose turn it is has control over when they end their turn by

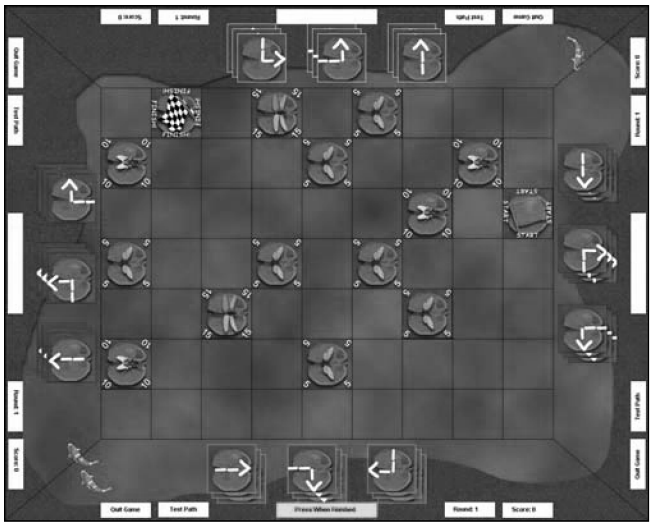

Figure 4: One "turn taking" button highlights at a time to indicate which player's turn it is. In this image, the green player's button is highlighted (located on the interface directly in front of this player) and all other "turn taking" buttons are white and inactive.

pressing their "turn taking" button. Play proceeds in a clockwise fashion as each player moves a piece(s) and relinquishes his turn. Players are allowed to "pass" if they do not want to play any pieces.

In the next phase of this project we examined how these adolescents practice effective group work skills when playing a cooperative computer game when there are no rules, when rules are enforced by a human facilitator, and when the computer enforces rules. For Session 2, we decided to test the controlled access (players can only move their own pieces) and turn-taking features in combination, as this requires players to communicate more and to become more coordinated in their attempts to create a solution.

Play Testing Session 2

Session 2 focused on how rules affect a group's ability to work cooperatively and how these adolescents respond to computer- versus human-enforced rules. The following questions guided this testing session:

- Does training in highly structured conditions help these adolescents perform better in later conditions when game play is unstructured?
- How do students respond to computer-enforced structure versus structure provided by a human facilitator?
- What is the role of a therapist or teacher during a tabletop computer activity with this special-needs population?

Method

To address these questions, we tested three variants of SIDES with two groups of four students, all from the same social cognitive therapy class. Four of the students who participated in Session 1 also participated in Session 2. These students were all in Group 1 for Session 2. Seven of the eight students had played the paper prototype in class before coming to the testing session at our university. All students except one had prior knowledge of the game rules, objective, and mechanics.

The two groups were presented with conditions as follows: Group 1: N, H, C, N and Group 2: N, C, H, N, where N = no rules, H = human-enforced rules, and C = computer-enforced rules. Each condition was presented as one round of play. In the N condition, students were presented with the basic version (similar to the version in Session 1, but with slight modifications to improve system performance) where no rules were enforced by the system and the therapist had limited involvement. The H condition again presented students with the basic version where rules were not enforced by the system, but under this condition, the therapist facilitated turn taking and enforced the "controlled access" of game pieces, only allowing students to move or play their own game pieces. In the C condition, turn taking and controlled access were enforced by the computer and the therapist had limited involvement in the activity, only providing occasional comments related to the group's strategy. Since Group 2 did not have prior experience with the computer version of SIDES, this group played the basic version without structure for approximately ten minutes to become familiar with the game and their teammates before beginning the conditions above.

As with Session 1, all game playing and discussion was videotaped for later analysis. Interactions with the interface were again logged by the computer. After the testing session, students individually completed a questionnaire to compare the above conditions and then participated in a follow-up group interview.

Findings (Session 2)

We evaluate group performance and compare the reactions to the three conditions in several ways. We present questionnaire data, feedback from follow-up interviews with the therapist and students, and an analysis of student conversation and behavior over multiple rounds of play. The effectiveness of verbal and non-verbal exchanges is an important indicator of success for these adolescents. The challenge these individuals face is not a lack of interaction so much as a lack of effectiveness in interactions [3]. Our research team reviewed videos of both groups for Session 2 and independently coded verbal and non-verbal exchanges according to Table 1. We developed this coding scheme by consulting with psychiatrists and mental health therapists specializing in adolescents with AS, referencing the Diagnostic and Statistical Manual of Mental Disorders (DSM IV), and using our observations of play testing sessions to identify prominent themes. Interrater reliability was above 85%.

Table 1: Categories for Conversation/Behavior Analysis

Positive	Aggressive	Non-Responsive
• Verbal agreement • Agreement by making suggested play • Encouragement	• Verbal command • Pushing • Loud outburst, screaming • Teasing	• Ignore or dismiss idea without discussion • Ignore/disregard therapist

It is important to note that students in Group 1 had prior experience working with each other while playing the earlier version of SIDES during Session 1. In Session 1, these students experienced the "chaos" of playing without rules. This experience gave them a benchmark to which they could compare their experience in Session 2. Group 2 had limited exposure to the game and minimal experience working with their set group of peers. For this reason and due to the limited scope of our data set, we do not directly compare the two groups in Session 2. Instead, we treat the two groups as separate cases and seek to understand design implications based on the varying group dynamics and reactions to the activity.

Group 1

Students in Group 1 exhibited an increase in positive language use as well as a decrease in the amount of aggressive behaviors over multiple rounds (Figure 5).

Based on conversational exchanges between group members, students in Group 1 performed best in the computer-enforced rules condition. Group 1 also demonstrated an improvement in conversation over the course of the trial and sustained this improvement in the final round without rules, the condition described as most difficult by students in Group 1. These students quickly adapted to the computer-enforced rules condition, becoming highly coordinated by skipping turns to get to a player who owned the piece necessary for the next move. Three out of four students in Group 1 rated the game as *easiest to play* when rules were enforced by the computer. Three out of four students in Group 1 also reported that they were *most relaxed* when rules were enforced by the computer. No students in Group 1 rated the computer-enforced rules condition as the *most difficult version to play* or as the condition they thought was *most chaotic* or *most frustrating*. Three out of four students in Group 1 said they *worked together best* during the computer-enforced rules condition and all four students reported that they *worked together worst* when there were no rules (condition N).

Group 2

In contrast to Group 1, all students in Group 2 stated that the game was *easiest to play* and that they *worked together best* when there were no rules. Three of the four students also indicated that they were *most relaxed* when there were no rules. The conversation analysis of Group 2 echoes the student questionnaire data. Group 2 exhibited more positive conversational exchanges and fewer aggressive behaviors in the no rules conditions (Figure 6).

Students in Group 2 sustained the same level of positive conversational exchanges and only slightly increased in aggressive behaviors over the four rounds. Group 2 indicated that the no rules condition was easiest and demonstrated conversation and behaviors that support their questionnaire responses. This group, however, did not indicate a majority opinion for the questions asking which version was *most chaotic* and *most frustrating*, but split their votes between the two conditions with rules. Responses to the condition under which the group *worked together worst* were also divided between the human- and computer-enforced rules conditions. The difficulty for students in Group 2 to work effectively with rules is in part due to the inflexibility of one player in this group, Brandon. Brandon (age 11) consistently expressed skepticism about the team's solution and delayed the game by refusing to give up his turn even if he did not have any pieces to play. After observing Session 2, the therapist said, "I wish I could get the rest of my students to play this because it really gives me an idea of what's hard for each individual. Like with Brandon, I had no idea he had such issues trusting other students until I saw him unwilling to give up his turn when the computer was enforcing turn taking."

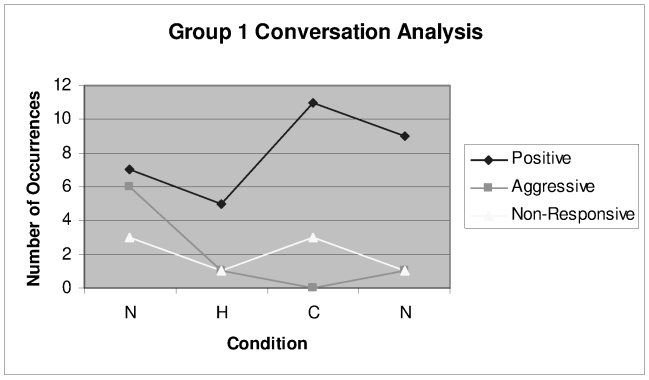

Figure 5: Number of occurrences of positive, aggressive, and non-responsive behaviors for Group 1.

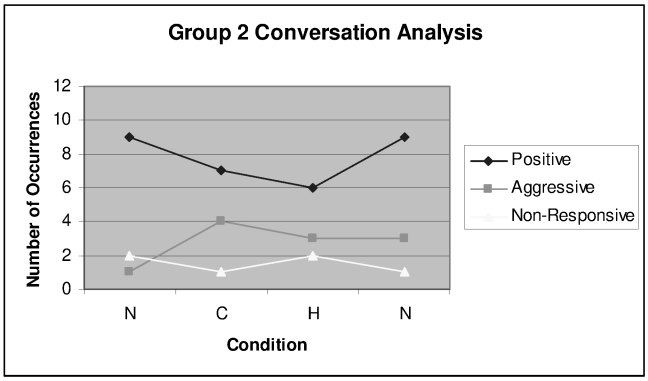

Figure 6: Number of occurrences of positive, aggressive, and non-responsive behaviors for Group 2.

Since our evaluation only involves two groups using SIDES for approximately one hour each, it is difficult to isolate exactly what influenced these behavioral changes. The improvements and sustained positive behaviors demonstrated by the groups could have resulted from learning the game and becoming more efficient at the activity. The therapist's intervention between rounds, giving students feedback on their behavior after each round, is another factor that likely contributed to both groups' improved performance. Nonetheless, adolescents within this population have a strong tendency to disengage when uninterested in an activity, thus making any improvement in positive conversation and behavior a successful outcome.

Therapist Feedback

In a computer game designed for this audience, it appeared more natural for rules to be embedded in the system as with the computer-enforced rules condition. The students' therapist stated, "These kids generally do better with rote, impersonal, nonsocial instructions. That's why they do well with computer games. There's no variance, so they don't have to worry about social conventions or social rules." When asked to compare how he thought his students performed in the conditions with computer-enforced rules and human-enforced rules, the therapist replied, "It's hard because I thought that they did better without me and my input. I tried to get them to think about strategy, but there was so much stimulus and enjoyment in the game that they didn't listen to me!" The therapist had a difficult time getting the kids to play in order (enforcing turn taking) and making sure players only touched their own pieces. Because of this he began to serve more as a strategist than a rule-enforcer, but still had limited success since the students were intensely focused on the game.

When asked to compare the human- and computer-enforced rules conditions, he explained, "They had to respond to an adult when I was facilitating it. The computer rules version eliminates one social interaction that they otherwise would have to attend to… Just listening to the game, which is more objective, made playing easier." Though the versions without rules and with computer-enforced rules might be easier for these adolescents, the goal of SIDES is to provide a supportive and motivating context to help students practice effective social interaction. This includes practicing listening skills and focusing attention on other people in the environment, including an adult moderator. Neither group exhibited a consistent trend in non-responsive behaviors throughout Session 2. Listening skills are central to overall social skills development and a predominant topic that this class covers. It would be informative for future studies to examine patterns of non-responsive behavior.

In future play sessions, the therapist could adjust the type of rules and how rules are enforced so that students experience a gradual increase in difficulty. One student (age 14) from Group 2 suggested something similar, "This game is a great example for kids needing to learn social skills because they can start out with it easy without rules and go to the harder parts where you have to take turns." Through our analysis we found that students vary in what they perceive as the most challenging part of playing SIDES. Some students struggle with controlling their frustrations when the computer restricts player movement. Others have difficulty learning to not take over the game and listen to others when game play is unrestricted. This variability in student learning needs reinforces the need for customizable rules and scalability depending on player ability.

The therapist had difficulty getting his students to listen to his comments while the game was running, so his most valuable role occurred after the gaming experience ended. Playing SIDES gave these students a rich experience, but it took the therapist discussing the game with his students afterward to tie the experience back into classroom topics and real world experiences. "The key is to give them the experiences to trust themselves, trust their abilities to interact so that generalizes to interacting with other kids in other settings… The goal is generalizing the experience," explained the therapist. This is exactly what he attempted to do for his students immediately following the session and during the week afterward. In class the week after each testing session, the therapist often referred to SIDES and used examples from the gaming experience to reinforce social skills topics. His ongoing integration of the experience into classroom discussion demonstrates the potential for cooperative tabletop computer games to supplement current social skills teaching methods for this population.

DISCUSSION

We designed SIDES to supplement current social skills group therapy techniques. Our evaluation of SIDES indicates that cooperative tabletop computer games are useful for supporting social group therapy activities. We now revisit the research questions that guided our evaluation of SIDES:

Q1.) *Are tabletop computer games an appropriate and feasible tool for facilitating social skills development for this audience?* Student interactions and feedback during the play testing sessions validated that tabletop computer games are both appropriate and motivating for this audience, middle school students with Asperger's Syndrome or related developmental disorders. Feedback from the therapist and parents revealed that a cooperative tabletop computer game for practicing social skills is a feasible and useful application of tabletop technology.

Q2.) *Do any sensory or motor issues specific to this audience affect interaction with tabletop technology?* We did not uncover any sensory or motor issues with the participants involved in this study. However, all participants were high-functioning and none had motor coordination difficulties that would impact use of a traditional computer workstation with a keyboard and mouse. Adolescents with an Autism Spectrum Disorder

have varying levels of noise tolerance and motor abilities, so an adolescent's ability to use SIDES or other tabletop software should be evaluated on an individual basis.

Q3.) *Does training in highly structured conditions help these adolescents perform better in later conditions when game play is unstructured?* In Session 2, we observed an upward trend in positive verbal exchanges and a decrease or sustained number of aggressive exchanges over the course of the activity. Given the scope of our testing sessions and data, we cannot conclude that experiencing the structured conditions was the key factor that led to a positive behavioral change. This result is likely also influenced by an increase in experience working with SIDES and with a set group of peers.

Though our current findings are inconclusive, we suspect that experiencing the structured conditions was a large contributor to Group 1's success in Session 2, as this group demonstrated the most effective group work in the structured conditions (H and C) and only showed a slight decrease in the final round where no rules were enforced. During the debrief after Session 2, the therapist said to his students in Group 1, "You guys didn't even notice that in the last round you could touch each others pieces and play in any order. You didn't reach across and take people's pieces like before, you kept working together." Students in Group 1 reported working together best under the conditions with rules, where as students in Group 2 explicitly stated that they did not like the versions with rules and performed worst in those conditions. The positive change in Group 2 and part of the change in Group 1 likely resulted from learning the game and learning to work with group members more effectively. Further studies are necessary to understand how the role of structure in cooperative computer games could help these adolescents practice and sustain more effective social behavior. For example, it would be helpful to test the structured conditions with more groups and compare these findings with groups who play for the same number of rounds, but never experience structured conditions.

Q4.) *How do students respond to computer-enforced structure versus structure provided by a human facilitator?* As described above in Session 2 findings, the therapist had difficulty getting students' attention and enforcing rules. It also appeared unnatural to have a human facilitating game play when a computer would be more efficient. Our findings indicate that the consistency in rule enforcement during the computer-enforced version has the potential to encourage positive behaviors during group work tasks. These adolescents find comfort in the consistency of automated game rules, where as rules enforced by a human moderator may be more subjective and add challenge to an already difficult task.

Q5.) *What is the role of a therapist or teacher during a tabletop computer activity with this special-needs user population?* According to our findings, the therapist or teacher's main role in tabletop activities, specifically cooperative computer games, for this audience is facilitating discussion after each round and after the entire experience. Through discussion of the activity, the therapist or teacher helps students reflect on the activity and tie their experience into real world situations.

SIDES provides a rich experience for students but requires the students' therapist to facilitate discussion and ground the experience in classroom social skills concepts. Regarding the students' experience, the therapist commented, "It's something they enjoyed doing, so it's not like a lesson where you're teaching them something in lesson form. With the game they're just learning these skills by doing something fun. It's like you're sneaking in learning without them knowing it." He goes on to explain, "It's great that they can feel confident and comfortable while working with each other because it's not torturous. These students didn't even see the activity as learning to work in a group." Helping students build confidence in their social abilities is another benefit we hope students receive by playing SIDES. For Brad, participating in the testing sessions was an experience far beyond just learning social skills. "[Brad] is a kid who has been tormented and terrorized by other kids in his class. For him to be able to participate and feel like he's part of the group and accepted was great. He probably enjoyed it more than anyone because his existence was validated through the shared activity," commented the therapist.

On both an individual and class-wide level, we observed the positive effects of situating an educational topic that is traditionally difficult for this group of students, social skills development, in an exciting and comfortable context, playing a cooperative tabletop computer game.

CONCLUSION

We have presented a design case study of a cooperative tabletop computer game for a special needs population. The goal of SIDES is to provide adolescents with Asperger's Syndrome with a positive experience through which they can develop effective group work skills and build confidence in social interaction. We consider sustained engagement in the activity and an increased ability to communicate with peers after multiple rounds of play as successful outcomes for this group of adolescents. Cooperative computer games are a new paradigm for teaching effective group work skills in a meaningful way. Tabletop technology is a promising tool for facilitating cooperative gaming experiences geared for this special needs population as well as the general public.

ACKNOWLEDGMENTS

The acknowledgements have been removed to facilitate blind review.

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