First Experiments with an Applied Gaming Intervention for reducing Loneliness of Children with Chronic Illness: Lessons Learned

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ABSTRACT

We present the first experiments from a pilot study with *Ruby's Mission*, an applied gaming intervention for reducing feelings of loneliness in children with a chronic illness. Based on a previously performed literature study, *Ruby's Mission* sets out to train specific socioemotional skills, through four children sharing emotional experiences. The present study contributes insights in (1) how asymmetrical player roles in a multiplayer game affect in-game social interactions, and (2) if socioemotional skills affect the in-game social interactions in a multiplayer video game. Experiments were conducted during a public event for introducing children to science. A baseline measure of socioemotional skills was made using the emotional awareness questionnaire (EAQ). Video and audio recordings were made during gameplay, and were annotated afterwards on social interaction. As per expectations, results suggest that asymmetrical player roles encourage different levels of social interaction. Analysing the effect of socioemotional skills on an individual player's in-game social interactions, surprisingly revealed a slight negative effect, where social interactions decreased as socioemotional skills improved. Interestingly, when investigating this effect on per gameplay group level, no interaction was found. Results also reveal that external factors such as parent interference, play environment, and peer relations might have an effect on social interactions as well.

CCS CONCEPTS

• **Applied computing** → *Psychology*; **Computer games**; • **Software and its engineering** → **Interactive games**; • **Social and professional topics** → **Children**.

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KEYWORDS

Applied gaming intervention, children, chronic illness, socioemotional skills, social competence, social interaction

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Figure 1: Splashscreen of *Ruby's Mission*: An Applied Game Intervention for reducing Loneliness of Children with Chronic Illness

1 INTRODUCTION

In the present article the first experiments with *Ruby's Mission* are discussed. Ruby's Mission is an applied gaming intervention for reducing loneliness of children with chronic illness. For its design decisions, the applied game explicitly builds upon recent academic insights with regard to (training the) socioemotional skills of children with chronic illness.

Children with a chronic illness, such as cystic fibrosis or juvenile arthritis, often face obstacles that can have a negative impact on children's physical, social-emotional and cognitive development, beyond the actual illness itself. Children with chronic conditions are, on average, lonelier than their peers without such conditions. Feelings of loneliness in children and adolescents have been associated with a wide range of negative outcomes, including school drop-out, depressive symptoms, social anxiety, suicide ideation, low self-esteem, eating disorders, and sleep problems. As such, the present investigation sets out to reduce these feelings of loneliness for children with chronic conditions, and notably, aims to do so by the structured design of an applied gaming intervention.

In previous work, we contributed (1) a literature-based understanding on *training socioemotional skills as a novel means to reduce feelings of loneliness in chronically ill children*, (2) intervention objectives that are aligned to this goal, and (3) a structured proposal for design guidelines that implement the intervention objectives into Ruby's Mission [3]. Our current aim is to investigate the social interactions between the players throughout the game. Ruby's Mission is designed such that most learning gain is expected to result from social interactions that take place between players while playing. We are specifically interested in (1) the type of social interactions that take place during gameplay, (2) if player roles (i.e., driver, collector, and decision maker) affect the social interactions of individual players, and (3) whether children's displayed social interactions are related to children's levels of social-emotional skills.

In the present study we provide results from a pilot study investigating our second and third aims; whether player roles affect the social interactions of individual players and if children's social interactions are related to their levels of social-emotional skills. Furthermore, we also present findings that based on non-structured observations during the gameplay sessions. We first reiterate relevant academic insights, and the design guidelines for Ruby's Mission based on these insights, from Anonymous et al. [3] respectively in Section 2 and Section 3. In Section 4 the methodology for the first real-world experiments is described. Section 5 presents the results from the experiments. In Section 6, the article is concluded by a discussion of the results and the lessons learned.

2 RELATED WORK

2.1 Loneliness in children with chronic illness

Two common themes within literature on children with chronic illness may be identified: (1) a discrepancy in desired and received support, and (2) the amount of rewarding peer-related activities. A report from the Verwey Jonker Institution in the Netherlands [29], showed that there were significantly more chronically ill children with the desire for more friendships compared to their typically developing peers. This discrepancy in need for support and the perceived support might induce feelings of loneliness in chronically ill children. Various studies show that children with chronic illnesses value friendships and being accepted as the most important factors in their life [26, 28]. Even though these children highly value their friendships and social belonging, they often have fewer friends, are more isolated, and have difficulty establishing and maintaining friendships [6, 30].

Regarding the amount of rewarding peer-related activities, it can be observed that children with chronic illnesses are often less exposed to (play) activities than their peers. For example, this group has significantly higher levels of school absenteeism, attend special forms of education such as home schooling more often, and participate less in public sport clubs [4, 14, 20, 29]. Furthermore, these children also face other challenges to participating in social activities with peers, such as being stigmatized [4, 16], falling victim to physical violence [10] or being bullied [18]. Frequent absenteeism from school limits the time spent with peers; reducing the amount of rewarding peer-related activities [25]. Limited time spent with peers might lead to impaired social functioning, which has indeed been found in previous studies [15, 19].

In summary, an abundance of academic literature suggests that an intervention targeted at improving the social competencies of children with chronic illness may lead to improved social relations.

2.2 Socioemotional skills

For our study, we decided to focus on improving so-called 'socioemotional skills' because emotions affect the social situation, are correlated to interpersonal functioning [8, 13, 17], and are free of stigma. As such, training socioemotional skills offers a heterogeneous approach for reducing loneliness in children with chronic illness, and it might address the underlying social challenges of this population. Following an analysis of (the overlap between) existing socioemotional constructs such as *mentalizing* [5], *emotional intelligence* [24], *alexithymia* [23], and *theory of mind* [7], we decided to focus our research on training the following three socioemotional skills [3].

Recognizing emotions in one-self and in others. The ability to recognize emotions in one-self and in others can be seen as a prerequisite for applying one's socioemotional skills in social situations. Theory and research suggests that misperception and misinterpretation of emotion cues or frequent failure to perceive them at all could seriously impede the development of socioemotional competence [9]. Training this skill is particularly relevant for chronically ill children, as reduced social participation may lead to deficits in chronically ill children's emotion recognition skills [27].

Understanding the meanings of emotions to guide thinking and doing. This skill concerns the interpretation of emotional meanings and considering these in daily (social) functioning. Indeed, expressed emotions convey specific information and modulate the social interactions and connections between individuals [2], e.g., being approached by a person with either positive or negative intentions. As such, understanding the meanings of emotions and using these interpretations to guide thinking and doing will arguably assist a person with navigating their way through social interactions with others.

Understanding the subjectivity of emotional experiences. Indeed, every person experiences emotions and emotional situations in a unique manner. Spithoven et al. [27] showed in their meta-analysis that lonely individuals have a negative cognitive bias in all phases of social information processing. They tend to have more attention for threatening stimuli, hold negative and hostile intent attributions, expect rejection, evaluate themselves and others negatively, endorse less approach- and more avoidance-oriented goals, and have low

self-efficacy. As such, being able to understand that even in the same situation other individuals may have emotions that are different from oneself, is something that may help to reduce this negative cognitive bias in social information processing.

Our hypothesis – as extensively discussed in [3] – is that training socioemotional skills will improve the social relations of children with chronic illnesses, thereby reducing feelings of loneliness in the long term.

3 GAME DESIGN

In Anonymous et al. [3, Section 3.1–3.2], we adopted a structured approach for translating the intervention objectives that were described in Section 2.2 into guidelines for the actual game interactions. Table 1 provides an overview of how the intervention objectives are aligned with their respective design guidelines and their implementation in the Ruby's Mission game.

We also reflected on a set of design guidelines for embedding the game in the actual social/physical context [3]. In summary, it is important to consider that an applied gaming intervention for children is embedded in a context in which parents also have a role, in which therapist have a role, in which the intervention may benefit from being peer mediated to some extent, that has to be played in an environment that is considered safe for the child, and that poses constraints on the physical setting in which the intervention is played, and on how the game is distributed. We kindly refer the reader to Anonymous et al. [3, Section 3.3] for an extensive description of proposed guidelines on these topics.

3.1 Overview of the game design

Ruby's Mission, is a cooperative online open-world game in which four players must aid a Ruby the robot to complete her mission; to gain understanding of emotions and their meanings. The game is created for both Windows PCs and Macs. Players can communicate through voice communication using their microphones and headphones. The game is developed for children aged 8 to 12 years old. The entire game consists of 8 levels. We have chosen for an intervention that lasts 8 weeks, in which the children will play one level per week.

Narrative framing. Ruby is a robot who travels to the human world to learn about emotions. The four players must guide Ruby through her mission. The narrative is framed such that the children (players) assume the position of human experts on emotions as they must aid Ruby in her mission. Because the children assume the role of experts on emotions, they will most likely not experience the narrative as stigmatizing.

Multiplayer. We decided to create a multiplayer game for four players, as this allows us to leverage the advantages of a peer-mediated intervention for practicing socioemotional skills. As mentioned earlier, the players are able to communicate through a voice connection. Each game task is designed such that it requires or elicits discussion and conversation between the players. They share their thoughts and experiences to find group answers for a common purpose; guiding Ruby through her mission.[1]

Asymmetric gameplay. Several game interactions are designed to be asymmetrical to achieve participation of all players. That is, each player is assigned a specific role – (1) driver, (2) collector, and (3) decision maker – which affects the actions that a child can take. The driver navigates Ruby (and the other players) through the game world. Collectors can collect gravity tags that are scattered throughout the world. Decision makers are responsible for selecting the correct team answers within the various mini-games. Conversation is promoted as cooperation is necessary to complete the game.

3.2 Task #1: Poster mini-game

The first game task is the poster mini-game (see Figure 2). Three posters can be found in the game world at each level. Once the players reach the poster, Ruby will read some information written on the poster. The text is also visible for the players to re-read. Next to the text, a person is depicted who is feeling this specific emotion. From this image, the players can learn about the body language and facial expressions related to this emotion. This interaction is related to the first intervention objective, because it teaches the children to recognize emotions in others via facial expressions and body language. Furthermore, it is also related to the second learning objective, as it conveys textual information of the emotional meanings of the emotion.

Next, Ruby asks the players to share their personal experiences with her, such that she can gain a better understanding of the emotional meaning. The poster contains text-fields via which the players can privately share their personal experiences with Ruby. This requires the players to reflect on their own experiences of when they felt this specific emotion, which is associated with the first intervention objective.

Finally, the players can choose to share their answer with Ruby only or to share it with the game world. Providing the children the possibility to only share their experiences with Ruby, they can practice with sharing their experiences in a safe environment. When the players choose to share their experiences with the game world, it will make their answers visible to the other players. Their answers are made visible in the game world via notes that are pasted on the wall next to the poster. Sharing their answers with each other supports the third learning objective, as players can now see that they have different experiences with the same emotion.

The interaction is designed such that there is no one correct answer as emotional experiences are subjective. Children (hopefully) learn from each other's experiences when they are shared in the game world.

3.3 Task #2: Scenario mini-game

The second game task is the scenario mini-game (see Figure 3). This task was inspired by the Levels of Emotional Awareness Scale (LEAS) which uses vignettes to test emotional awareness [12]. Two scenario's are placed in each level. A scenario starts when the player encounters a specific in-game character. This character tells Ruby a short story about something that happened to him or her. The players must then decide as a group how this character would feel. They can select one or multiple emotions from a set of seven

[1] To this end, note the importance of a safe play environment. Indeed, cyberbullying is an inherent risk to online multiplayer games. This could imperil the safe play environment for the children. We hope to limit this risk of cyberbullying by instructing the parents of the participants to find friends, classmates, family members, or other children that already know their child to play Ruby's Mission with.

Table 1: Overview of the design guidelines proposed for achieving the intervention objectives.

Intervention objectives	Game interactions	Implementation
Learn to recognize emotions in one-self and in others	Requires the players to reflect on their own experiences of when they felt a specific emotion.	Include a task in which the players are directly asked to share their experiences of a specific emotion with an in-game character.
	Require the players to deduce the feelings of another game character or entity from the social context.	Based on the story of an in-game character, the players must deduce the character's feelings to persuade him in the players' favor.
	Teach players about body language and facial expressions associated with specific emotions.	Information on body language and facial expressions can be shared via animations and images in the game world. Players can be required to use this information in e.g. puzzles.
	Stimulate players to make decisions based on their previous, real life, experiences.	Present the players with a set of events from which the players must select the event that they associate most with a specific emotion.
Learn about the meanings of emotions to facilitate thinking and doing	An interaction is required which presents the players with the emotional meanings of various emotions and their consequence on a person's behavior.	Players interact with an in-game character that is feeling certain emotions. To achieve the desired game outcomes, the players must consider the character's emotions during their interaction.
Learn to understand that emotional experiences are subjective	Require the players to share their personal experiences of the same emotion with each other.	Personalize the game world by enriching it with players' personal experiences. For example, by 'painting' large walls in the game environment. Via visualization in the game environment, the players are able to see the experiences of others.
	Require the players to make a group decision on an emotion-related topic.	Present the players with a set of events from which they must select, as a group, the event that fits best with a given emotion. Through their own experiences, they will argue which event they think fits best, and share their personal experiences with each other.

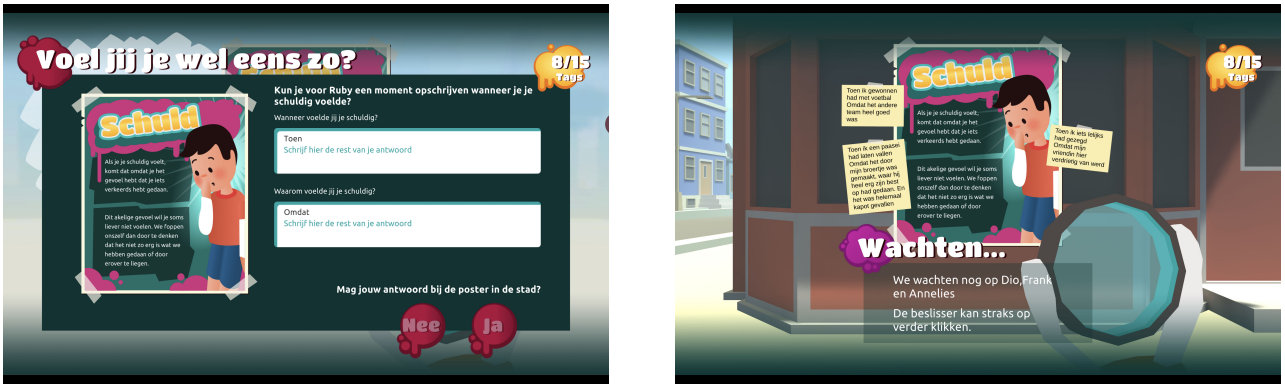

Figure 2: The poster mini-game. *Left*: the players are presented with textual and visual information on the emotion 'guilt'. Via the input-fields, they can share their personal experiences of this emotion with Ruby. *Right*: if the players choose to share their experiences in the game world, they become visible to the other players via 'post-it' notes next to the poster.

emotions, four primary emotions (anger, sadness, happiness and fear) and the three emotions covered in the current level. After the players made their group decision, they are presented with how this character is actually feeling. This part of the scenario mini-game is associated with the first learning objective; the players must deduce the emotions of another character from the 'social' context.

In the next phase of this mini-game the players must help Ruby to respond in a socially responsible manner to this character. Each player is presented with a *different* answer. They must discuss their answers and select one that they find most fitting as a group. Ruby will respond with this answer. The character will then provide feedback to the players by giving a final response to this answer. The answers were composed in cooperation with child psychologists. Four answers are prepared in total, where each answer mentions none, one or multiple emotions that the character is feeling. The most fitting answer is the answer that acknowledges all of the

Figure 3: The scenario mini-game. *Left*: The players select as a group which of the 7 emotions the character in the scenario is feeling.. *Right*: Each player is represented with a unique possible reaction that Ruby might say to the character. Below we see red buttons with the players' names that the decider can use to provide the group answer.

emotions that the character is feeling. This interaction is related to the second learning objective; the players must choose a response to the characters story, while taking into account its emotions. They must carefully consider the emotional meanings of the various answers when they select an answer. The character then provides feedback on the chosen response, by telling Ruby what her response made her feel.

This task also indirectly supports the third learning objective. Because the players must make group decisions on which emotions the character is feeling and which response would be socially the most responsible, they must share their opinions which are based on their thoughts and experiences. Therefore, players might see experiences other than their own.

3.4 Task #3: Graffiti mini-game

The last game task is the graffiti mini-game (see Figure 4). Scattered throughout the game world graffiti tags can be found. These tags contain text of situations which are associated to one of the three emotions covered by the current level. Per emotions five tags are to be found. The players can gather these emotions by clicking on them when they see them. After the group collected five tags corresponding to the same emotion, the mini-game is started.

As Ruby's "storage" is not large enough to store all 5 tags, she asks the players to *individually* select three out of five tags which they think correspond best with the corresponding emotion. The children must now call upon their previous real life experiences to make a selection. They are likely to recall and compare previous situations to the ones presented. Therefore, this interaction is associated with the first learning objective.

In the next phase of the mini-game the players will see each other's selections. They must now make a final group decision on which tags to include in Ruby's memory. There are usually two tags that receive the majority of the votes. Therefore, the players must discuss which of the last tags would fit best to the corresponding emotion. Through discussion and sharing their motivation based on their own experiences, the players must make a group decision. Therefore, this interaction is associated with achieving the third learning objective.

4 METHOD

4.1 Measures

Audio and video recordings. To analyze social interactions we collected video- and audio recordings during gameplay. Each of the participants would play with headphones (including a microphone) on their own laptop (provided by us). Video recordings were made using the built-in webcams and audio recordings were made using the integrated microphones in the headsets. Collecting data this way, we were able to acquire separated video and audio streams for each participant. It also allowed us to easily include/exclude participants from data collection. Recordings were started, stopped and stored automatically by the game.

Emotion Awareness Questionnaire (EAQ). To gain a baseline measure of socioemotional skills, we used the EAQ (Dutch version) developed by Rieffe et al. [21]. The EAQ measures six aspects of emotional functioning which we deem closely related to what we call socioemotional skills: (1) differentiating emotions (ADIF), (2) verbal sharing of emotions (ATALK), (3) not hiding emotions (AHIDE), (4) bodily awareness of emotions (ABOD), (5) attending to others' emotions (AOTH), and (6) analyses of (own) emotions (AOWN). While the questionnaire does not provide cut-off scores, and is not designed as a diagnostic tool, the tool is still suitable for our experiments. We use the tool as a baseline measure to compare within our population, therefore we do not require norm-scores. Secondly, we believe that children with a chronic illness only slightly differ in their socioemotional functioning as compared to their peers; a diagonistic tool is therefore not required. The EAQ has been validated in various populations [1, 11].

4.2 Experimental Setup

Experiments were performed during the 'Weekend of Science' (WoS) event at Utrecht University, in the Netherlands. During the event, children get introduced to various disciplines in science (e.g., biology, chemistry, game research, etc.). This event is targeted at children aged 8 years and older. We tried to recruit as many participants as possible that were within our target age range (8 to 12 years old). However, as we did not want to exclude any children during the event we did not refuse any children based on their age.

Figure 4: The graffiti mini-game. *Left*: players individually selecting 3 out of 5 tags that fit best with the given emotion. *Right*: players selecting 3 out of 5 tags as a group that fit best with the given emotion. The players can see the selections of the individual players.

The event consisted of multiple 30-minute 'workshop rounds' between which children could rotate. At the start of each round a new group of children was recruited to play Ruby's Mission. During the first two rounds there was only enough space for 1 group (4 children) to play Ruby's Mission. Due to the great amount of interest a second gameplay setup was created after the second round. The first 4 (or 8 after workshop round 2) children who arrived at the location were chosen to play Ruby's Mission. Before starting a gameplay session, the parents and children were asked if we could collect data during gameplay. They were explicitly told that they could still play Ruby's Mission if they did not agree with their data collection. If parents or children did not agree with the data collection, we would turn on a toggle that disabled collection of data for this child.

At the start of each gameplay session an introduction was given by the main researcher. The children were explained what the purpose of the research was and that we would like them to help us improve the game. After asking each of the children if they wanted to participate in the study and informed consent was given by their parents, they were asked to fill in the EAQ and LEAS-C. Once all children completed filling in the instruments, they were given their 'secret' player code[2] that they could use to play the game. Once they started the game, they could play until they either finish the first level or until the time for the workshop round ran out.

4.3 Annotation

We first annotated each participant's verbal communication during their gameplay session. The annotation scheme was discussed among authors. For the present pilot study, the first author did the annotations. As audio streams are recorded and stored separately for each participant, we were able to conveniently annotate verbal communication for each participant individually. Adobe's Premiere Pro video editing software was used for the annotation process. All audio and video streams from a single gameplay session were first assembled into a single Premiere Pro project. Next, markers were placed per audio stream (i.e. participant) to indicate the start of 'new' verbal communication for this participant.

[2]The secret player code is also used to store each participant's data pseudonymised.

Verbal communication was defined as any form of communication from one participant to another during gameplay. Other forms of verbal communication that were not explicitly targeted at another participant (e.g., exclamations about the game) were also included in the annotations. All forms of verbal communication with non-players, such as parents or researchers, were excluded from the annotations. We excluded these forms of verbal communication because they are not representative of the forms of verbal communication that can occur during a regular gameplay session. That is because Ruby's Mission is designed for children to play online without the intervention of parents or others.

Verbal communication was annotated as 'new' when a participant had finished their previous interaction. An interaction was considered as finished when the type of interaction would change (e.g., a participant finished answering another participant's question and now gives command to another participant), when there was a significant amount of time between two interactions (e.g., another participant asked another question in between the answer of the participant for which was currently being annotated), or when there would be a change in tone or emotion (e.g., a participant says "we should go to the right" without any irritation in their voice. Next they say again "go to the right", now irritated.).

4.4 Linear Regression

Linear regression analyses were then performed performed on the frequency of social interactions and the emotional awareness scores to investigate if emotional awareness affects social interactions in game. Similar analyses were performed for each sub-scale of the EAQ-30 questionnaire.

5 RESULTS

Descriptive Statistics. We first provide general descriptive statistics in Tabel 2. In total 35 children participated in our gameplay sessions. 20 of the participants were boys, and 15 were girls. The average age of a participant was 9.89 years old. Girls were on average older than boys (10.13 and 9.63, respectively). Boys and girls scored equally on total EAQ-scores[3] (2.14, std. dev. 0.20, and 2.20, std. dev. 0.32,

[3]Although norm scores are not available, other studies have employed the EAQ before [1, 11, 22]. EAQ scores measured in our study are similar to scores measured by others.

respectively). Higher scores indicate a greater emotional awareness. Boys and girls also scored similar on the sub-scales most sub-scales. Noteworthy differences were found on the *"not hiding emotions"* (1.90 and 2.23, respectively) and *"attending to other's emotions"* (2.23 and 2.61, respectively) sub-scales. Finally, girls showed on average a higher frequency of social interaction (37.46) as compared to boys (23.24).

Group statistics. Next we summarized statistics per gameplay group to be able to make a comparison on a group-level (see Table 3). A total of 8 groups of children played our game. Average ages per group varied from 8.67 to 11.50. All groups consisted of at least 25% boys up to 100%. There were no groups in which all participants were girls. The average frequency of social interactions per player per group varied between 4 and 57. Only one group included a participant that had a chronic illness. Average EAQ scores varied between groups from 2.03 to 2.43.

Two groups included at least two players that participated in gameplay from one device; operating as 'single entity' in the game. Interference from parents indicates that parents either intervened in gameplay (e.g., their children got stuck playing or they corrected their children's behavior), or participated in gameplay (in these cases, parents played along with their children from one device). Mild interference indicates that there were few moments during gameplay that parents intervened or participated in gameplay with their child, but mostly did not intervene. Strong interference indicates that parents intervened or participated in gameplay for the majority of the gameplay. This appeared in groups 6, 7, and 8. Mild interference only occurred in group 4. Finally, no interference from parents was seen in groups 1, 2, 3, and 5. In groups 6 and 7 none of the participants knew each other before the event. In groups 1, 4, 5, and 8 a pair of siblings participated in our gameplay session. Group 3 contained 2 pairs of siblings participating, however both pairs played from a single device. Finally, all participants in group 2 knew each other (either siblings or friends).

Player Roles. We also investigated the average frequency of social interactions per player role (i.e., decider, driver, or collector). The results are presented in Table 4. Players who had the decider role had an average social interaction frequency of 41.25 in a single gameplay session. Drivers showed an average frequency of 15. Collectors showed an average frequency of 38 per gameplay session. EAQ scores for the various roles were similar.

Linear Regression Analyses. In a final step, we plotted the linear regression of the participants' EAQ scores and their frequency of social interaction, to analyse if there is a visible trend between emotional awareness and social interactions (see Figure 5, left). The results revealed a slight positive trend. We repeated this step for each of the EAQ sub-scales to investigate potential trends within the various domains of emotional awareness (see Figure 5, right). The *attending to other's emotions* and *analysis of (own) emotions* sub-scales revealed stronger positive trends. The *verbal sharing of emotions* sub-scale revealed a slight negative trend. No visible trends were discovered for the other sub-scales. All regressions show a relatively low R^2 values, which may be indicative of variance within the dataset.

6 DISCUSSION

6.1 Socioemotional Skills

One of the goals of the present study was to gain more insight on the effect that player roles might have on players' in-game social interactions in game Ruby's Mission. We first discuss the effect that socioemotional skills might have on a player's social interaction on an *individual* level. While our population was not large enough to make claims on statistical significance, we can observe a *slight* positive trend in the linear regression analysis for total EAQ scores. Although the trend is only small, this outcome suggests that higher emotional awareness scores are correlated with slightly more social interactions.

To investigate further, we performed linear regression analyses for each of the sub-scales as well. The "attending to other's emotions" (AOTH) and "analysis of (own) emotions" (AOWN) sub-scales showed greater positive correlations with the frequency of social interactions; suggesting that greater scores on these sub-scales display more social interactions. The "verbal sharing of emotions" (ATALK) sub-scale showed a somewhat greater negative trend; suggesting that children who can more easily express their emotions verbally, are more likely to display fewer social interactions.

We also analysed the effect of socioemotional skills on player's social interactions on a per group level. Ruby's Mission is designed as a four-player online multiplayer video game. Since the game is played by four children, it could be that the social interactions are affected by the group's emotional awareness levels rather than the individual's social awareness. Although we cannot draw any conclusions of statistical significance, Table 3 suggests no visible interaction between the two. Similar to our hypothesis, frequency of social interaction does not communicate any information on the contents of the participants' conversations. Therefore, there might be a correlation that is not revealed by the current results.

6.2 Player Roles

The second aim of the present study was to investigate if player roles have an effect on players' in-game social interactions. As mentioned in the previous section, our population is too small to make any claims of statistical significance. However, from Table 4 we can observe that participants who were given the *driver* role, said more than twice as little as the decider and collector roles (15, 41.25, and 38 social interactions on average, respectively). Scores for EAQ were relatively similar, therefore it is not expected that emotional awareness had a great impact on the social interactions. The results suggest that people in the driver roles are encouraged less to interact with their peers.

The gameplay of Ruby's Mission could be divided into two parts: (1) driving through the city, and (2) solving mini-games. Both parts require different efforts from the various player roles. While players are driving through the city, the driver is responsible for moving towards the next point of interest on the map (i.e. the next mini-game). All information is available to this player via the mini-map on screen. Therefore, the driver is not required to communicate with their teammates. The collectors on the other hand are tasked with collecting graffiti tags that are scattered throughout the city during this phase. During gameplay we noticed that they were often instructing the driver to stop, or to move in a certain direction to

Table 2: Descriptive statistics of all participants that participated in the Weekend van de Wetenschap event. The values indicate the average value or score per participant. Higher scores for the EAQ scores and sub-scales indicate a greater emotional awareness. The scores range between 1.0 to 3.0.

	Sex	Age	Interaction	EAQ	Std. Dev.	ADIF	ATALK	AHIDE	ABOD	AOTH	AOWN
Boy	20	9.63	23.24	2.14	0.20	2.24	2.10	1.90	2.15	2.23	2.20
Girl	15	10.13	37.46	2.20	0.32	2.24	2.07	2.23	1.99	2.61	2.08
All	35	9.89	28.61	2.15	0.26	2.24	2.09	1.94	2.08	2.40	2.15

Table 3: Statistics per group. Consent for video and audio collections for one of the participants was missing for group 4. Therefore, the social interaction frequencies for this group is based on 3 participants. *Share laptop* indicates that at least 2 children were playing the game from the same laptop. *Interference from parents* was classified into three categories: (1) no interference indicates that parents did not participate in or interfered with gameplay; (2) mild interference indicates few moments that parents participated in or interfered with gameplay; (3) strong interference indicates that parents participated in or interfered with gameplay for almost the entire duration of the gameplay session. *Relations* indicates if participants in a group knew each other before the experiments.

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Chron. Ill	No	No	No	No	Yes	No	No	No
% Boy	25%	25%	25%	100%	50%	100%	50%	75%
Age (mean)	9.25	10.00	11.50	8.67	9.67	9.20	10.25	10.25
Interaction (mean)	43	49	57	23	25	13	4	15
Share laptop	No	No	No	Yes	Yes	No	No	No
Inter. parents	None	None	None	Mild	None	Strong	Strong	Strong
Relations	1 Pair	All	2 Pairs	1 Pair	2 Pairs	No	No	1 Pair
ADIF	2.07	2.71	2.11	2.21	1.94	2.31	2.62	2.21
ATALK	2.00	2.42	1.75	2.08	2.00	2.13	2.44	2.00
AHIDE	2.10	2.65	1.75	2.15	2.09	1.60	2.07	2.00
ABOD	2.45	2.35	1.85	2.05	1.65	2.16	2.07	2.35
AOTH	2.55	2.47	2.75	2.40	2.37	2.20	2.20	2.25
AOWN	2.50	1.95	2.05	2.40	2.14	2.16	1.87	2.05
EAQ	2.28	2.43	2.04	2.22	2.03	2.09	2.21	2.14

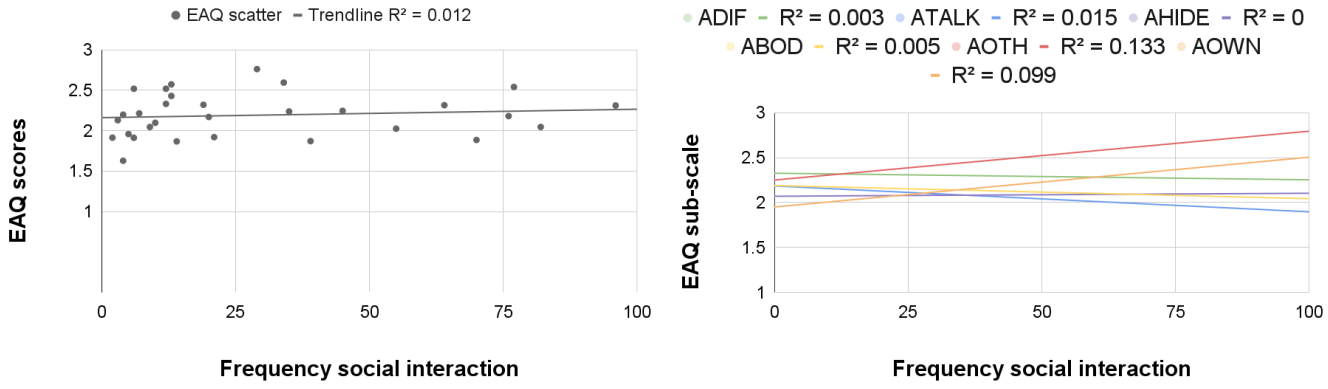

Figure 5: *Left*: Linear regression for participants' EAQ scores against frequency of social interaction in game. *Right*: Trendlines for participant's EAQ sub-scale scores against frequency of social interaction in game. Data points have been omitted for clarity.

Table 4: Mean interaction, mean EAQ scores, and EAQ scores standard deviations per player role in a gameplay session.

Role	Interaction	EAQ	EAQ Std. Dev.
Decider	41.25	2.19	0.19
Driver	15	2.08	0.41
Collector	38	2.31	0.26

collect another graffiti tag. It was also noted that driving is initially a cognitive demanding task for many players, as the mechanic is often considered difficult to learn. During the gameplay sessions we saw that collectors often gave commands to the driver, while the driver was doing their best to follow these up without responding verbally.

The mini-games often require group decisions to be made and communicated to the game system. We observed that the deciders often acted as a game master during these mini-games. They were asking the other players what they should answer as a group. Meaning that in this phase, the decider is encouraged to actively interact with his teammates. The driver is apparently not stimulated to interact socially with their peers as the other roles are. In addition, the driver role appears to be most cognitively demanding during the driving phase of the game, which could make it more difficult to engage in interaction with the other players.

Similar to what was discussed in the previous section, we do not have any information on the contents of the social interactions. It could be that the number of social interactions related to the children's emotions and to the mini-games were similar, while other children interacted more on in-game mechanics and other topics as well.

6.3 Role of the Parents

An interesting observation was the effect that parents could have on their children's gameplay. Children attended the WoS with their parents. Since it was an event that was meant to introduce children to science it is only reasonable that the parents are also interested in the activities. This meant that for some groups, the parents would co-play with their children from one device. Table 3 shows that participants in groups 6, 7, and 8 interacted much less with the other players as compared to the other groups. On average the frequency of social interaction with the players in groups 6, 7, and 8 was 10.58 (std. dev. 5.63). The other groups that had no (or little) interference from parents had an average frequency of social interaction per player of 39.23 (std. dev. 14.97). The results show that interference from parents could have a negative effect on their children's social interactions with their peers in gameplay. Similar observations were made during play tests during the iterative development of Ruby's Mission [3].

6.4 Play Environment

Ruby's Mission is originally designed to create a safe and forgiving play environment in which children could practice their socioemotional skills. One consideration that was integrated in the design of Ruby's Mission is that the game is designed to be played with trusted peers (e.g., friends, family, classmates), because emotional experiences might be personal and intimate. The results in Table 3 show that groups 1 to 5 display more social interaction than groups 6 to 8. In the previous section we discussed that parents participated actively with these groups in gameplay, which could have negatively affected the social interactions of these groups. However, we can also see that in groups 1 to 5 there was at least 1 pair of children that already knew each other beforehand. This could have made a great difference, since these participants likely had a more trusted relationship with each other. In group 8 there was also one pair of children that knew each other beforehand. However, it could be that the negative effects from parent interference weigh heavier than the positive effects of trusted relationships between peers.

Previous studies tested Ruby's Mission in a gameplay environment that could be considered more safe. In preliminary gameplay tests during the iterative development process, the game was tested with trusted peers in an online setting. A master thesis on narrative in applied video games (unpublished) also performed gameplay tests with two classes from different schools in an offline setting (in one of the school's classrooms). In these gameplay sessions, four children from the same class would play together. During these experiments we observed on average more interaction per gameplay session than in the present study[4]. We expect that a trusted relationship between players is crucial for the social experience of players.

Another important decision that was made is to play Ruby's Mission in an online setting. The game was originally designed to be played in an online setting because it allowed children to play from a physical location that they perceived as safe, and because it alleviates practical issues such as physical distance, lack of time, inaccessibility of buildings, etc. In the present study, the game was played in an offline setting: each participant played from the same physical location using their own devices. We observed that participants would alter their social interactions because of the offline play location. For example, they would point on each other's screens to indicate where they should navigate or click. Sometimes a participant would even walk to another participant that was the driver to navigate to the correct location. In an online setting, the players are forced to communicate verbally to help each other or to explain where they would like to navigate to. Although one could argue that these interactions are not necessarily related to social-emotional skills, but rather to teamwork; it does change the communication from verbal to more physical. In turn, this could affect the learning objectives.

Finally, during the experiments we had few groups where two children would play from one device, acting as a single player in the game (two children playing from one laptop, fulfilling a single player role). We noticed that these participants often isolated themselves from the other participants by interacting mainly with each other. The group decisions in the mini-games were mainly the moments that these players were encouraged to interact with the others. Groups 4 and 5 included at least two participants playing from a single device. We can see that groups 4 and 5 interacted on average less (mean 23.57, std. dev. 18.56) than groups 1, 2, and 3 (mean 49,58, std. dev. 31.57). We can see that participants in group

[4]Results from these experiments were not annotated on social interaction. The researchers involved in both studies observed that there was more social interaction between participants during these experiments.

1, 2, and 3 interacted on average more than twice as much than participants in group 4, and 5. One may argue that groups 4, and 5 interacted on average more than twice as much as groups 6, 7, and 8 (mean 10.58, std. dev. 9.96) where one person was playing from a single device. We believe that the interference from players had a greater negative effect on the observed social interactions in these groups, than the isolated groups that originate from two children playing from a single device. We expect that the creation of these isolated groups is uncommon in an online setting, as participants are not physically near one another.

6.5 Limitations

An important limitation of the present study is that we only annotated the frequency of verbal communication to investigate the participants' social interactions. As discussed previously, frequency of verbal communication holds no information on the contents of the social interaction, or on the type of social interaction (e.g., questions, answers, commands). We expect that learning gain is achieved via social interactions on emotions and personal experiences. Therefore, we are currently unable to investigate what and how players actually interact.

Another important limitation was the setting in which the experiments were conducted. We were guests on the WoS event, so our primary goal was to organize a fun workshop for the participating children. Therefore, we could not stay as close to the intended game and experiment design. The game is designed to be played in a safe play environment with trusted peers. However the game was played in a classroom at Utrecht University, and most attending children came alone (with their parents) or with a sibling. Usually we would instruct parents not to interfere with or participate in gameplay with their children. However, we did not want to separate parents from their children as they were attending a public event together. Although the experiment design differed from the intended design, it did lead to interesting insights.

7 CONCLUSIONS AND FUTURE WORK

The present study was a pilot study set out to investigate players' in-game social interactions in relation to the learning objectives in the applied game Ruby's Mission. In the current paper we contribute insights in how asymmetrical player roles affect social interactions in a multiplayer gaming intervention, and if socioemotional skills affect the social interactions in a multiplayer gaming intervention.The results suggest that the asymmetrical player roles in Ruby's Mission encourage different levels of social interaction. Varying responsibilities, or difference in cognitive strain could explain these differences in social interaction.

We only found a *slightly* positive trend between emotional awareness scores and frequency of social interactions on a per-person level. A greater positive interaction was found for the sub-scales "analysis of (own) emotions" and "attending to other's emotions", implying that children who score higher on these skills are likely to display more social interactions. A slight negative interaction was found for the "verbal sharing of emotions" sub-scale, indicating that children who can more easily express their emotions are more likely to display fewer social interactions. The results showed no visible interaction between group emotional awareness scores and social interactions. Other factors such as player personalities (e.g., extroversion vs. introversion), or parent interference may have a larger on effect on social interactions than emotional awareness scores.

External factors such as parent interference, player relations, or the physical play location might also have an effect on in-game social interactions. Strong player interference was found to negatively affect social interactions. Playing from the same physical location might also have an effect on player's social interactions. Finally, it appears that trusted peer relations are important to social interactions between players.

In future studies we will extend the analyses on social interactions to contain more information on the contents of the interaction. Including information on type of interactions, direction of interaction (e.g., player 1 to player 2), and topic (e.g., emotions, gameplay) provide more insight in the social interactions in relation to the learning objectives.

We are also going to investigate the effect that the various phases (i.e. mini-games, and collecting/driving phase) in the game have on the social interactions of the players. Currently, we investigated the social interactions over the span of the entire game. The mini-games all have been designed differently to encourage social interactions. Investigating the effects of these specific phases individually may provide us with more insights in the actual mechanics that encourage social interactions.

Another important aspect for future work is to consider the play setting in which the game is tested. In future experiments we are going to test Ruby's Mission either in a school setting or in an online setting from home. Although the game was designed to be played from home in an online setting with trusted peers, testing in a school setting also has its merits. It ensures no interference from parents, and classrooms are typically considered a safe space for students. Testing in a school setting also increase the chances that peers already have a trusted relationship.

Finally, an interesting direction to explore is to investigate if chronically ill children differ in their in-game social interactions from the general population. Our hypothesis is that chronically ill children only slightly differ in their socioemotional skills from the general population due to fewer opportunities to practice these skills [3]. It would be interesting to compare the chronically ill children to a group of which it is known that they have lower socioemotional skills in general (such as children with autism spectrum disorder).

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