The Draining Nature of Pinball: How different multiplayer playstyles affect demand.

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ABSTRACT

This study investigates the impact of various multiplayer modes on the demand experienced by a player while playing pinball. The multiplayer modes explored in this research are: playing alone, playing with one spectator, cooperative play where both players use one flipper, parallel play and turn taking. It also takes other potential influential factors into consideration like competitiveness, anxiety, familiarity with the other player and experience. A within-subjects experiment was conducted in which a participant played pinball alone and in one of the four multiplayer modes. Participants (N=41) were divided over the four multiplayer modes and rated their experienced demand on the Video Game Demand Scale. The analysis of the results showed that there was no significant difference in demand between any of the multiplayer modes and playing alone. The other potential factors were also shown to not significantly influence demand. The article concludes that a larger participant pool is needed for a more generalizable conclusion, but as for this preliminary research it concludes that demand does not seem to be impacted by multiplayer modes or the other mentioned factors.

KEYWORDS

Video Game Demand, Pinball, Video games, Multiplayer, Social play, Parallel play, Competitiveness

1 INTRODUCTION

Recently pinball has made a resurgence in popularity [52][1]. Pinball is a hybrid digital and physical game that involves one or more balls inside a machine, propelled through two (or more) player-controlled flippers, which can be aimed to hit different ramps, bumpers, toys, and targets. Players can play alone, play while being watched, take turns, play next to each other on nearby machines or even with two people both controlling one flipper. The goal of most, if not all, pinball machines is scoring as many points as possible until the ball is outside the play area. Machines are themed, generally involve a loose narrative, and require strategic play combined with physical skill to generate high scores.

Playing pinball can be draining, both mentally and physiologically. The lights, the sounds, the haptic feedback, the pinball that keeps on coming. It can take a lot for a person to keep focus and continue to react in the right way on the right moment. But what if a social component is added into this mix? While pinball does not seem as the most social game to play, the paper *"Shoulder-to-Shoulder: How Pinball Supports Men's Wellbeing"* concluded that pinball was a helpful tool for men to socialize with each other [38]. Other papers have found that spectators have both positive impact on a player [40] as negative impact [42].

As such, this thesis will try to find a connection between playing pinball together and the effect on how draining this is for players. Consequently, the problem statement reads as follows: *Do various ways of presence of others through different pinball multiplayer modes have an effect on the demand generated from playing pinball?*

Which will be investigated through the following research questions:

- RQ1: To what extend does playing pinball with one spectator affect the video game demand a player experiences?
- RQ2: To what extend does playing pinball while taking turns affect the video game demand a player experiences?
- RQ3: To what extend does playing pinball while playing in parallel affect the video game demand a player experiences?
- RQ4: To what extend does playing pinball while playing cooperatively affect the video game demand a player experiences?
- RQ5: To what extend does anxiety affect demand in various playstyles?
- RQ6: To what extend does competitiveness affect demand in various playstyles?
- RQ7: To what extend does game experience affect demand while playing alone?
- RQ8: To what extend does pinball experience affect demand while playing alone?
- RQ9: To what extend does familiarity with the other player affect the video game demand a player experiences?

2 LITERATURE REVIEW

In this literature review the concept of demand and it's multiple definitions in HCI will be outlined. Afterwards the multiple ways of playing together with two people will be discussed, including playing a game with a spectator, taking turns, cooperatively and parallel. Lastly other potential concepts that could impact demand will be analyzed.

2.1 System demand

Systems and applications always demand a certain amount of our attention. They are in a continuous battle to engage the user while trying not to overstimulate them. This concept of using a person's attentional recourses is one of the main topics in the study of Human Computer Interaction, but a standardized form of what this concept is named, what it exactly is and how to measure it is harder to find.

2.1.1 Cognitive Load Theory. Some researchers refer to the attention needed by a system and its demanding nature as cognitive load. This definition is most of the times derived from the Cognitive

Load Theory (CLT), a theory created on the basis of educational psychology. CLT is based in this field because it attempts to explain psychological or behavioral phenomena resulting from instruction [53]. The cognitive load construct specifically takes into consideration the demands that a certain task imposes on an individual [53]. The central problem identified by Cognitive Load Theory (CLT) is that learning is impaired when the total amount of processing requirements exceeds the limited capacity of human working memory [53]. By using knowledge of the relations between working memory and long-term memory, CLT has been able to generate instructional procedures [53].

The theory divides Cognitive Load into three types of load: extraneous load, intrinsic load and germanous load [53]. Some information imposes a heavy cognitive load on the user because of its intrinsic nature. That load is referred to as intrinsic cognitive load. It can only be changed by changing what is learned or by changing the knowledge levels of learners. Other information imposes a heavy cognitive load because of the way it is presented, that load is referred to as extraneous cognitive load [53]. Germane load was a later addition to the CLT. The distinctive characteristic of germane cognitive load is that, unlike the other two types of load, it has a positive relationship with learning. This happens because germanous load is the result of devoting cognitive resources to schema acquisition and automation rather than to other mental activities [53].

Cognitive load research has produced several methods and approaches to measure cognitive load, yet there is neither a single standardized method for cognitive load measurement nor a common measurement paradigm [53]. Subjective measures like participants rating their perceived mental effort or their perceived task difficulty on subjective self-reported rating scales are most common [47]. Paas also mentions the use of learning outcomes or the task complexity as a method to measure the cognitive load in an instructional product [53].

More objective measures have also been shown to have the ability to measure cognitive load. Most of these are based on physiological responses, for example eye-tracking and pupillary responses [72], changes in heart rate [69][17], galvanic skin reactions [63][55]. It's even been measured by looking at brain activity through electroencephalography [4][44] and fMRI [73][51].

2.1.2 Mental Workload. As it has been established, within the field of human-computer interaction many authors who are interested in understanding the demands placed upon users of interactive systems have adopted the term cognitive load [75][35]. While this term is one that suggests that it considers the cognitive aspects of a work task, much of the original theory on which it is based is focused on laboratory-based problem-solving tasks and instructional methods. It very much takes a working memory-driven cognitive psychology approach to the issue of load [13][58]. Human factors researchers are inevitably working with real-world tasks or jobs where expertise, memory, attention, situation awareness and social and organisational factors that all come together to contribute to the individual's experience of workload, thus a concept is needed that reflects this real-world complexity.

This need resulted in the term Mental Workload (MLW). Multiple definitions have been proposed for MLW. Nevertheless, current definitions of workload all fail to stand the test of widespread acceptance or quantitative validation [75]. Young and Stanton propose a definition of MWL as representing 'the level of attentional resources required to meet both objective and subjective performance criteria, which may be mediated by task demands, external support and past experience' [76]. Wickens takes another route and notes the key characteristic of workload as 'the demand imposed by tasks on the human's limited resources, whether considered single or multiple' [74]. Sharples and Wilson suggest that noting what exactly is tested when measuring Mental Workload is more important than finding an exact definition of mental workload [75]. According to them the following three concepts are most important when measuring MWL:

- The physical and cognitive task demands: these reflect the characteristics of the task or tasks performed by a person and thus the demand imposed upon that person.
- Operator workload: this concept is conceived in terms of the operator performing the task and is equivalent to measures of operator strain or effort.
- Performance: most frequently described in terms of speed and errors.

Surprisingly enough, or maybe not surprising as the concepts of CLT and MWL seem to overlap in many studies, most of the physiological or psychophysiological methods used to measure cognitive load have also been shown to measure MLW [14]. This includes but is not limited to pupillary response [62][37] and heart rate [21].

The main difference mostly lies in the subjective measurements used in MWL, such as the widespread use of NASA-TLX rating scale. Some researchers have even used the NASA-TLX to measure cognitive load. While this scale is a great tool, it does not in fact measure cognitive load [35]. More subjective scales made to measure MWL include SWAT, Cooper–Harper and the Air Force Flight Test Center [75].

2.2 Video Game Demand

Mental workload is more in line with measuring demand for general usage in human computer interaction cases and cognitive load measures how demanding teaching material is. However, they both do not measure the demand that is specifically created by games. While games do tend to fall under HCI, not all theories that fit HCI will fit the very particular experience of playing a game. Bowman set out to create a theory that fits the demanding nature of games better. In his book: *'Video Games; A medium that demands our attention'* he used the work of various researchers to prove that playing games require various cognitive skills [8]. And while his concept of cognitive demand can tell us a lot about how taxing a game is, Bowman also incorporated three other concepts he found impacted the player, namely: emotional demand, physical demand and social demand. These concepts collectively form Bowman's theory on Video Game Demand and have served as the foundation for developing the Video Game Demand Scale (VGDS).

2.2.1 Cognitive Demand. Studies showing correlations between gaming and cognitive ability suggest, by proxy, that gaming is cognitively demanding. One reason for this is the multiple different cognitive abilities required to play a video game [45]. For example, one

study found that abilities like eye-hand coordination and mental rotational ability served as strong predictors for in-game performance [10]. Nacke, Stellmach and Linley used electroencephalogram data to demonstrate increased brain activity in games where complex level design was implemented [54]. It is even suggested that there is a correlation between increased video gameplay and the ability to attend to and multitask among various visual stimuli [30].

Besides these articles where the presence of cognitive demand in gaming is investigated, Bowman also builds upon theories of other researchers to define cognitive demand as follows: *the extent to which the user is required to implicitly or explicitly rationalize or understand the game.* Cognitive demand is conceptualized as the consumption of attentional and cognitive resources. In simplest terms, cognitive demand refers to how much (or how little) the video game made one think [8].

One of these researchers was, Gee, argues that video games by their nature are learning experiences. Players are required to constantly learn and adapt as they play, and this learning often happens implicitly as players progress through a game [27]. The specific focus on "rationalizing" is derived from Boyan and Banks, who explain that a prerequisite to any player's success in a digital world is that they must construct durable-yet-pliable mental models of the systems themselves [11]. It is interesting how this theory seems to also use concepts that were important to cognitive load theory, but link it specifically to games.

2.2.2 Emotional Demand. Emotional demand is defined as: *the extent to which a video game causes the user to have an affective response to the game.* At the most basic level, emotional demand refers to how much (or how little) the video game made one feel [8]. Regardless of valence, more emotionally arousing experiences can be understood as more emotionally demanding ones. These emotions experienced in games are not simply limited to pleasure, or frustration, but extend the range of human emotional experiences, including being moved, touched, amused [57], and even guilt over virtual misdeeds [31].

Oliver et al. investigated the effect of enjoyable video game play experiences compared to meaningful video game experiences. Enjoyable video game play experiences lead to positive affect (amused, happy, humored, positive). While meaningful video game experiences also evoke these emotions, a more mixed affect was also discovered (touched, moved, compassionate, inspired) and even a negative affect (angry, anxious, tense, negative) [57].

2.2.3 Physical Demand. Yet another source of demand that games place on their players is related to the physical input put into a game via controller, which can be conceptualized as: *the extent to which a system requires the user to exert discrete or holistic physical effort.* While physical demand is present in some, if not all, human computer interactions, in gaming it is one of the most important factors. The player might well have solved the cognitive demand posed by the system and acclimated themselves to the emotional demand of the task but they would still be unsuccessful if they're unable to handle the controls of the game.

Physical demand is often in other contexts measured as whole-body exertion [23], which is critically important to more unrestricted gaming experiences like Wii games and VR games that use the players entire body movement as input. Besides these big movements, physical demand in video games can also involve fine-motor skills that are more aligned with handheld and/or button-based gaming inputs (e.g. controllers and keyboards). As players play with these controllers they begin to form mental models of the relationships between the controller functions and the on-screen actions. It is the strength of these mental models that reduces the physical demands of the system. The most obvious example of these mental models are computer users who have learned to type with the QWERTY key layout with great speed and precision [56].

More "naturally mapped" controllers, a type of controllers that tries to closely mimic the simulated physical equivalent of the game actions, are hypothesized to reduce physical demand by allowing players to apply their pre-existing mental models to gameplay [9][65]. While studies do find that naturally mapped controllers improve presence and engagement [18][50], they also paradoxically find that players would rather use a 'normal' controller which they are more familiar with [3]. Bowman together with Liebold and Pietschmann conclude in their more recent paper *Natural in the eyes of the (be)holder: A survey on novelty and learning effects in the enjoyment of naturally mapped video game controllers* that 'natural' does not only depend on technological features of a user interface, but also on the user's previous experiences with a device [49].

2.2.4 Social Demand. An explication of social demand is: *the extent to which a video game triggers an implicit or explicit response in the player to the presence of other social actors.* Even if players are not directly engaging each other, the presence of others exerts social pressure on the player [8]. It can be either indirectly, through a social facilitation effect in which the presence of others is a source of arousal that transfers to gaming performance [10]. It can also be directly by way of the social interactions of tandem play, when several people engage a single-player game together, that can compel players to make in-game decisions aimed at maintaining the social interaction rather than accomplishing in-game goals [16].

2.3 The infuence of social play-styles on game experiences

As a single player game pinball might not seem like a socially demanding game, while at first glance this seems to be true, Johnson et al. found in their paper *'Shoulder-to-Shoulder: How Pinball Supports Men's Wellbeing'* that playing pinball together can result in strong social connectedness between male players [38]. While this would probably not occur if someone would be playing all alone, there are multiple ways in which it would be possible. The multiplayer possibilities on a pinball machine are playing with a spectator, turn-taking, playing parallel to each other and cooperatively with both players operating one flipper.

2.3.1 Spectators. Pinball could be found in all kinds of places before entire arcades or arcade machines even existed. It used to be placed in bars and other locations. Pinball is an interesting machine to watch as it easily shares the successes and failures of the players visually and sonically with onlookers. Not everyone has the funds to have a pinball machine at home, most players will therefore have to play in shared spaces with potential audiences. It is interesting to see what kind of effect these spectators could have on a player.

Early Social facilitation theory stated that social presence has impact on an individual performance. Subsequent research has found the relationship between social presence and individual performance to be complicated. Task complexity, evaluation context, and type of presence are some of the factors that researchers have demonstrated moderate the impact of presence on performance. The theory now not only hypothesizes that presence leads to performance enhancements, but also causes impairments [2].

One study found that both negative and positive audience activity drove players to become more engaged in the video game. In contrast, silent audiences made players feel unnerved and less engaged in gameplay [40]. Kao took a different approach and investigated if the relationship between a player and spectator had any impact on their experience. He found that a player who was observer by a researcher would play longer and perform better than a player who had no spectators. They would also score higher on player experience and intrinsic motivation. But when this spectator was changed to a professor participants were observed to, at times, have significantly lower performance, player experience, intrinsic motivation, playing time and higher anxiety [39].

Taking game complexity into account, Kimble and Rezabek found that when playing a 'simple game', such as pinball, the good players frequently performed worse while poor players performed better under audience pressure. However, when playing a 'complex game' such as Tetris, all participants played worse regardless of skill level [42]. In addition to positing the presence of a 'social choking' effect in such situations, Kimble and Rezabek suggested that good players tend to be more self-conscious and self-evaluative, that self-attention is an interfering factor during play, and that good players are therefore more likely to underachieve in the presence of audiences. Consequently, we formulated the following research question:

Research Question 1: To what extend does playing pinball with one spectator affect the video game demand a player experiences?

Null hypothesis (H_0): Playing with one spectator has no affect on the video game demand experienced by a player.

Alternative hypothesis (H_1): Playing with one spectator will increase the video game demand experienced by a player.

2.3.2 Turn Taking. Turn taking creates a similar situation where a player has one spectator. But turn taking has also been shown to have effects on the players. Spectators were found to perceive gaming as more enjoyable after being told that they would get a turn themselves. This increased enjoyment even persisted through multiple rounds in which they weren't the one playing the game. Their engagement in the game followed a similar pattern. This suggests that an audience member who knows they are going to play the game are more engaged in the game and get more enjoyment out of the entire experience [24]. As a result, the following research question was defined:

Research Question 2: To what extend does playing pinball while taking turns affect the video game demand a player experiences?

Null hypothesis (H_0): Playing while taking turns has no affect on the video game demand experienced by a player.

Alternative hypothesis (H_1): Playing while taking turns will increase the video game demand experienced by a player.

2.3.3 Parallel-play. After the release of Space Invaders the demand for the game was so strong that it birthed the traditional game arcade, where a bank of the same video game machine were arranged next to each other to support multiple players [28]. The experience is clearly synonymous with psychology's parallel play [28]. Parallel play is a form of play observed in young children, typically between the ages of 2 and 3, where they play alongside each other without interacting directly. Instead of engaging in cooperative play, children engage in independent activities near each other, occasionally mirroring each other's actions or sharing toys without direct interaction or cooperation. Even though this form of play naturally occurs within arcades, it is not widely studied what kind of effects this playstyle has on teenager or adults.

What's interesting about parallel play is that it has a two-way influence between independent activity and social activity [34]. Simon attests to this as he suggests that people who are doing their own thing next to a player are still important in constituting the fun or absence of fun during a gaming experience [64]. Even when players are not directly engaging socially with others, their co-presence provides both an audience and ambient social backdrop to gameplay [25]. It can therefore be reasoned that parallel play can cause a sense of the presence of an audience within a player, even though the player next to them might not have taken notice of them at all.

While the effects of parallel play is not researched a lot, one study did set up an experiment where kids between the ages of nine and twelve were tasked to solve puzzles. They either did this alone, together with a child of the same gender or parallel to a child of the same gender. The expected results of the study was the notion that the kids would perform better if they played together. While this hypothesized result was indeed true, a more peculiar observation was made, the young boys performed better when playing in parallel instead of alone while the girls performed worse when they played in parallel compared to playing solo [36]. As this was an unexpected result the article did not include an explanation of why this occurred. This led to the formulation of the following research question:

Research Question 3: To what extend does playing pinball while playing in parallel affect the video game demand a player experiences?

Null hypothesis (H_0): Playing in parallel has no affect on the video game demand experienced by a player.

Alternative hypothesis (H_1): Playing in parallel will increase the video game demand experienced by a player.

2.3.4 Cooperation. Cooperation is a subject studied in multiple online settings, but is less researched in offline spaces. A study that compared people playing an exergame alone, cooperatively with another person and parallel with a competitor in separate rooms found that parallel competition in separate physical spaces was the optimal play mode, since it resulted in both high enjoyment and future play motivation and high physical intensity. The results also showed that playing with another person was more enjoyable and more motivating than play alone in the exergaming context.

However, they did not form any conclusions from this research, as they had trouble with finding a game that fit all their requirements and as they experienced a literature gap regarding physical space and video game play, particularly with regard to multiplayer modes [60]. It would therefore be interesting to add to this research gap and see if cooperatively playing pinball influences cognitive demand, which leads to the following research question:

Research Question 4: To what extend does playing pinball while playing cooperatively affect the video game demand a player experiences?

Null hypothesis (H_0): Playing cooperatively has no affect on the video game demand experienced by a player.

Alternative hypothesis (H_1): Playing cooperatively has an affect on the video game demand experienced by a player.

2.4 Other possible influential factors

Many unknown factors could influence the performance of a player. This study will therefore focus on a few extra possible factors that could be related to cognitve demand: anxiety, competitiveness, game and pinball experience and familiarity to the other player.

2.4.1 Anxiety. As it has been described in both the section about social demand and the parts where the role of spectators was discussed, the presence of other people can have an impact on the player. A player who deals with anxiety might be more effected by spectators or the social setting.

Attentional control theory (ACT) is an approach to anxiety and cognition. In this theory anxiety is defined as '*An aversive emotional and motivational state occurring in threatening circumstances*. ACT states that anxiety is associated with processing inefficiency. Adverse effects of anxiety on processing efficiency depend on two central functions involving attentional control: inhibition and shifting. Inhibition involves using attentional control to resist disruption or interference from task-irrelevant stimuli or responses. Shifting refers to the adaptive changes in attentional control based on task demands [26]. Simply said, someone who experiences anxiety may have more problems keeping focused on their main task and have a harder time adapting while going back and forth between multiple tasks. However, anxiety may not impair the quality of the performance when it leads to the use of compensatory strategies. Someone with anxiety could compensate for their inefficiency by enhancing their effort or increase their use of processing recourses [7]. Anxiety does however influence performance in situations in which it consumes more resources than an individual can recruit for the task at hand [6][29].

From this it can be reasoned that someone who experiences anxiety might use more attentional recourses and thus experience playing pinball as more demanding than someone who does not experience anxiety. Using the antisaccade task, previous studies have found that anxious individuals demonstrate impaired attentional control compared to non-anxious individuals. Derakshan et al. found that anxious individuals showed longer antisaccade latencies than non-anxious individuals [22]. Similar impairments in attentional inhibition efficiency have been observed among socially anxious individuals [48]. This supports the earlier mentioned attentional control theory in that anxious individuals exhibit less efficient attentional inhibition than their non-anxious counterparts. In light of this, the following research question was formulated:

Research Question 5: To what extend does anxiety affect demand in various playstyles?

Null hypothesis (H_0): Anxiety has no affect on the video game demand experienced by a player.

Alternative hypothesis (H_1): Anxiety will increase the video game demand experienced by a player.

2.4.2 Competitiveness. Competitiveness could be a factor why someone would try to perform better. While none of the playstyles are inherently presented as competitive, there could be instances were a person might try to compare themselves with another player or try to compete with themselves to get a higher score then before. A person who is competitive might put more pressure on themselves to perform well while playing a game. This is shown in one study were participants played an exergame (exercise game). They found that competitive participants had higher exercise compared to non-competitive participants while racing against a live competitor [68]. A similar study found significant difference in the performance between competitive and non-competitive participants, as competitive participants performed better [59]. Both these studies found that physical exertion increased in competitive players, they might therefore experience more physical demand. This prompts the following research question:

Research Question 6: To what extend does competitiveness affect demand in various playstyles?

Null hypothesis (H_0): Competitiveness has no affect on the video game demand experienced by a player.

Alternative hypothesis (H_1): Competitiveness will increase the video game demand experienced by a player.

2.4.3 Game Experience. In the section physical demand, it was hypothesized that people who have already created mental models of the controls will experience less demand. But this is not the only advantage more experienced players might gain. Researchers have consistently found that gamers who play action video games and experience extreme demand on their speed of processing have enhanced performance on speed of processing and attentional control tasks compared to non-gamers [5] [15]. This is not limited to only action video games, as players of more hybrid genres like action-rpg's, real-time strategy games and MOBA's (Multiplayer Online Battle Arena) have also been observed having many similar enhancements in speed of processing and cognitive control [20][19][41][46]. This brings up the following research questions:

Research Question 7: To what extend does game experience affect demand while playing alone?

Null hypothesis (H_0): Video game experience has no affect on the video game demand experienced by a player.

Alternative hypothesis (H_1): Video game experience will decrease the video game demand experienced by a player.

Research Question 8: To what extend does pinball experience affect demand while playing alone?

Null hypothesis (H_0): Pinball experience has no affect on the video game demand experienced by a player.

Alternative hypothesis (H_1): Pinball experience will decrease the video game demand experienced by a player.

2.4.4 Familiarity. In the section about spectators the relationship between the player and spectator was discussed. While Kao found a difference in player experience when the spectator was a professor, not a lot of research has been done about whether the familiarity of the spectator and participant with each other has any effect [39]. Therefore the following research question was formulated:

Research Question 9: To what extend does familiarity with the other player affect the video game demand a player experiences?

Null hypothesis (H_0): Familiarity with another player has no affect on the video game demand experienced by a player.

Alternative hypothesis (H_1): Familiarity with another player will has an affect on the video game demand experienced by a player.

3 METHODOLOGY

In this chapter the procedure of the experiment will be discussed. This include the preliminary procedure used in the pilot study and what was learned from this pilot study. It will also include a detailed description of the materials, the contents of the survey used in the experiment and an overview of the participants.

3.1 Pilot study

Prior to the main study's data collection, a pilot study was conducted with seven participants who were selected through convenience sampling. The pilot study was performed to investigate the feasibility of the study and how participants react to playing on a pinball machine. Ideally, the tested gender ratio should be equally divided between male and female, but it skewed heavily towards male. The participants did have a wide range of pinball and game experience between them. This was beneficial, as it resulted in a better understanding of what amount of playtime would be appropriate for the experiment. The procedure for the pilot study was as follows:

(1) A participant receives the Information Sheet, reads through it, and agrees to it.
(2) The participant is asked to fill out the first part of the survey.
(3) The participant is guided to the pinball machine and gets a short introduction to the mechanics.
(4) The participant tries out the pinball machine for about a minute to get comfortable with the controls.
(5) The participant plays pinball together with another participant in a specific multiplayer mode, this will take about 12 minutes.
(6) The participant is asked to answer the second part of the survey.
(7) Both participants take part in a semi-structured interview to review the experience.
(8) The participant has completed the experiment.

One of the interesting things to figure out during the pilot study was determining an adequate amount of time for participants to play on the pinball machine. Multiple options could have sufficed, for example: letting participants play until they run out of a specific number of pinballs, setting a specific amount of time for them to play, or letting them play until they want to quit. During the pilot study participants were informed to remark when they would stop playing normally, a timer was present to measure when this occurred.

Another important part of the procedure which needed calibration was the trial round. It is valuable to know how much time the participant will need to try out the machine before they actually start playing. The participant needs to feel comfortable with playing the pinball game, but they should not start the main experiment already overwhelmed or mentally drained from the trial round.

Lastly the pilot study was meant to iron out any kinks in the procedure. This is were the semi-structured interview comes in. Participants were asked multiple question to find any problems that occurred and to be as critical as possible. This included the following main questions:

- Were you given sufficient time to practise?
- Were the instructions clear?
- Were you comfortable with playing pinball?
- What did you think of the amount of time you got to play pinball?
- What did you think of the survey?
- How did you feel about playing pinball together like this?
- Is there anything else you would like to add about the experiment?
- Did you get distracted by anything in the environment?

3.1.1 Results of the pilot study. After the pilot study multiple tweaks to the survey were done, such as changing a couple of words in the introduction of questions to make them clearer and adding a definition where needed. From the responses to the question "What did you think of the survey" it was concluded that the questionnaire was not too long. For the most part the study ran smoothly.

One of the biggest concerns were the questions asked by the Video Game Demand Scale and the Liebowitz Social Anxiety Scale. Some terms like 'cognitive demand' and 'tugging at the heartstrings' were unclear to the participants, therefore some definitions were included in the survey to ensure every participant understands what the question is asking of them.

When it came to the timing of things like practice time and actual play time it was found that the practise time of not more than two minutes was adequate. The play time limit for participants was found to be around 15 minutes. Which would be around six balls if the couple played in parallel, but around nine balls if they played cooperatively.

Some interesting remarks were made during the semi-structured interview. Players who played in parallel responded to the question: 'How did you feel about playing pinball together like this?' that they did feel competitive and wanted to do better, even though they didn't have the capacity to see how well the other player was playing at all. When asked the question 'What did you think of the amount of time you got to play pinball?', players with more pinball experience responded that they did not feel like they had exerted themselves at all, which corroborates the findings in the literature review. It was also noted that some players were a bit

stressed before they started playing because of factors outside of the experiment. To catch if the affect and feelings a participant has before they started playing impacted the results the Self-Assessment Manikin was included in the survey.

3.2 Procedure

Between the pilot-study and the actual experiment it was decided to make the experiment within-subjects. This changes the earlier mentioned pilot-study procedure to quite an extent. The entire procedure can be seen in Figure 1 and will be discussed in detail below. A short example will also be given at the end of the section.

Before the experiment starts, it will randomly be decided in what order the participants will be doing the experiment. This randomization prevents the effects of earlier play sessions from spilling over onto later ones, as well as a few types of research bias like sampling bias and selection bias. A participant will have two play sessions, one alone and one in a multiplayer mode with another player.

Participants will first receive an information sheet and are allowed to ask any questions. After a participant has given their consent to take part in the study, the two participants will start filling out the first part of the survey, which consists of general questions about the participants, such as age and gender. It also includes the LSAS, the SAM and the IOS, which will be further discussed in the survey section.

Afterwards the participant or participants that are about to play will fill in a section of the survey, including the SAI and how comfortable or fearful they are in this moment. It is necessary they fill this in right before they play to measure their state of mind before it may change because of the play experience.

The participant or participants will then be guided to one of the pinball machines. If it is a participant's first time playing a specific pinball machine in this experiment, they will get a short tutorial and one minute practise time on the machine.

The two participants will either play alone or play one of the multiplayer modes with the other player. Either way they will get 12 minutes to play on the pinball machine.

After the participant(s) are done playing pinball, they will be asked to answer the SAI again. Two laptops will be present so both participants can immediately fill out the survey. The survey is partly a self-report and as such it is important that not much time has passed between the participant playing pinball and answering the second part of the survey. They will then have a break of six minutes to rest from playing pinball. The break is included to negate some of the tiredness that could skew results in within-subjects experiments.

After the break there are two options: the participant will either play in a different mode, alone instead of multiplayer, or has a break while the other player plays alone. Altogether three rounds of pinball will be played by two people. When a participant has played twice they are asked to fill in the last part of the survey, which includes the revised competitiveness scale.

Quick overview of one possible route of the procedure:

(1) A participant receives the Information Sheet, reads through it, and agrees to it.
(2) The participant is asked to fill out the first part of the survey.
(3) The participant waits outside of the room while the other participant plays pinball.
(4) The participant is asked to return and to answer a section of the survey pre-play.
(5) The participant is guided to the pinball machine and gets a short introduction to the mechanics and a tutorial if needed.
(6) The participant plays pinball alone ore together with another participant.
(7) The participant is asked to answer a section of the survey post-play.
(8) The participant has a six minute break
(9) The participant is asked to answer a section of the survey pre-play.
(10) The participant plays pinball alone ore together with another participant, depending on which mode has already been completed.
(11) The participant is asked to answer a section of the survey post-play.
(12) The participant is asked to answer the last part of the survey.
(13) The participant has completed the experiment.

3.3 Materials

The study makes use of two separate pinball machines, see Figure 4. Both machines consist of two 'compartments', the bottom one containing the pinball playing field, the top one containing a small screen showing visuals and keeping track of the score. The machines have the same dimensions.

The left pinball machine is 'Jurassic Park', which was created five years ago. This machine is considered to be one of the best modern pinball machines [61]. It is described as easy to play, but difficult to master, it's playing field can be seen in Figure 2. The player's mission is to rescue park staff and recapture dinosaurs from the chaotic amusement park environment [70]. Because of this the machine was picked as the main pinball machine which will be used by almost all of the participants. Since there is only one of this machine available, another pinball machine was used for one of the participants if they play in the parallel multiplayer mode.

The other is machine is 'The Mandalorian', a pinball game first released three years ago. It is considered a decent modern pinball machine [61], with gameplay that requires relatively high precision, but is also describes as intuitive for beginners who may not be familiar with pinball mechanics. Players are taken on a journey through the galaxy as they team up with allies, battle enemies and protect Grogu [71].

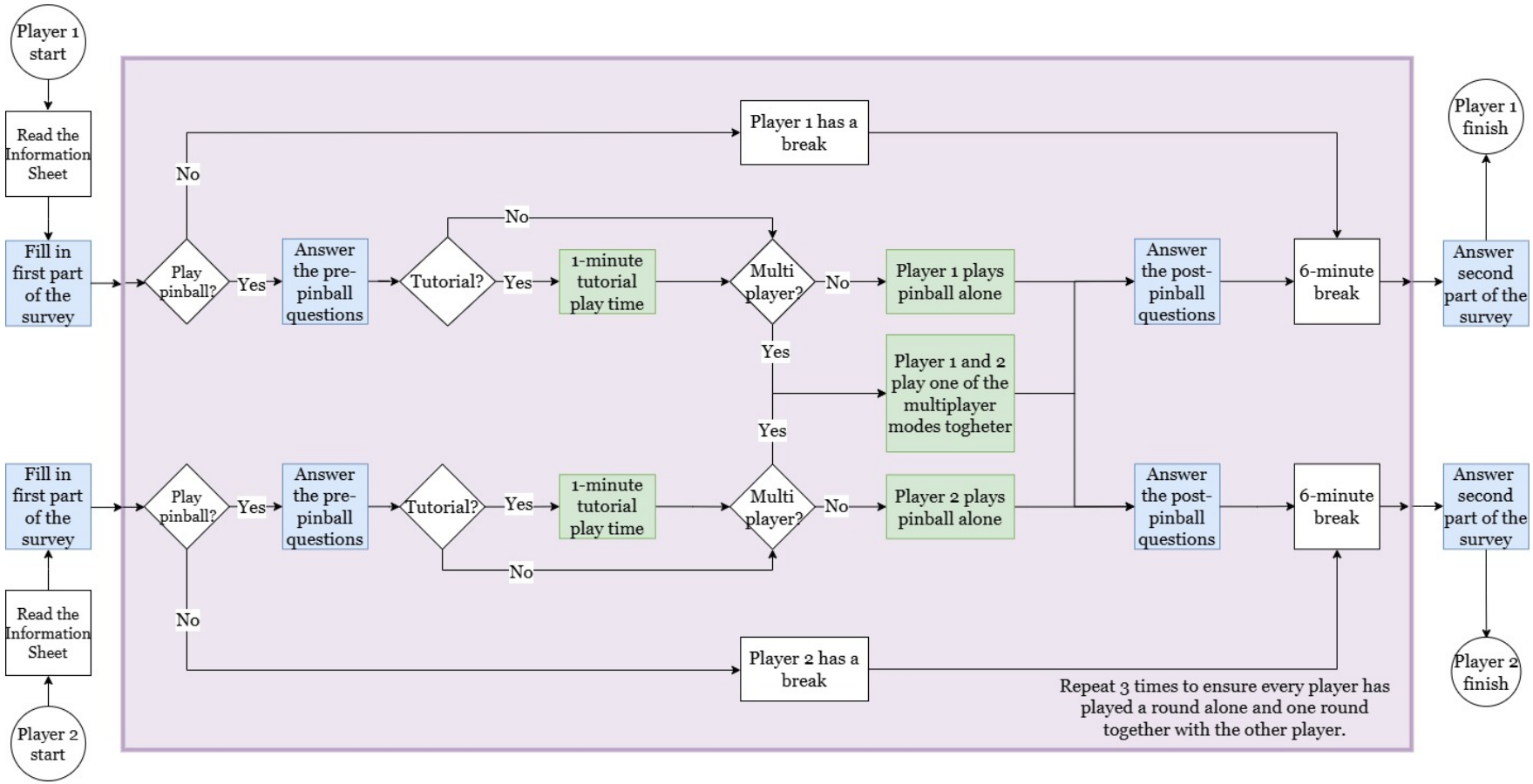

Figure 1: Diagram of the experiment procedure.

Figure 2: Playfield of the Jurassic Park pinball machine.

The experiment was performed inside a building of Utrecht University. The pinball machines where placed close to the entrance of a building to spark the interest of possible participants. They were blocked off from the rest of the hallway by quite thick borders except for an open space to let people see the machines. Figure 2 and 3 show the set-up of the experiment. Once participants were playing the 'entrance' would be blocked off to give the participants privacy, the inside of the room can be seen in Figure 4.

3.4 Participants

The main study used mostly proximity sampling and snowball sampling to gather participants. The experiment was set up next to the entrance of a building to gather attention from possible participants.

The experiment gathered a total of 41 participants consisting of mainly university students ranging from the age of 18 to 30.

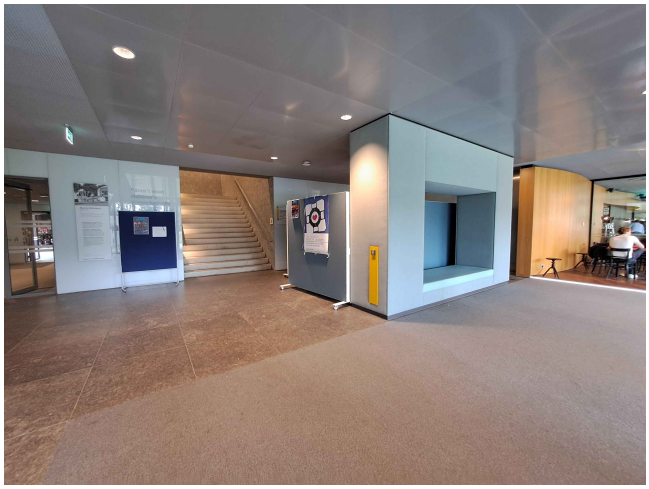

Figure 3: View of the experiment 'room' from the entrance of the building.

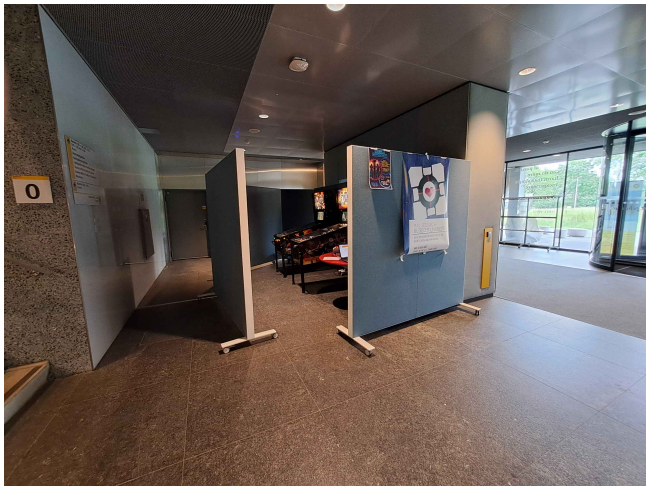

Figure 4: View of the experiment 'room' and the pinball machines within.

Thirty of the participants were male whereas eleven were female. There was a small range of game and pinball experience between the participants. Whereas there was a broad range of participants' relationships with each other, which varied from unknown to very familiar.

3.5 Survey

The survey consists of multiple scales and short questions to try and gather as much information as possible about the factors mentioned in the literature review which might influence the cognitive demand put upon a person when playing pinball. These will all be discussed in detail in the following paragraphs. A quick overview of the survey:

Figure 5: Inside of the experiment room, from left to right: Jurrassic Park, The Mandalorian, the table with two laptops and snacks for the participants.

- The first part of the survey includes general questions like age and gender, but also questions using the IOS scale, the SAM and the LSAS
- The pre-play questions included the STAI and two question that ask the player how fearful and comfortable they are with how they are going to play pinball [1].
- The post-play questions included the STAI again and the VGDS. Altogether a participant will fill in the STAI four times and the VGDS twice.
- The last part of the survey is about the competitiveness of the participant and uses the RCI.

3.5.1 Independent Variables. One of the main independent variables are the playstyles, consisting of: playing alone, playing with one spectator, cooperative play where both players use one flipper, parallel play and turn taking. As discussed playing style might impact game experience and performance.

As stated in the literature, the relationship between a player and a spectator might influence the game experience of the player. To measure if familiarity between two participants has any effect on video game demand, the Inclusion of Others in Self image will be used. Three questions will ask the participants in various ways to describe their relationship to the other person by selecting the one of the seven images.

Competitiveness might influence how much a participant exerts themselves. To measure how competitive a player is they will answer fourteen questions from the Revised Competitiveness Index (RCI) [33] [67]. This measurement tool is based on Helrnreich and Spence's definition of competitiveness as "a desire to win in interpersonal situations" [32]. The index is widely used measure to assess trait competitiveness and has been used in game related studies before [43] [66]. The questions are answered on a 5-point Likert scale.

Someone with anxiety might be compensating for their inefficiency by enhancing their effort. Anxiety will be measured through the Liebowitz Social Anxiety Scale (LSAS). Its purpose is to assess the range of social interaction and performance situations feared by a person. The scale features 24 items, which are divided into two subscales; 13 questions relate to performance anxiety and 11 questions relate to social situations.

Three questions will be asked about the game experiences and pinball experiences of the player, as it was shown in the research

[1]The pre-play question were included in the survey for data gathering purposes for a larger study. These will not be used in this article.

that game experience can impact cognitive abilities. One question asks if the participant is familiar with pinball, another ask how regularly a participants plays video games. The last question regarding this subject asks the player if they play games that require fast reflexes and for the player to pay attention. This question includes examples that were found in the literature like: Action games, Multiplayer Online Battle Arenas, Action Role Playing Games, etc.

3.5.2 Dependent Variables. The dependent variable is the demand put upon the player, this will be measured through the earlier mentioned Video Game Demand Scale (VGDS). The VGDS consists of 28 questions on a 7-point likert scale. These questions are divided into four categories: Cognitive Demand, Social Demand, Physical Demand and Emotional Demand and are designed based on video game demand as described by Bowman [8].

3.5.3 Control Variables. Besides the validated questions from different scales, some general questions will also be asked to the participants. These are seven questions that contain topics like gender and age.

The survey also includes a self-assessment part using the Self-Assessment Manikin (SAM) to measure the levels of arousal, valence and dominance in a participant before they play pinball. This is included to check if the state of a participant influences their experience in the experiment. This test enables the participant to rate their current state of arousal, valence and confidence on a 9-point likert scale. SAM asks participants to indicate which image fits best with their mental state and is a quick and easy way for participants to assess themselves [12].

4 RESULTS

To answer the research questions the data gathered through the survey was imported into Studio R. The data was then prepared for. For each research question the appropriate statistical test was chosen and performed. This chapter will elaborate upon these tests and discuss their results.

4.1 Video game demand between playstyles

4.1.1 Spectator. A pairwise t-test was used to test answer the research question: *To what extend does playing pinball with one spectator affect the video game demand a player experiences?* with video game demand (recorded as a score on the VGDS) as the outcome variable and the playstyle (either playing alone or playing with a spectator) as the predictor variable. See Figure 6 for the visualization of the scores.

There was not a significant difference in Video Game Demand between playing alone (M = 75, SD = 11) and playing with a spectator (M = 85, SD = 19); t(3) = -0.225, p = 0.837. Therefore the null hypothesis *"Playing with one spectator has no affect on the video game demand experienced by a player."* is not rejected.

4.1.2 Turn Taking. A pairwise t-test was used to test answer the research question: *To what extend does playing pinball while taking turns affect the video game demand a player experiences?* with video game demand (recorded as a score on the VGDS) as the outcome variable and the playstyle (either playing alone or taking turns) as the predictor variable.

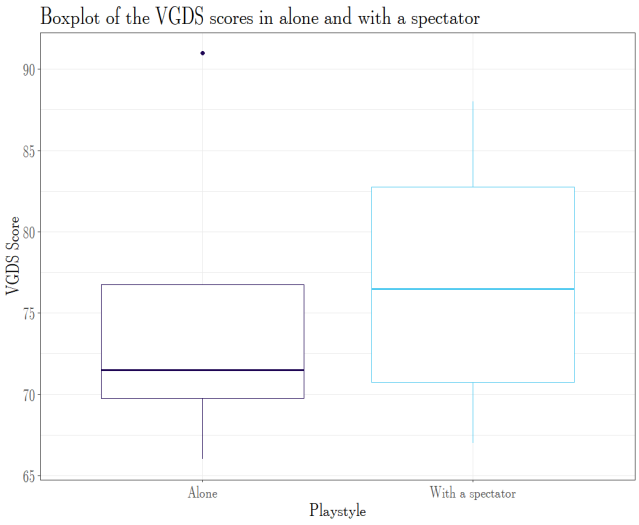

Figure 6: Boxplot of the VGDS scores when playing alone and with a spectator

There was not a significant difference in Video Game Demand between Alone (M = 74, SD = 19) and Taking Turns (M = 82, SD = 14); t(9) = -1.13, p = 0.288. Therefore the null hypothesis *"Playing while taking turns has no affect on the video game demand experienced by a player."* is not rejected. See Figure 7 for the visualization of the scores.

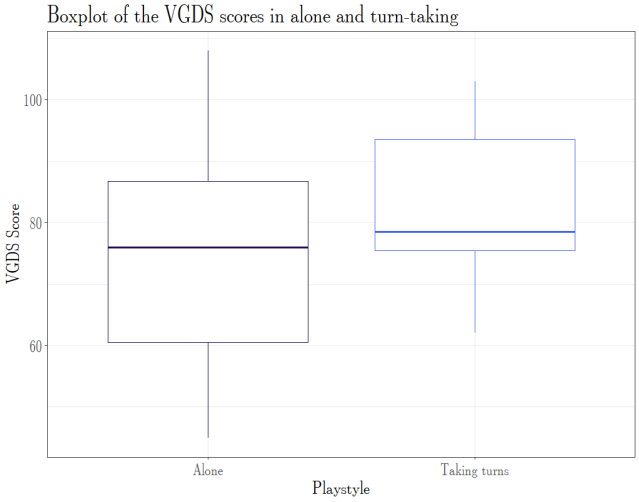

Figure 7: Boxplot of the VGDS scores when playing alone and when taking turns

4.1.3 Parallel-play. A pairwise t-test was used to test answer the research question: *To what extend does playing pinball while playing in parallel affect the video game demand a player experiences?* with video game demand (recorded as a score on the VGDS) as the outcome variable and the playstyle (either playing alone or playing in parallel as the predictor variable.

There was not a significant difference in Video Game Demand between Alone (M = 65, SD = 16) and Parallel (M = 73, SD = 19); t(11) = -1.09, p = 0.298. Therefore the null hypothesis *"Playing in parallel has no affect on the video game demand experienced by a player."* is not rejected. See Figure 8 for the visualization of the scores.

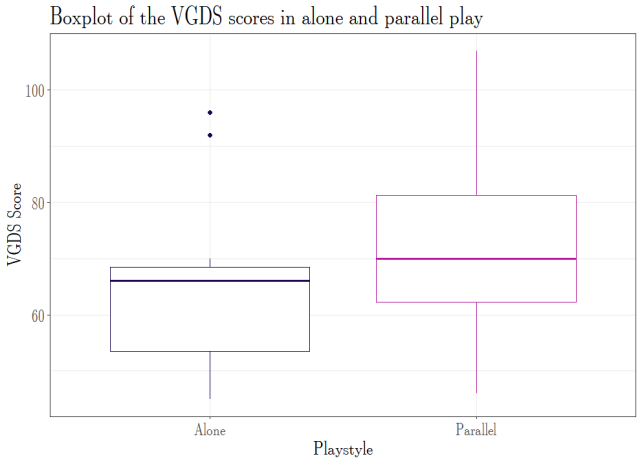

Figure 8: Boxplot of the VGDS scores when playing alone and when playing in parallel

4.1.4 Cooperation. A pairwise t-test was used to test answer the research question: *To what extend does playing pinball while playing cooperatively affect the video game demand a player experiences?* with video game demand (recorded as a score on the VGDS) as the outcome variable and the playstyle (either playing alone or playing in parallel as the predictor variable.

There was not a significant difference in Video Game Demand between Alone (M = 75, SD = 20) and Cooperatively (M = 85, SD = 18); t(10) = -1.01, p = 0.336. Therefore the null hypothesis *"Playing cooperatively has no affect on the video game demand experienced by a player."* is not rejected. See Figure 9 for the visualization of the scores.

4.2 Anxiety and Competitiveness

4.2.1 Performance and Social Anxiety. To answer the research question: *To what extend does social anxiety affect demand in various playstyles?* a Pearson correlation coefficient was computed. The linear relationship between a participants VGDS score after the participant played one of the multiplayer modes and their LSAS performance anxiety score was analysed.

For the cooperative multiplayer mode there was a positive correlation between the two variables, r(9) = 0.38 , p = 0.256.

For the parallel multiplayer mode there was a negative correlation between the two variables, r(10) = -0.47 , p = 0.123.

For the turn-taking multiplayer mode there was a negative correlation between the two variables, r(8) = -0.40 , p = 0.257.

For the spectator multiplayer mode there was a negative correlation between the two variables, r(2) = -0.55 , p = 0.454.

The correlations are visualized in Figure 10, except for playing with a spectator, as it only has four data points.

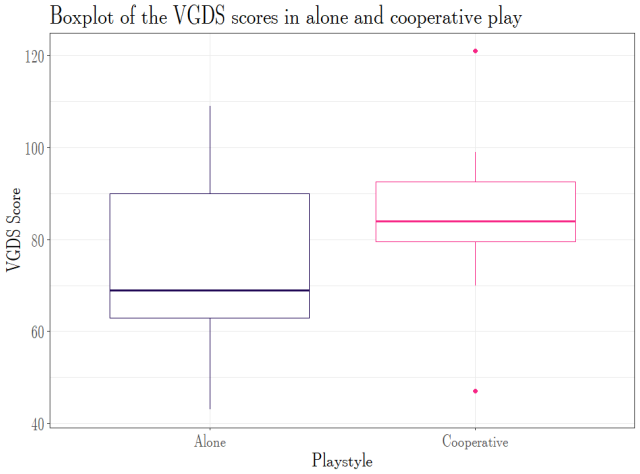

Figure 9: Boxplot of the VGDS scores when playing alone and when playing cooperatively

The linear relationship between a participants VGDS score after the participant played one of the multiplayer modes and their LSAS social anxiety score was also analysed.

For the cooperative multiplayer mode there was a positive correlation between the two variables, r(9) = 0.14 , p = 0.684.

For the parallel multiplayer mode there was a negative correlation between the two variables, r(10) = -0.50 , p = 0.101.

For the turn-taking multiplayer mode there was a negative correlation between the two variables, r(8) = -0.53 , p = 0.112.

For the spectator multiplayer mode there was a negative correlation between the two variables, r(2) = -0.071 , p = 0.287.

The correlations are visualized in Figure 11, except for playing with a spectator, as it only has four data points.

None of the tests showed any significant results. Therefore the null hypothesis *"Anxiety has no affect on the video game demand experienced by a player."* is not rejected.

4.2.2 Competitiveness. To answer the research question: *To what extend does competitiveness affect demand in various playstyles?* a Pearson correlation coefficient was computed. The linear relationship between a participants VGDS score after the participant played one of the multiplayer modes and their competitiveness score was analysed.

For the cooperative multiplayer mode there was a negative correlation between the two variables, r(9) = -0.35 , p = 0.284.

For the parallel multiplayer mode there was a positive correlation between the two variables, r(10) = 0.15 , p = 0.646.

For the turn-taking multiplayer mode there was a positive correlation between the two variables, r(8) = 0.18 , p = 0.622.

For the spectator multiplayer mode there was a negative correlation between the two variables, r(2) = -0.31 , p = 0.687.

The correlations are visualized in Figure 12, except for playing with a spectator, as it only has four data points.

None of the tests showed any significant results. Therefore the null hypothesis *"Competitiveness has no affect on the video game demand experienced by a player."* is not rejected.

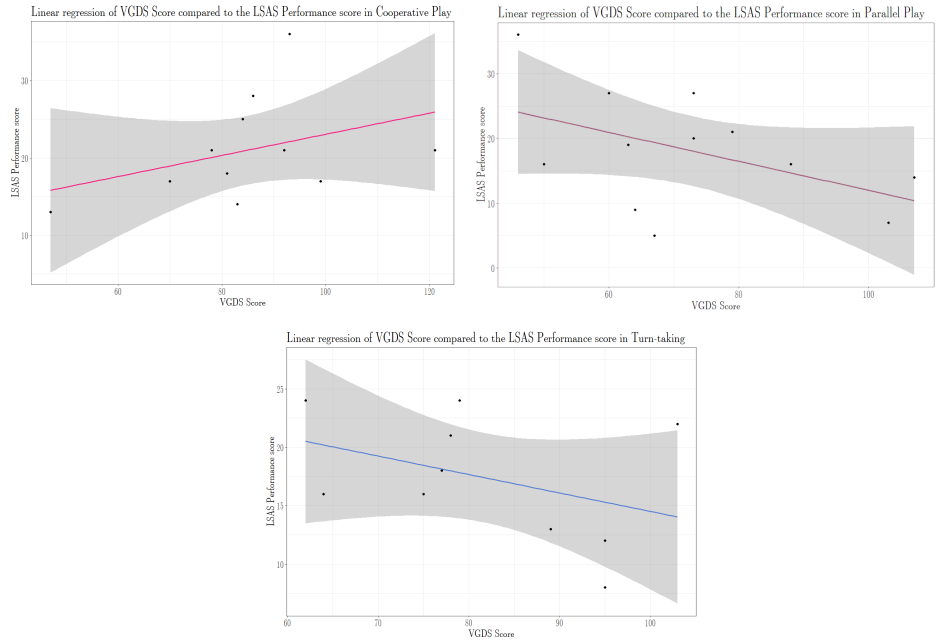

Figure 10: Linear regression graphs showing the relation between Performance Anxiety and Video Game Demand for the different multiplayer modes. In the top left it is shown for cooperative play, in the top right for parallel play and in the bottom for turn taking.

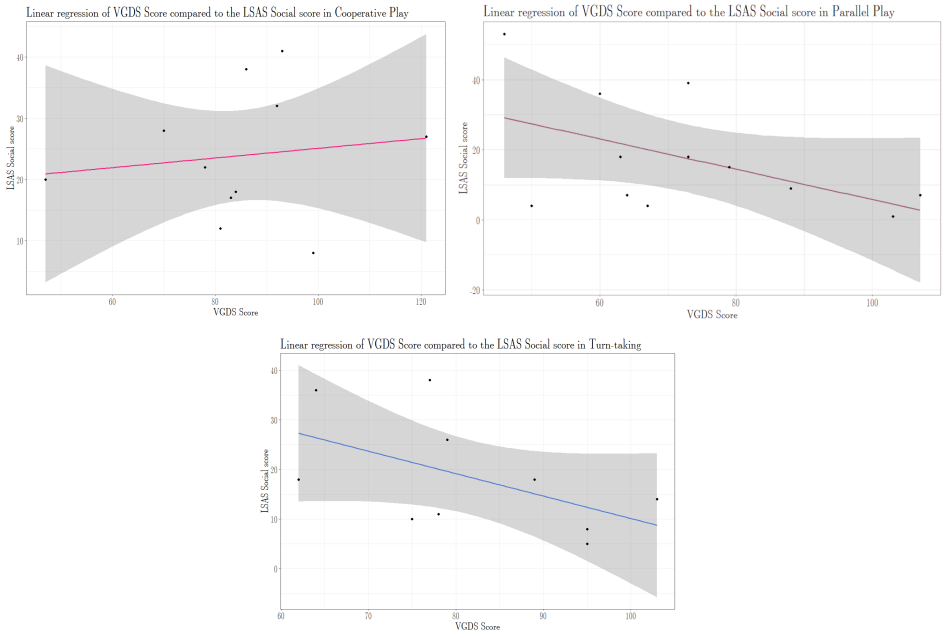

Figure 11: Linear regression graphs showing the relation between Social Anxiety and Video Game Demand for the different multiplayer modes. In the top left it is shown for cooperative play, in the top right for parallel play and in the bottom for turn taking.

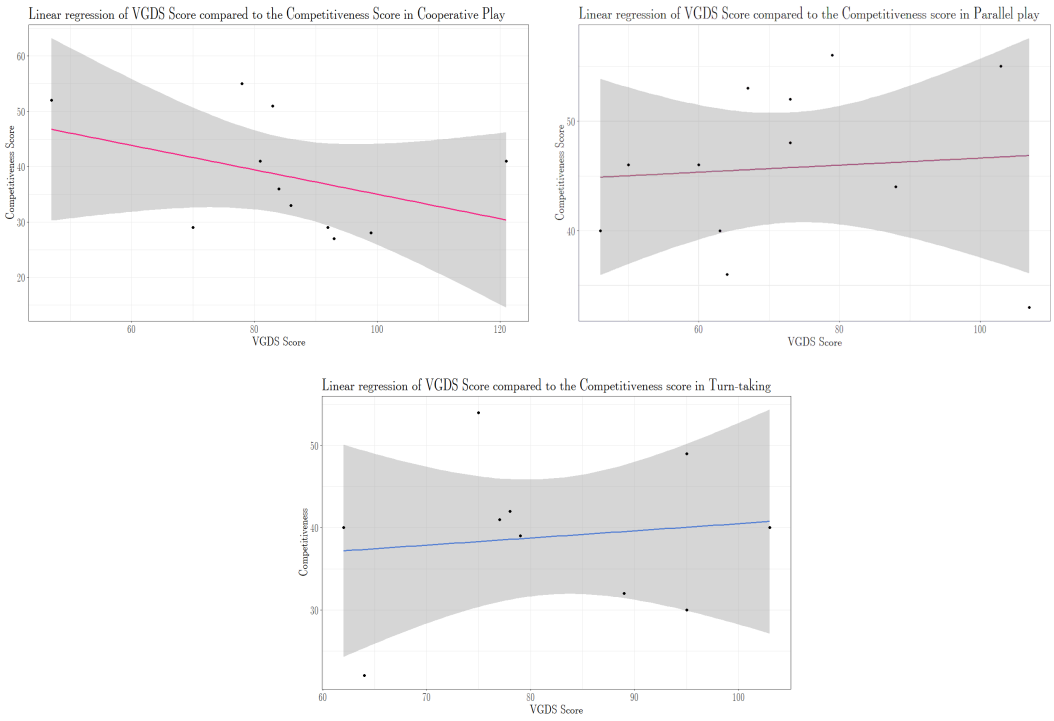

Figure 12: Linear regression graphs showing the relation between Competitiveness and Video Game Demand for the different multiplayer modes. In the top left it is shown for cooperative play, in the top right for parallel play and in the bottom for turn taking.

4.3 Game and Pinball Experience

4.3.1 Game Experience. A one-way ANOVA was used to test answer the research question: *To what extend does competitiveness affect demand in various playstyles?* with video game demand (recorded as a score on the VGDS) as the outcome variable and game experience as the predictor variable.

Game experience was measured with two questions on a likert scale ranging from 1 to 5. These scores were added up resulting in a game experience score from 2 to 10. The scores were then separated into three categories: the scores 2 to 4 were categorised as below average, the scores 5 to 7 were categorised as average and the scores 8 to 10 were categorised as above average. A comparison of the three groups is visualized in Figure 13.

The one-way ANOVA revealed that there was not a statistically significant difference in video game demand between the three groups ($F(2, 35) = 2.014$, $p = 0.147$). Therefore the null hypothesis *"Video game experience has no affect on the video game demand experienced by a player."* is not rejected.

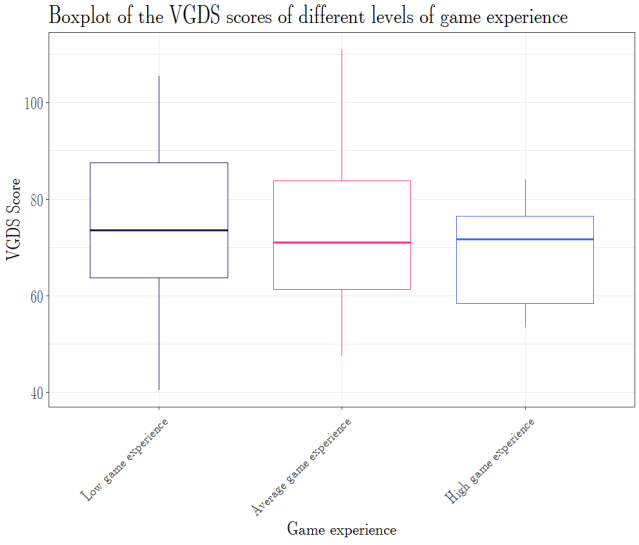

Figure 13: Boxplot of the VGDS scores of different levels of game experience.

4.3.2 Pinball Experience. A one-way ANOVA was used to test answer the research question: *To what extend does pinball experience affect demand in various playstyles?* with video game demand (recorded as a score on the VGDS) as the outcome variable and pinball experience as the predictor variable.

Pinball experience was measured with one question on a likert scale ranging from 1 to 5. This score was then separated into three categories: the answers 1 and 2 were categorised as below average, the answer 3 was categorised as average and the answers 4 and

5 were categorised as above average. A comparison of the three groups is visualized in Figure 14.

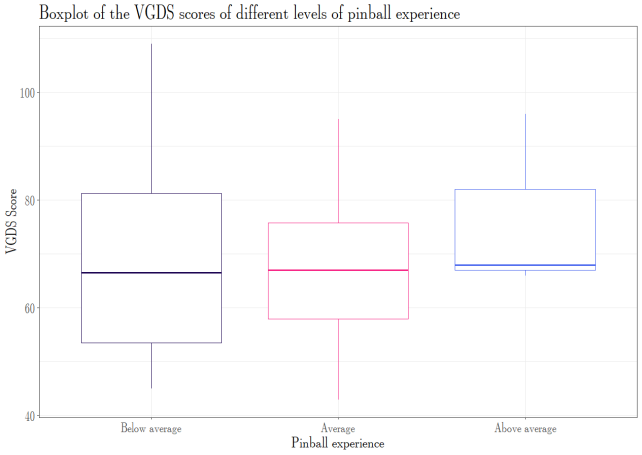

Figure 14: Boxplot of the VGDS scores of different levels of pinball experience.

The one-way ANOVA revealed that there was not a statistically significant difference in Video Game Demand between the three groups ($F(2, 38) = 0.262$, $p = 0.771$). Therefore the null hypothesis *"Pinball experience has no affect on the video game demand experienced by a player."* is not rejected.

4.4 Familiarity

A one-way ANOVA was used to test answer the research question: *To what extend does familiarity with the other player affect the video game demand a player experiences?* with video game demand (recorded as a score on the VGDS) as the outcome variable and familiarity as the predictor variable.

Familiarity was measured by adding up the results from three questions that used the IOS on a likert scale ranging from 1 to 7. This score was then separated into four categories: results from 3 to 7 were categorised as 'Not familiar', results from 8 to 12 were categorised as 'Slightly familiar', results from 13 to 17 were categorised as 'Familiar' and results from 18 to 21 were categorised as 'Very familiar'. A comparison of the four groups is visualized in Figure 15.

The one-way ANOVA revealed that there was not a statistically significant difference in Video Game Demand between the three groups ($F(3, 37) = 1.184$, $p = 0.329$). Therefore the null hypothesis *"Familiarity with another player has no affect on the video game demand experienced by a player."* is not rejected.

5 DISCUSSION, LIMITATIONS AND FUTURE WORK

The goal of this study was to answer the research question: *Do various ways of presence of others through different pinball multiplayer modes have an affect on the demand generated from playing pinball?* This chapter will discuss the results and try to answer this question.

According to the earlier discussed literature different multiplayer playstyles can have an effect on how a game is experienced by a

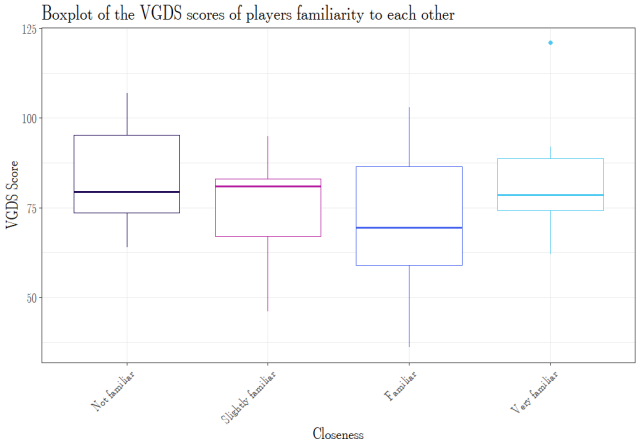

Figure 15: Boxplot of the VGDS scores of different levels of pinball experience.

player and can affect a players performance [39][24][42]. With this in mind, it was hypothesised that different playstyles might also have an effect on the demand experienced by a player. The results section has shown that there were no significant differences in demand between playing alone and playing in any of the four multiplayer modes. Therefore the null hypothesis could not be rejected. These results were most likely impacted the low amount of participants. 41 participants took part in the experiment, but only played one of the multiplayer modes, which means that most modes only had around ten participants. This was especially limiting when it came to analysing the role of spectators, as only four people ended up playing with a spectator. Another variable that could have skewed results is the fact that one of the participants was forced to play on a different pinball machine during parallel play.

Research question five asks if anxiety affect demand in various playstyles. The literature around the subject discussed the possibility of a person with anxiety allocating extra recourses to make up for their shortcoming, thus resulting in exerting more demand [7]. In practise, it was found that there was not a significant difference in demand between participants who showed signs of performance or social anxiety. Interestingly, the only a positive correlation between anxiety and demand was found in the cooperative play mode. It would be interesting to dive deeper into the cooperative play style and what part anxiety plays in such situations.

There is still not a lot known about the role of competitiveness and demand when it comes to gaming. This study has found no significant relation between the two variables. What was interesting is that only the parallel and turn taking modes showed a positive correlation between demand and competitiveness. This could be because these seem to be the most competitive situations. Both situations gave the players the opportunity to see or hear how well the other player was doing. Even during the pilot study it was stated that players did feel competitive during the parallel play session, even though they weren't able to keep much track of the other players progress.

The low amount of participants is also an issue for the analysis that includes the competitiveness and anxiety scores of the participants. While interesting results have been found, it is inadvisable to form any conclusions as the amount of participants taking part in this study was limited(N=41). Another limitation when it comes to the anxiety and competitiveness is the errors made in the survey, both the LSAS and the RCI are accidentally missing one question. This oversight might have impacted the results as not all the needed answers to calculate the scores of each scale were available. Because of these shortcomings and interesting results a more thorough experiment focusing on parallel play and competitiveness might be worthwhile, as parallel and specifically the relationship between these two factors is an interesting area that lacks research.

Both the section about physical demand and game experience have shown that it was possible that more experienced players experience less demand because of their mental models or/and their trained cognitive skills [9][65][19]. Research question seven asked if game experience affected demand while a participant was playing alone. From the analysis in the results it becomes clear that this is not the case, which is surprising. It could be that pinball is not as cognitively demanding as the games mentioned in the literature. It would be interesting to compare the demand of different video games to pinball to see if this is the case. While the video game demand scale is a good tool to measure demand in video games, the section about social demand might not be as applicable on pinball as it is on other games. Various participants expressed confusion during the experiment about the questions specifically relating to social demand, as they did not see the how they related to playing pinball. This could have influenced results. Another limitation was the amount of participants that saw themselves at the extreme ends of the spectrum. There were not a lot of people who had no game experience or saw themselves as extremely experienced.

The same goes for pinball experience. Almost all the participant were slightly familiar with a pinball machine and had played before, but there were almost no participants who deemed themselves to be extremely familiar with pinball. While demand was hypothesized to be decreased for more experienced players, this was not found in the results. Future studies could aim to gather a more diverse group of participants with varying levels of pinball experience and have more in-depth questions about their experience.

Lastly the question if familiarity affects video game demand was asked. Again there does not seem to be a significant difference between players who were very familiar with each other and those who did not know each other. Because of the limited pool of participants, it was not worthwhile to analyse if different multiplayer modes had any influence in this. For play styles especially like cooperation, were planning and talking is very important, it might be interesting to see if familiarity has any effect on the participants experience and demand.

Self-reporting was a major part of the procedure in this experiment. Both the VGDS, LSAS and RCI relied on a participant being able to identify how they feel in the current moment and in hypothetical scenarios. For future work it could be interesting to measure demand by one of the physiological tests mentioned in the literature instead of a self-report. This would also give the researcher an exact measurement of how the player was experiencing the game while playing instead of how a participant thought they felt about the situation after experiencing it.

6 CONCLUSION

This study aimed to investigate if demand experienced by a pinball player is effected by different multiplayer modes. It also included factors that could potential influence demand such as anxiety, competitiveness, game and pinball experience and familiarity. Based on the quantitative analysis of video game demand experienced by players in various multiplayer modes, it can be concluded that demand is not significantly influenced by different play modes. It was also found that the other potential factors, such as competitiveness and anxiety, did not cause significant differences in video game demand between participants. Parallel play, cooperation and turn taking, while not significant, were shown to have both positive and negative correlations with anxiety and competitiveness. Game and pinball experience did not result in having a significant effect on demand, which challenges most understanding of experience on cognitive and physical demand. Based on these results, future research could consider using the four multiplayer modes used in this study in their experiments and be less concerned with the impact on demand the multiplayer mode has on the participants. Further research is needed to determine if there are any strong relationships between the potential influential factors and video game demand in specific multiplayer modes. While the small participant pool limits the generalizability of the results, this approach provides new insight into demand and specifically the demand experienced during a pinball game.

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