
Physiological Reactions to Stress Induced by a Game

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Worksheets for Multimodal Perception and Cognition

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Introduction

The primitive fight and flight response is stimulated in the sympathetic nervous system and is most prominent when perceiving a threat [Cannon, 1927]. The body prepares for the exertion to deal with the stressful situation: Adrenalin and cortisol are released, and the body produces sweat in order to cool itself down. Stress has been investigated in video games, e.g. in first person shooters games that relies on quick responses. This study examines whether or not failure in a tablet game can stimulate a response similar to the fight, flight, or freeze response, as seen in a study by Cannon, (1927), also, the tend and befriend response defined by Taylor et al., (2000), which is a response to how women react in a stressful situation [Taylor et al., 2000]. For this study we observed students' reactions to a stress situation in a game. We designed a coding scheme of what we defined as tendencies in the four different types of responses. The coding scheme was used in the video analysis, focusing on what the subjects communicated to each other, their facial expressions, and how concentrated they were with the task of tracing an invisible line.

Chapter 1: Physiological Reactions to Threats

In this chapter, we will discuss the physiological reactions happening in the body and mind when put in a stressful situation. The chapter begins with a section about the perception of threats and how the autonomic nervous system reacts to the perceived threat. The next section will describe the cognition related to the perception of threats, and the last section will go through the motor reactions related to this.

1.1 Perception of Threats

Animals as well as humans have a build in sensor system to perceive threats to their survival. The sensor system uses the senses of the body as well as the mind in its aspect of memorizing a similar situation and the evaluation of the magnitude of the threat. We humans have through the years developed a more detailed sensor system, and we are able to use it, not only to perceive situations threatening our survival, but also recognize situations which might compromise our social status. The most common way of experiencing the evolved sensor system, is when being put in a stressful situation, as this would activate the autonomic nervous system in a physiological reaction. A scenario could be forgetting to deliver a report at work and be pointed out by your boss, or just being stressed in general due to the current workload.

1.1.1 Changes in Behaviour due to Perception

It is believed that emotions have been developed to affect our behaviour when put in a stressful situation, in order to identify and react to a perceived threat, to increase the survival rate. Accord-

ing to Fernandes Jr. et al., (2003), emotions can change our behaviour in a positive or negative direction, depending on the situation. This also gives us the opportunity to prepare for stressful situations by training the control of our emotional response to a threat. A reaction to the current situation can this way be altered by past event, which could be the aforementioned training of emotional control or recall of a similar situation. As the action or motor performed by the individual is directly linked to the emotional state, which is dependant on our past memories or physiological reaction. The reaction time in humans is directly related to how we perceive an emerging threat. If the threat is pointed towards us: If a gun is pointed at the viewer, our reaction time is slowed. When a gun is pointed towards another person, our reaction time is increased compared to a neutral state. This gives evidence of our perception of the threat changes how the body reacts to the situation. [Fernandes Jr. et al., 2003]

1.1.2 Bodily Changes as Result of Threat Perception

When a threat is perceived, the first reaction of the brain is to activate the amygdala part, which processes emotions, memory and decision-making. The information about the situation is send to hypotalamus, which creates Adrenocorticotropic hormon (ACTH). This starts the production of the stress hormone cortisol and adrenaline, making the body respond by increasing heart rate, blood pressure, decrease the immune system functionality and digestion also making a constant stressful environment harmful to the health. If the amygdala is constantly negatively stimulated, it can lead to depression and other anxiety, altering the reaction to stressful or harmful situations. Depression can in this sense also be helped by changing the way the amygdala reacts to stressful situations as it has a direct relation to the information send further to the autonomic nervous system (ANS) regulating the autonomic body functions. One of the primary parts of the ANS is the sympathetic nervous system, which is sometimes referred to as the fight or flight system, as it automatically alters the autonomic body functions to create a sense of anxiety or aggression. The anxiety or aggression creates a bias for what action is made in a stressful situation, and the next section will further dig into the action taken depending on the physiological changes in the body when put into a stressful situation.[Pocock, 2006] [Kalin, 2014] [Jansen et al., 1995]

1.2 Cognitive Respond to Threats

The cognitive response to a threat is the evaluation of the physiological changes as described in Section 1.1. As we gain information from the brain and body because of how we perceive a threat, we start to evaluate the autonomic bodily changes to respond with the best possible reaction. Mainly we look at the two categories which are fight and flight, the oldest principle, dating back to 1927 [Cannon, 1927], described as reactions of anxiety and anger. An example where anxiety is created, would be a situation where one arrive at an important meeting, only to discover one is

unprepared. This situation creates a sense of anxiety, where the heart rate rises together with blood pressure, respiration, and other autonomic bodily changes as a reaction to the perceived threat, inducing a flight reaction, fleeing the location where the situation occurred. If however, it was another person's fault one was not prepared, there could be more biased towards an emotion of anger, wanting to fight, either a physically or verbally. [Cannon, 1927]

1.2.1 Changes in Cognitive Response

The feeling of anxiety or anger, when put in a situation of perceived threat might change specific emotions, depending on the individual and their past memory of similar situations. An example of the cognitive process could be when a fire alarm goes off. The normal perception of the situation would be the fear of harm or threat. This initialises the cognitive process, which determines the reaction to the event depending on previous knowledge. If one is at home, one might have specific knowledge of what might have caused the threat, e.g. the burned lunch one forgot. Perhaps one would not flee, but rather fight the situation, by stopping the events setting off the alarm. On the other hand, does the alarm go off at the workplace, one could be more biased to flee, if one has no knowledge about the threat's cause or location. These are also depending on the feelings of anger, as you just burned the food, or anxiety, as you do not know what set off the alarm at work.[Cannon, 1927]

1.3 Motor Processor

The last step of the human reaction to a stressful situation, is the motor or action part. The model can be referred to as the model of human information processing, which consists of four steps:

- Sensing
- Perception
- Cognition
- Motor (Acting)

The motor steps are the actions we can start interpreting as how the full processing of the perceived information has occurred.[Card et al., 1986] We define the different motor categories as fight, flight, freeze and tend/befriend, and in the following we elaborate each response. The categories are described with a definition of the action and what information processing the user has gone through to react according to the category. The specific actions related to the category will be described, as this will be the basis of how we can analyze the stressful reaction to the broken level in the game.

1.3.1 Fight

The fight response is greatly biased by an aggressive state, which is shown in actively trying to deal with a posing threat. The feeling of aggression is associated with the will to fight, which is induced by the physiological response of releasing hormones when a threat is perceived. As adrenaline is released, heart rate increases, muscles tense up, making the body ready to fight off the threat. This motor processor is a part of the body's automatic energy conserving system, where the body can be in a state of the lowest possible energy until a threat is perceived, where it in an instant can release the hormones suddenly raising the energy available to a much higher level than normal. Fighting can be seen as tension building up in the body, needed to be expressed physically.

The fight reaction to a stressed situation is becoming more and more active in solving the problem or fighting off the threat, which can result in a physical reaction, violence, verbal expression of anger or annoyance.

1.3.2 Flight

The flight response can be associated with the feeling of anxiety, where fleeing is considered the best option. Flight is often the first action which is considered as it would raise the possibility of survival compared to getting into a fight. If escaping the situation is not an option, the fight response is initialised through the increasing emotion of anger. The flight response is as fight also amplified by the hormone release happening in a threatening or stressful situation. Muscles tense and heart rate increases to help a faster escape. For the flight response, blood will gather in the legs compared to the fight response, where blood flows to the upper body, either giving extra physical strength to escaping or fighting the situation.

Flight is represented fleeing or escaping a situation because of rising anxiety and the idea of not being able to solve the problem or deal with the posing threat. It is often seen as fleeing the location or removing oneself from the situation.

1.3.3 Freeze

As a last resort, freeze can be used when escaping and fighting is not a possible solution. An example is when being attacked by a bear, where running away would increase the chance of it chasing and the physical superiority of the bear would omit the fighting response. Playing dead or becoming passive would give the greatest chance of survival, making the freeze response become the best option. Freeze can be triggered when no obvious solution is present, either in fight or flight, but might transition into the other motors as a solution presents itself by evaluation of the situation. Freeze can be triggered when the muscles tense up, but no solution in fight or flight can be chosen to deal with the threat or situation.

The freeze response can be seen as becoming passive, trying the same solution over and over can be seen as passiveness if it does not help remove the stressful situation, but done because no other response is possible.

1.3.4 Tend/Befriend

According to Taylor et al., (2000), a female stress response can be characterized by the pattern tend and befriend. This pattern involves joining and strengthening social groups in order to share resources, especially, in groups of other females. The study suggests that this pattern builds on biobehavioral attachment/caregiving system that depends on oxytocin, estrogen, and endogenous opioid mechanisms, among other neuroendocrine underpinnings, and that this is an alternative to the biobehavioral response of fight/flight.

In this the actor is actively trying to solve a stressful situation by strengthening social networks and relying on shared resources. [Taylor et al., 2000]

Chapter 2: Experiment

With this knowledge about different stress reaction patterns, a test scenario was constructed to examine the following problem statement.

“In the game situation a stress response can be provoked for the user, and a response can be grouped into one of the four categories of fight, flight, freeze and tend/befriend.”

2.1 Methods

A scenario was constructed in which a stress response was provoked from the user. A pair of test participants were competing against each other in a tablet game, see Appendix A.1. They went into the test believing they were competing fairly, but in truth the final level of the second test participant was rigged, so that he or she could not complete the level. The subject’s reaction to the stress situation of being unable to complete the level, was then observed by looking at a pre-set preliminaries, see Appendix Table A.2, and grouped into one of the pre-defined patterns of reaction fight, flight, freeze, and tend/befriend. For the test there were two cameras, one focusing on the tablet and one capturing the two participants’ facial expressions, see the setup in Appendix Figure A.2.

2.2 Participants

When choosing test participants we went for pairs of students already sitting in groups and made the assumption, that they would be acquaintances, and more inclined to engage in competition,

than two strangers. We also chose to test on different combinations of males and females, as it is illustrated on table, see Appendix Table [A.2](#). All the subjects were 3rd semester Medialogy students at Aalborg University and had the following demographics, see Appendix [A.3](#).

2.3 Procedure

The procedure for the experiment was controlled by the test conductor, who instructed the test participants what to do, while another test conductor was in charge of the camera setup. When the test participants entered the room, they were asked to give verbal consent to being recorded. After the participants received the instructions, Appendix [A.3](#), the test conductors left the test room, so the response of the participants was not affected by the presence of test conductors. Subject A played through the three levels of the tablet game, and after each level the score is noted down on a scoreboard by the participants themselves, in order for them to keep track on who was in the lead. After completing the third level they switched seats, and Subject B played through what appeared to be three similar levels, as they were unaware of the third level being rigged. The game was completed, after the timer ran out in the broken level, and the participants gestured to the test conductors that they were done. After the test session followed a semi-structured interview of both participants, see Appendix [A.3](#) If they did not approach the subject of the broken level themselves, the test conductor revealed this to them and got their final comments.

2.4 Results

The results consisted of a summary of each session with Subject B in the broken level. The summary was based on the observations made from the video analysis.

Session 1: The subject moved his eyebrows when he encountered the broken level. He attempted to trace the line twice and attempted to follow the line, as he remembered it. When he was unable to find the green light, he exclaims “fuck”, and continued to lift the tangible widget while exhaling, after entering the red circle.

Session 2: When she encountered the broken level she struggled for approx. 10 seconds with little facial response, other than a brief smile. When Subject A then looked at her, she struggled to hold back a smile, until Subject A comments “That’s very red”, after which she erupts with laughter, which intensifies when the score is presented.

Session 3: His voice is higher pitched when he found himself in trouble. He cursed and his face turned more red. When the light turned red he exclaimed “now it is super red” in an agitated voice. He continued to struggle while laughing while previously having a smock expression when he observed Subject A.

Session 4: Subject A comforted and helped Subject B. When unable to remember the line, Subject A tells her to: “Follow the colours”. Subject B had open mouth when she was moving the tangible widget, but when she lost her path, she closed it with little twitches. She smiled upon giving up and leaned back, afterwards she looked at the timer and leaned back again.

Session 5: The subject furrows her brow in concentration when encountering the broken level. She moves the widget slowly through the whole session, while Subject A is quiet and calm. Deeply concentrated on the task at hand. When the light turns red, she goes back to the beginning and starts over. This is repeated three times.

Chapter 3: Discussion and Conclusion

3.1 Discussion

The discussion is based on an analysis of when each Subject B are in the fight, flight, freeze or tend/befriend state in the broken level. Further observations were also discussed and can be found in Appendix [A.3](#).

Test 1: The subject raised his eyebrow in surprise and after a short while of asserting the situation quickly ended the level and leaned back away from the tablet, fleeing the task. When he realized that he still had some time left, he moved in to try one more time in an attempt to fight. He makes uncomprehending noises and performs the task very unfocused, and as soon as the time runs out he leans back and away again.

Test 2: The subject froze when encountering the broken level, and sat very still repeating a circular motion on the tablet, trying not to draw the attention of Subject A. Her face gradually turned more red and she holds back a smile, and when Subject A made his comment she laughed.

Test 3: His tone rose in pitch and he tried to laugh off the situation he was not comfortable with, which was clear due to the increased color of his face. He fled the situation by defusing the seriousness of the competition with humor.

Test 4: The subject completed the level with little deviation from the path, and in pace, which suggested she attempted to follow the line from memory, disregarding the missing light feedback. When she first lost track of the line, she reached out to the spectator: “It gets—It gets completely red”, which the spectator reacted upon by turning her gaze to her. This situation can be interpreted as a tend/befriend, as they react to the stressful event by socializing. Furthermore, her body language with her leaning back and sitting restless in the chair pointed towards a flight situation.

Test 5: She kept attempting to find the line, and when it failed, she started over while leaning further towards the tablet with an even more focused expression, signalling annoyance and concentration. She continued to fight and ended up retrying the level three times, which indicated a

response of fight.

3.2 Conclusion

- When a person perceives a stressful situation, the autonomic nervous system is activated as a physiological reaction.
- The human response to stress can be categorised as fight, flight, freeze, tend/befriend.
 - Fight is an active/aggressive reaction
 - Flight is an active/non-aggressive reaction
 - Freeze is a passive reaction
 - Tend/befriend is an active/social reaction

In the experience we managed to provoke all of the four different stress reactions, and in some instances, they came across as a mix of reactions. The reactions would start in one category and then transition to other categories as time passed. With the sample size being so small, however, it was not possible to significantly conclude that the different combination of gender had any influence on the provoked reaction.

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Appendix A:

A.1 Game Design

Game Description

The game that is used in this test is a game that has been developed as part of a 7th medialogy semester project. Therefore it is still in development. The current version on the prototype fulfill its purpose for this test. Additional features, if any, would be welcomed but is not expected to have any significant influence on the test results.

Tablet Game Application with a Tangible Widget

The game is developed in Unity and is made for tablets. This is done with the intention of exploring unconventional methods for interacting with games on a tablet. For this purpose, as part of the semester project, a tangible widget, which can be seen in Figure #, has also been produced. The tangible widget touches the tablet screen with two points, and through nails and conductive copper tape these points are registered as touch input. The center between the two touch input is computed, which is basically the user input. In this center the software computes a coloured light, which can be perceived through the light conductive material.

The game itself is designed with the purpose of measuring a user accuracy over time in a game scenario to see if using the widget can improve the performance. Therefore, the user task is to trace a pixel thin line using the tangible widget. Two circles are displayed, starting circle is green the ending is red. The two circles are then connected by this pixel thin line. The line will only be displayed for a short period of time right when each level starts, then it fades away. The user uses the tangible widget to trace the line as accurately as possible. The help they receive to complete the given task is a light feedback ranging from green to yellow to red. When the line is being traced accurately the light is green, when they are slightly off it goes to yellow, and when the user gets too far from the line it is red. The color changes happens gradually with a ramp and does not just switch between the three colors.

Tutorial

When the game is first started, the user is presented with a tutorial that explains the interaction with the widget on the tablet, and how to understand the light feedback. Furthermore, before the user is presented with one of the actual game levels, they get to play a level with the line they have to trace as being visible.

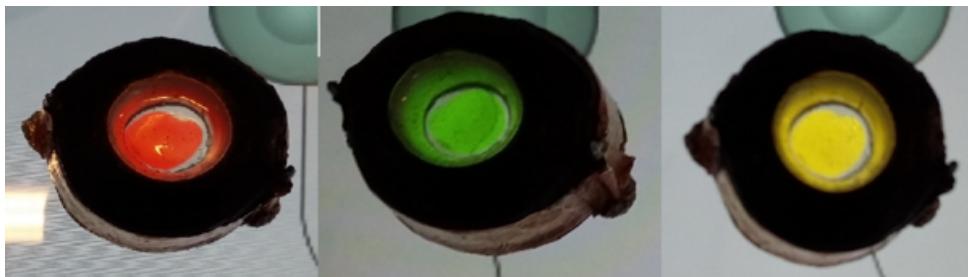


Figure A.1: The widget showing the three different states of light. Green on the line, Yellow slightly off, red far off.

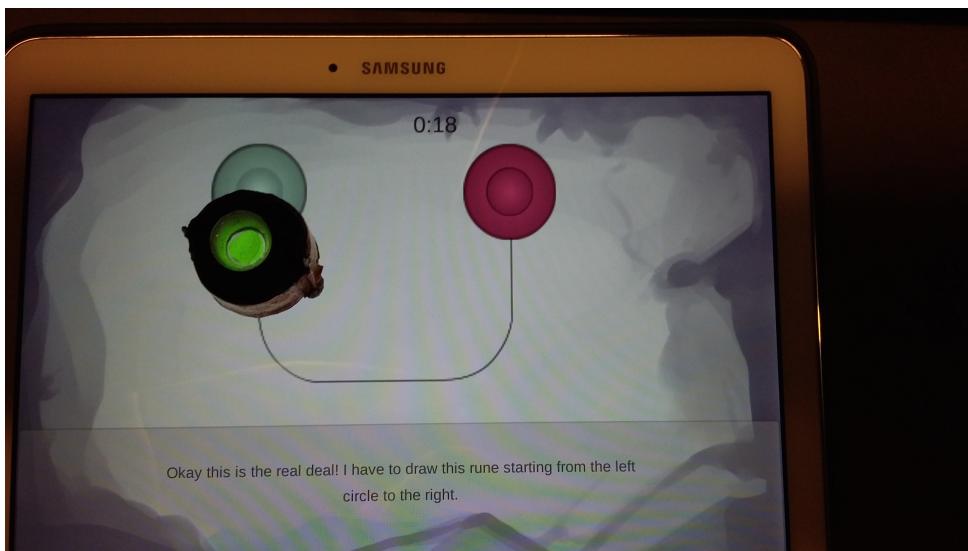


Figure A.2: Tutorial level with the line visible and with widget show on the line with green light coming through.

Level Design

For each level there is a timer centred at the top of the screen. For this test the game has been modified so that the level will only end when the timer runs out. The user can be as accurate within the given timeframe as possible, e.g. by retracing the line or by jumping to specific parts of the line, if they wish to. They can even start back-tracing the line during an attempt to trace the line. In the original game design, however, the level would have ended upon reaching the red circle at the end of the line.

When the user completes a level their final score will be displayed in a box on the middle of the screen. The score will be displayed as a number of cat heads as a score from 1-5. This value is arbitrary and the user unaware of exactly what the thresholds for each head is. Hence, they get an accuracy score in percentage where they can see exactly how many percentage of the line they managed to hit.



Figure A.3: Here the user achieve the grade 4 out of 5, displayed in the form of cats, moreover the user hit 68% of the line and can now press next to continue to the next level.

For the purpose of this experiment the game has been modified to be played by the first subject and continued by the second one. The game loops through the tutorial and then three levels of the game for both subjects. In the second playthrough the third and last level has been modified as well, so that the light feedback for tracing the line stops working halfway through the level. Initially it will be displayed as being the full line before it fades away, but the user will not be able to trace the line for more than half of the original length.

A.2 Test Setup

Coding Scheme

On the tablet	Releasing the widget Searching with the widget Retrying the level Ending the level before the time is up Fidgeting with the widget in their hands
Facial expression	Frowning, annoyance, aggression smiling, both delight and nervousness Speech(taunting or helping) Gaze, looking to the other subject for help Posture, leaning forward over the tablet, or leaning back in chair

Table A.1: The coding scheme is used for the video analysis in order to analyze, which of the categories fight/flight/freeze/tend and friend response.

Setup



Figure A.4: Camera setup for the tests.

Session 1	Session 2	Session 3	Session 4	Session 5
Male/Male	Male/Female	Female/Male	Female/Female	Male/Female

Table A.2: The table illustrates the combination of gender in the test. The second entry for all session (labeled as B) was the second participant, who experienced the rigged level.

A.3 Test Results

Demographics

Session 0 Table (Pilot Test)

Demographics	Subjec A	Subject B
Gender	Male	Male
Sudy	Mobilites and Urban Studies	Mobilities and Urban Studies
Tablet Use	Laptop Tablet: Daily	Occasionally
Tangible Widget Experience	None	None
Language	English	English
Name	Atte	Valentin
Tutorial Level	100%	100%
Level 1	65%	76%
Level 2	33%	18%
Level 3	51%	21%

Note: Timer set to 1:30 minutes. Doodles on scoreboard.

Interview notes:

- time was too long
- subject A won
- light feedback: green didn't come => felt frustrated, but laughs
- competition is not bad

After revealing the test purpose:

- ok, very last cm the green came back, "why the hell no green?"
- he just followed, tried it all

Session 1 Table

Demographics	Subjec A	Subject B
Gender	Male	Male
Sudy	Medialogy 3. Semester	Medialogy 3. Semester
Tablet Use	Occasionally	Some Times Daily
Tangible Widget Experience	None	None
Language	Danish	Danish
Name	Kaspar	Jens
Tutorial Level	100%	62%
Level 1	73%	81%
Level 2	17%	69%
Level 3	74%	51%

Notes: Timer set to 45 seconds. Subject B was physically disabled.

Interview notes:

- good concepts
- Subject A talks a lot, Subject B did not have a lot speaking time
- It bugged subject A that it was difficult to see the circle under widget, he liked the “lens” to be bigger and a more
- clear colour, he thinks that it can be a learning game for drawing
- Subject B: the light was occluded by the hand, fun to remember the line
- It was a competition
- Had to wait between the levels
- Did not know that they could go back while drawing
- Subject B won, Subject A react by saying that he cheated, but admits it is in denial
- Competition is important, would have missed it otherwise and needing diversity
- Subject B: light turns red, when I expected it to turn green, stressful factor, unable to get the green light
- Subject B calls it a drawing game

After revealing the test purpose:

- Subject B: A bit annoying, there is nothing I can do, thought the test was about memory (both)
- Suggested to look into oso, a music a rhythm game

Session 2 Table

Demographics	Subjec A	Subject B
Gender	Male	Female
Sudy	Medialogy 3. Semester	Medialogy 3. Semester
Tablet Use	Twice Monthly	Occasionally
Tangible Widget Experience	None	Once in Test
Language	Danish	Danish
Name	Fatja 1	Fatja 2
Tutorial Level	95%	100%
Level 1	47%	77%
Level 2	83%	44%
Level 3	72%	17%

Note: Doodles on scoreboard.

Interview notes:

- Subject B: didn't go well, a bit difficult the last one to trace back to the line, that was annoying, went back to the green light and was not even half way through the level.
- Subject A: had some difficulties understanding

After revealing the test purpose:

- It made more sense for Subject B, she tried everything, right until there was only two seconds left.

Session 3 Table

Demographics	Subjec A	Subject B
Gender	Male	Female
Sudy	Medialogy 3. Semester	Medialogy 3. Semester
Tablet Use	Every Third Month	Daily
Tangible Widget Experience	Yes, Stylus	Yes, Stylus
Language	Danish	Danish
Name	Emilie	Kejser
Tutorial Level	100%	100%
Level 1	90%	82%
Level 2	31%	97%
Level 3	67%	28%

Note: No tablet video recording for Subject B, because the subject move the tablet instead of switching chairs. Writing the total score on the scoreboard. A: 188 and B: 207.

Interview notes:

- The light feedback was gone in the level 2 for Subject A and level 3 for Subject B.
- Tutorial was easy, they both got 100%.
- Subject A: Her dad would move the tangible widget rapidly back and forth in order to hit the line.
- They tried to track back to the green light, trial and waiting when to turn green again.
- Teasing a little, “who is the victor”, they start calculating, B wins, they are in the same group, poking a bit to each
- other. Subject B really needs to win, “fuck”.
- Subject A: is not that competition fixated, but admits that it might be because she started playing instead of ending it.

After revealing the test purpose:

- Subject B: That explains why I got beaten. Subject A: answers you won anyway.
- Subject B: Appeals to logic, worked from trial and error. Needed to win this, shit!
- Subject B: colour blind, red-green efficient not blind.
- Subject A: looked down in the tablet and not the light (Subject B agrees). Imagined that the level could stop when reaching the goal.

Session 4 Table

Demographics	Subjec A	Subject B
Gender	Female	Female
Sudy	Medialogy	Medialogy
Tablet Use	None	None
Tangible Widget Experience	None	None
Language	English	English
Name	Sofia	Jette
Tutorial Level	88%	100%
Level 1	73%	76%
Level 2	68%	51%
Level 3	22%	16%

Interview notes:

- Subject B: difficult at the end, it was completely red, used a combination of different methods, mostly moving back.
- Otherwise it was straightforward,
- They use few words in the interview.
- Light: “Where the fuck am I?”, bigger than the side
- Not mean to each other, they laugh, they played more separately.
- Suggest to give visual feedback after the level to see the path drawn by the user.

After revealing the test purpose:

- Subject A expressed it was frustrating
- Subject B confirms it didn't go well, being a bit quiet, it has to be more difficult in order to get mad (implying that she needs to invest more of herself, before experience it negatively)

Session 5 Table

Demographics	Subjec A	Subject B
Gender	Male	Female
Sudy	Medialogy 3. Semester	Medialogy 3. Semester
Tablet Use	Rarely	Rarely
Tangible Widget Experience	Once	None
Language	Danish	Danish
Name	Sargen	Christina
Tutorial Level	53%	87%
Level 1	0%	77%
Level 2	2%	28%
Level 3	20%	36%

Note: The battery of the tablet was low, which caused an interference from test conductors in the tutorial of Subject A.

Interview notes:

- Subject A: “second player advantage”, quick to finish a level, he didn’t see the first line, though he had to drag the green circle to the red one.
- Subject B: the green light feedback is uneven, tried to go back to the line, too little time, looked mostly on the light as a scale.
- Subject A: too much time in the levels, he used the light when he found the line.
- Subject A claims that B was evil, she had the right to taunt him, because she won.

After revealing the test purpose:

- Subject B: so that is why, very annoying, angry, wondered why she couldn’t find it.
- Subject A: thought level 2 was broken.

Test Instructions

Introduction in the test room:

- Demographics: study, usage of tablets, experience with tangible widgets.
- Start camera - confirm permission to film
- We will be leaving the room, so listen carefully
- Explain what the game is about
 - Trace the line with widget
 - show where to hold it
 - explain the delay
 - time limit - continues till time runs out, can't finish earlier
 - focus on accuracy within the time limit “as close to 100% as possible”
 - “There will first be a tutorial, then a training level and then you will play three real levels that are the “real test””
 - “When the first person is done, switch seats(for the camera) and play through it again”
 - Explain why two participants
 - * Give them paper and explain that they need to fill out the fields so they can compare results
 - * facilitate a way to choose who goes first - if they can't decide by themselves rock paper scissors
 - start the game - “When you are both done, come get us, we will be right outside the door”
 - final questions?

Semi-structure Interview

The questions in the post test interview asked to the participants general experience of the game in order to see, if they bring up the subject of the misguiding light feedback. And the last part of the interview reveals the broken level in order to detect how they react on it.

- “How was it?”
- General comments
- “Who won?”
- Check their map scores
- “Was it fun?”

- Take the conversation wherever it leads
 - What did you think of the light feedback?
 - was it easy to trace the line?
 - Did you like interacting with the tangible widget?
 - Did you like
- Reveal gimmick
 - It is actually a different test for a perception and cognition course
 - The last map for the last person was rigged
 - Looking for the reaction at that point
 - Listen to feedback on that / comments on that
 - Thank them for participating

Further Observations

- Female/male mixed pairs were competitive, while the two females were more inclined to help one another or giving moral support. Some had more attention on the score than. All subjects expressed some sense of relief or relaxation when receiving the score, as their concentration is less focused.
- Verbally the subjects expressed themselves by asking questions to themselves or the spectator, by cursing, by giving commands to the light feedback, and by making small uncomprehending sounds.
- Some subjects did not speak much while interaction with the game, as they were in full concentration in the task of tracing the line. Instead they made small unconscious facial expressions.
- All subjects would smile or make small twitches with their mouth while interacting with the system.
- There is a tendency that Subject B is very curious when Subject A is interacting with the system. This can be to learn the mechanics of the game, learn from Subject A's mistake, or making their own strategies, as they believe they have the advantage. While Subject A reacted by teasing the other with the score, making suggestions, or by looking away passively.