# 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, 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. Ac-

cording 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 hypatalamus, which creates Adrenocorticotropt 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 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 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 of. 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 of 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 of 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). 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 preset preliminaries(see Appendix), 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 ??.

## 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 **??**). All the subjects were 3rd semester Medialogy students at Aalborg University and had the following demographics(See Appendix).

## 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, see Appendix Section ??, 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). 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.

# Bibliography

[Cannon, 1927] Cannon, W. B. (1927). *Bodily Changes in Pain, Hunger, Fear and Rage*. New York and London D. Appleton and Company.

[Card et al., 1986] Card, S. K., Moran, T. P., and Newell, A. (1986). *The Model Human Processor: An Engineering Model of Human Performance*. UIR-R-1986-05.

[Fernandes Jr. et al., 2003] Fernandes Jr., O., Portugal, L. C. L., Alves, R. C. S., Campagnoli, R. R., Mocaiber, I., David, I. P. A., Erthal, F. C. S., Volchan, E., de Oliveira, L., and Pereira, M. G. (2003). *How You Perceive Threat Determines Your Behavior*. Journal, Frontier in Human Neuroscience.

[Jansen et al., 1995] Jansen, A. S. P., Nguyen, X. V., Karpitskiy, V., Mettenleiter, T. C., and Loewy, A. D. (1995). *Central Command Neurons of the Sympathetic Nervous System: Basis of the Fight-or-Flight Response*. Magazine, Science, Vol. 270, No. 5236.

[Kalin, 2014] Kalin, N. H. (2014). *Perspectives in the Management of Anxiety Disorders*. Session of Char Summit; Master Class for Neuroscience Professional Development.

[Pocock, 2006] Pocock, G. (2006). *Human Physiology*. Oxford University Press.

[Taylor et al., 2000] Taylor, S. E., Klein, L. C., Lewis, B. P., Gruenewald, T. L., Gurung, R. A. R., and Updegraff, J. A. (2000). *Biobehavioral Responses to Stress in Females: Tend-and-Befriend, not Fight-or-Flight*. Psychological Review, Vol. 107, No. 3.