

# Biofeedback Research Report

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## Team Physion

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## Conclusion

Two of the most important factors we considered during our research on biofeedback is how easy to analyze the data and how salient it could be during game play.

Also, based on device search, availability of suitable device for our project would be examined.

With those factors, the biofeedback data types we will use are Sweat Gland which is Galvanic Skin Response, Brain Waves and Heartbeat Rate.

In addition, we would use motion sensor to increase immersive experience.

## Biofeedback

Criteria	*Easy analysis	*Salience	Suitable Device
Muscle Action	X	O	X
Skin Temperature	O	X	O
<b>Galvanic Skin Response</b>	O	O	O
<b>Brain Waves</b>	O	O	O
<b>Heartbeat Rate</b>	O	O	O
Heat Flux	O	X	X
Chest Movement	X	X	X
End-tidal CO2	X	X	X
HEG Feedback	X	X	X
Heart Electricity	X	X	O
<b>Motion</b>	O	O	O

**O: Available, X: Not Available**

**\*Easy Analysis:** Availability that we can obtain numeric data without expert analysis

**\*Salience:** Propriety of player's recognition and obtained biofeedback data. Also related with the speed of the reaction comes to numeric data.

**\*Suitable Device:** Availability of suitable device for our project



## 1. EMG (Muscle Action Potentials)

An Electromyograph in a biofeedback setting typically uses electrodes in order to measure muscle action potentials. These action potentials result in muscle tension. The patient can learn to recognize the way tension subjectively feels by using the objective EMG readings, and as a result learn to control the muscle tension.

### Pros:

- Can help to improve experience according to player's potential action

### Cons:

- Every probe can only detect one part of player's body. But, too many probes will hinder player's movement
- Expensive equipment is required. (\$2000+)
- Mainly used for medical purpose and hard to apply to game



## 2. Thermometer (Skin Temperature)

A thermometer attached to the subject's digits or web dorsum measures the subject's skin temperature. Because there is a correlation between a drop in body temperature and the patient's experience of stress, a low temperature reading indicates the need to begin relaxation techniques.

### Pros:

- Affordable price
- Able to detect player's emotion level

### Cons

- Players' physical movement during game play may affect temperature.
- It usually doesn't change much during game play.



## 3. Electrodermograph (Galvanic Skin Response)

Easily measured and relatively reliable, GSR has been used as an index for those who need some measurable parameter of a person's internal "state". Physiology, the GSR reflects sweat gland activity and changes in the sympathetic nervous system and measurement variables. Measured from the palm

or fingertips, there are changes in the relative conductance of a small electrical current between the electrodes. The activity of the sweat glands in response to sympathetic nervous stimulation (Increased sympathetic activation) results in an increase in the level of conductance. There is a relationship between sympathetic activity and emotional arousal, although one cannot identify the specific emotion being elicited. Fear, anger, startle response, orienting response and sexual feelings are all among the emotions which may produce similar GSR responses.

**Pros:**

- Most salient biofeedback
- Easy to measure
- Able to know tensions

*\*Lie Detector (Polygraph)*

*Check 3 factors: Respiration, pulse rate, galvanic skin response (in finger) sweat gland activity*



**4. EEG (Brain Waves)**

An electroencephalograph, or EEG monitors the activity of brain waves. These brain waves correspond to different mental states, such as wakefulness (Beta waves), relaxation (Alpha waves), calmness (Theta waves), and light sleep and deep sleep (Delta waves).

**Pros:**

- Can detect player’s brain activity such as focusing and meditation
- There are a lot of research and device

**Cons**

- Traditional device is huge and expensive
- It is complicated to analyze the brain wave



**5. Photoplethysmograph (Heartbeat)**

Photoplethysmographs, or PPGs, in biofeedback are used to measure peripheral blood flow, heart rate, and heart rate variability (HRV). To measure HRV, PPGs measure the varying distances between

heartbeats, also known as the interbeat interval (IBI). This data guides users in finding a breathing pattern that increases their variability.

**Pros:**

- Can detect whether people is calm or excited
- Easy to measure.



## 6. Heat Flux

Heat Flux is the rate at which heat is being dissipated from body. Exercise physiologists are interested in the heat energy produced by the body, your muscles are fairly inefficient and we all produce a lot of heat energy when we perform physical work.

**Pros:**

- Check energy consumption

**Cons**

- Need relatively long time to measure
- Time lag between observed value and state of person



## 7. Pneumograph (Abdominal/Chest Movement)

A pneumograph measures abdominal/chest movement when breathing. It's used to detect breathing rate, and correct ineffective breathing patterns such as thoracic breathing, reverse breathing, and apnea. They are also often used in conjunction with a PPG in HRV training.

**Pros:**

- Can detect whether people is physically tired or relaxed.

**Cons:**

- Since people can easily count respiration rate with only a stopwatch, there is few automatically respiration detectors.
- The existing devices are hard to connect to PC.



## 8. Capnometer (End-tidal CO2)

A capnometer measures end-tidal CO2 with an infrared detector. All biofeedback training that employs the use of a capnometer aims at normalizing end-tidal CO2 at 5%.

### Pros:

- Portable model exist (EMMA Emergency Capnometer)

### Cons:

- Need tube directly connects to the mouth or nose - inconvenient
- Usually need expensive heavy equipment: costs \$ 1200 or more
- Hard to connect to PC



## 9. Hemoencephalography

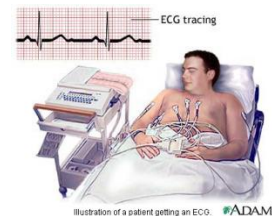
Hemoencephalography, or HEG biofeedback is an attempt at functional infrared imaging. As its name describes, it measures the differences in the color of light reflected back through the scalp based on the relative amount of oxygenated and unoxygenated blood in the brain.

### Pros:

- Able to know which part of brain is being used

### Cons:

- Expensive, new equipment costs \$1500++
- Complicated to analyze (need a neuroscience expert)



## 10. ECG/EKG

An electrocardiogram (e-lek-tro-KAR-de-o-gram), or EKG, is a simple, painless test that records the heart's electrical activity. To understand this test, it helps to understand how the heart works.

With each heartbeat, an electrical signal spreads from the top of the heart to the bottom. As it travels, the signal causes the heart to contract and pump blood. The process repeats with each new heartbeat. The heart's electrical signals set the rhythm of the heartbeat.

### Pros:

- Can know how fast your heart is beating
- Whether the rhythm of your heartbeat is steady or irregular
- The strength and timing of electrical signals as they pass

**Cons:**

- expensive

## 11. Accelerometer

An accelerometer is a device that measures the vibration, or acceleration of motion of a structure. The force caused by vibration or a change in motion (acceleration) causes the mass to "squeeze" the piezoelectric material which produces an electrical charge that is proportional to the force exerted upon it.

**Pros:**

- Measure the movement
- If we use Wiimote, it is not hard to program.

**Cons:**

- Not biofeedback

