Data Analysis Report

The report takes a deep dive into data collection during cognitive training sessions, known as Brain First and Aristotle, involving young players from PSV youth club. We are particularly interested in their physiological responses, which were measured using equipment like the Shimmer 3GSR+ for Skin Conductance and the Movesense Heart Rate Sensor for Heart Rate Variability (HRV).

Data Requirements
Most of the data requirements have already been satisfied for this data analysis report on the football training sessions.

Data Selection: The data for the exploratory data analysis has been confirmed to include Skin Conductance and Heart Rate Variability (HRV) measurements from the Aristotle and Brain First football training sessions.

Stakeholder Identification: A comprehensive list of significant stakeholders who will benefit from this report has been compiled. These stakeholders will gain insights from the analysis of the Skin Conductance and HRV datasets.

Attribute Compilation: The relevant attributes for the tables in the dataset have already been gathered. However, a thorough reevaluation of data preparation and exploratory data analysis will be conducted in subsequent phases to ensure data quality and completeness.

Relationship Establishment: While all potential attributes for the relevant tables have been collected, the upcoming phases will focus on establishing relationships and correlations between these attributes within the dataframes. This step will provide a deeper understanding of how different factors are interconnected and influence the PSV players physiological responses during the training sessions.

Data Extraction & Collection
The data regarding the cognitive training were extracted and collected by a previous paramedics students which was given to us from the Jurrit Sander during our interview meeting and it was mentioned that these are all the datasets that we are supposed to work upon.

Source Data: Cognitive Stress Data

Source Data Password: PSVcognition-1

Process of Measuring Skin Conductance
First, we power on the Shimmer 3GSR+ and establish a Bluetooth connection between the Shimmer and our PC. We utilize the ConsensysPRO software to manage the Shimmer, configuring important settings such as trial names, measurement frequencies (for instance, we used 10Hz), and what exactly the Shimmer should measure.

Next, we proceed to the live data recording phase. Within the ConsensysPRO software, we select the Shimmer, establish a connection, and choose the type of measurement we want to conduct. Its important to note that we can only initiate one measurement at a time.

Once the measurement is complete, We have the option to record the data in two ways. We can either save it on the Shimmers SD card or on the PC its connected to. If we choose to save it on the PC, its crucial to stay close to the Shimmer to maintain the connection, ensuring that the data recording remains uninterrupted.

Process of Measuring Heart Rate Variability
Shifting our focus to measuring Heart Rate Variability, We utilize a dedicated app on an Android phone with Bluetooth and location services enabled. After opening the app, we establish a connection with the Movesense sensor. We have the option to customize

the measurement by setting parameters such as frame duration.

Once we initiate the measurement, we record HRV data, and when finished, we ensure we press Stop and then return to the main menu before closing the app. To access and analyze the HRV data, we open the data summary and select the appropriate HRV file. Typically, we concentrate on the RMSSD value, which represents Heart Rate Variability.

Data Understanding
There are 2 types of cognitive training test: BrainsFirst (BF) and Aristotle (AR). Brain First is a simpler cognitive training test, while Aristotle is a more complex one with various challenging tasks.

Both of these cognitive training programs gathered data from 4 young soccer players who were part of the PSV youth club. The primary objective of these tests was to assess cognitive stress, a crucial factor in understanding and enhancing an athletes performance. The assessment involved the measurement of two key indicators: Skin Conductance and Heart Rate Variability.

Skin Conductance was monitored using a specialized device known as the Shimmer 3GSR+ with a sampling rate of 10 Hz. The data collection process for skin conductance was facilitated by the Consensys PRO software, which ensured precise measurements and data recording.

Heart Rate Variability, on the other hand, was recorded using a sensor called the Movesense Heart Rate Sensor. The software responsible for connecting to this sensor was developed by a Fontys student and is named Fontys (Santys). This software played a major role in acquiring accurate heart rate variability data, enabling a comprehensive analysis of the players cognitive stress levels during the training programs.

The data from the Cognitive Stress Project is organized into two separate folders. The first folder contains all the data related to the BF1 and BF2 training, while the second folder contains all the data for the Aristotle training. Despite the initial differentiation, the data structure and setup within both folders are identical.

Below is a visual representation of one of these folders, specifically the training folder for Aristotle:

To ensure long-term accessibility to the provided dataset, we plan to migrate the dataset from my laptops local storage to a cloud-based web platform. This will enable universal access, allowing anyone to view the dataset and the analysis from any location at any time, without requiring my laptop credentials.

Technology Impact Cycle Tool

Data Analysis Report

As is evident from the visual representation of the folder, we have received both raw and processed data. Following several discussions with the instructors of previous paramedic students, we reached a consensus that the Raw Data is more reliable. This conclusion arose from the fact that the previous paramedic students lacked the expertise to effectively clean and process the datasets.

Consequently, we made the strategic choice to initiate the cleaning and transformation process on the raw data, rather than relying solely on the processed data for our analysis. To delve into the actions and assumptions underlying our dataset preparation, we will provide a step-by-step description of our procedures supported by visual aids on one of the file, showing our methods for generating the processed dataset.

I will provide a step-by-step explanation of the Raw Data, which relates to Skin Conductance measurements > on the Finger > of Player 1. This data was originally obtained in MATLAB and is now stored in an Excel file, with pages named CDA and TTP. Following a discussion with the instructor of the Paramedics students, it is strongly recommended to use the CDA dataset, as it is considered a more accurate representation of Skin Conductance compared to the TTP dataset.

It is worth mentioning that both dataset files contain exactly two Excel sheets, CDA and TTP, each of which includes the same two columns of data.

We have received the following 2 columns of Raw Data: CDA.SCR-Onset and CDA.SCR-Amplitude

CDA.SCR-Onset: represents the onset times of changes in Skin Conductance response (SCR) during the Aristotle game. Skin Conductance response is a physiological measure that reflects changes in the electrical conductance of the skin, often associated with emotional responses. The values in this column represent the times when changes in Skin Conductance were detected. In the context of the Aristotle game, it provide information about when specific physiological responses occurred, related to cognitive reactions during the game.

CDA.SCR-Amplitude: represents the magnitude of the Skin Conductance response (SCR) at the corresponding onset times. The amplitude of SCR can provide insights into the intensity of physiological responses. In the context of the Aristotle game, this column offer information about the magnitude of physiological reactions at specific time points, which can be used to assess the intensity of physiological changes during different phases of the game.

This Skin Conductance Raw Data on the Finger of Player 1 has 96 observations, with each row indicating a specific time point (CDA.SCR-Onset) when a Skin Conductance response occurred and the corresponding magnitude of that response (CDA.SCR-Amplitude). These rows collectively provide a timeline of physiological responses, related to cognitive stress reactions during the Aristotle game.

Data Preparation

After gaining valuable insights from the dataset, the subsequent step involves Data Preparation. In this phase, we implemented various adjustments, such as:

Step 1: Rename Column
To enhance clarity, consistency and data usability.

Step 2: Add Row Number
To maintain data integrity during sorting and tracking data-related changes.

Step 3: Unit Conversion & Rounding Calculations
To navigate and interpret data easier, which is important for Exploratory Data Analysis.

Peak Per Minute Timeframe: This metric is determined by dividing the CDA.SCR-Onset Raw Data by 86,400, which converts the value from seconds to minutes. The result is then formatted then in the HH:mm:SS format as shown below.

Skin Conductance Finger Amplitude: This metric is computed by rounding the CDA.SCR-Amplitude Raw Data to two decimal places for improved readability, using the formula =Round(CDA.SCR-Amplitude Raw Data,2).

Step 4: Import the Cleaned Data in Power BI
To connect various data files (AR, BF) and create data models for a Business Intelligence Report.

Applied Steps: As it can be visible from the image, we outline the actions taken to further prepare the dataset for exploratory data analysis. These steps include:

Sub-Step 1: Remove Unnecessary Columns:
Narrowed down the dataset by eliminating columns that didnt contribute to our insights, allowing us to focus on the most relevant information.

Sub-Step 2: Add New Column
To provide additional context. These columns include:

Training Type: Indicates the type of training conducted, distinguishing between BrainFirst and Aristotle.
Player ID: Identifies the specific player on whom the training was conducted.
Test Measurement: Specifies the body part on which the Skin Conductance Measurement was applied.
Sub-Step 3: Append Query
To combine data from different training types, players, and test measurements for our visualization.

Step 5: Cleaned Dataset

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1. Row Number: is utilized to maintain data integrity during sorting and tracking data-related changes.
2. Training Type: represents the type of training conducted, distinguishing between BrainFirst and Aristotle.
3. Player ID: represents the specific player on whom the training was conducted.
4. Test Measurement: represents the body part on which the Skin Conductance Measurement was applied.
5. Peak Per Minute Timestamp: represents the onset times of changes in Skin Conductance response (SCR) during the Aristotle game. Skin Conductance response is a physiological measure that reflects changes in the electrical conductance of the skin, often associated with emotional responses. The values in this column represent the times when changes in Skin Conductance were detected. In the context of the Aristotle game, it provide information about when specific physiological responses occurred, related to cognitive reactions during the game.
6. Skin Conductance (Finger/Shoulder) Amplitude: represents the magnitude of the Skin Conductance response (SCR) at the corresponding onset times. The amplitude of SCR can provide insights into the intensity of physiological responses. In the context of the Aristotle game, this column offer information about the magnitude of physiological reactions on (fingers / shoulder) at specific time points, which can be used to assess the intensity of physiological changes during different phases of the game.

Phase 3: Exploratory Data Analysis
As we move into the heart of our project, the second phase entails data analysis. During this phase, we will delve into the data weve prepared. Our primary focus will be on applying exploratory data analysis techniques to uncover meaningful insights for the Peaks Per Minutes Datasets. We will explore correlations, patterns, and trends within the data, shedding light on how the athletes physiological responses relate to the training methods used in Aristotle and BrainFirst sessions.

Average of Skin Conductance

Average vs Count of Skin Conductance Over Time

This graph shows the average and count of skin conductance over time. The average skin conductance is increasing over time, while the count of skin conductance is fluctuating. The average skin conductance is a measure of the overall level of arousal, while the count of skin conductance is a measure of the number of peaks in skin conductance.

Average of Skin Conductance Per Player Over Time

This graph shows the average skin conductance per player over time. The average skin conductance per player is fluctuating over time, but there is a noticeable sharp increase in skin conductance towards the end of the session for some specific players.

Average of Skin Conductance Per Measurement Over Time

This graph shows the average skin conductance per measurement over time. The average

skin conductance per measurement is fluctuating, but there is another noticeable increase in skin conductance towards the end of the training session, particularly in the shoulder measurement.

Average of Skin Conductance Per Training Over Time

This graph shows the average skin conductance per training over time. The average skin conductance per training is fluctuating over time.

Average of Skin Conductance Per Training Over Time
The image below shows three graphs of average skin conductance per training over time, for three different training types: Aristotle, Brain First 1, and Brain First 2.

Aristotle: Average of Skin Conductance Per Training Over Time

The AR graph reveals a continuous fluctuation in the average skin conductance over time, resembling a mountain-like pattern with two prominent peaks and three valleys. This suggests that players experience two significant stress peaks during the entire session.

Brain First 1: Average of Skin Conductance Per Training Over Time

The BF1 graph shows a sharp drop in skin conductance during the first 30 minutes of the training session. Afterward, theres an unpredictable and sustained increase in skin conductance that persists until the end of the session.

Brain First 2: Average of Skin Conductance Per Training Over Time

The BF2 graph displays a relatively stable line along the x-axis, with a few peaks and valleys along the way. However, there is a sudden increase in skin conductance observed toward the end of the training session which could be an outlier.

Average of Skin Conductance Per Player Over Time
The picture below shows three graphs of average skin conductance per player over time. The graphs are labeled Aristotle, Brain First 1, and Brain First 2.

Aristotle: Average of Skin Conductance Per Player Over Time

The AR graph shows a gradual increase in average skin conductance over time, with some peaks and valleys along the way. The overall trend is upward, suggesting that players are having more skin conductance peaks over time.

Brain First 1: Average of Skin Conductance Per Player Over Time

The BF1 graph shows a more pronounced increase in average skin conductance over time, with fewer peaks and valleys. The overall trend is still upward, but the rate of increase is faster than in the AR graph.

Brain First 2: Average of Skin Conductance Per Player Over Time

The BF2 graph shows a gradual decrease in average skin conductance over time. The overall trend is gently sloping downward, with few peaks and valleys.

Average of Skin Conductance Per Measurement Over Time
The picture below shows three graphs of average skin conductance per player over time. The graphs are labeled Aristotle, Brain First 1, and Brain First 2.

Aristotle: Average of Skin Conductance Per Measurement Over Time

The AR shows a steady increase in skin conductance for both shoulder and finger over time. The finger line is consistently higher than the shoulder line, indicating that the finger is more responsive to stimuli.

Brain First 1: Average of Skin Conductance Per Measurement Over Time

The BF1 graph for finger shows a consistent, unchanging line throughout the training session. In contrast, the shoulder line exhibits an erratic and unpredictable increase in skin conductance, occurring roughly halfway through the session and reaching an exceptionally high level.

Brain First 2: Average of Skin Conductance Per Measurement Over Time

The BF2 graph shows a gradual decline in skin conductance for the shoulder over the course of the training session. On the other hand, the finger line appears as a relatively stable straight line along the x-axis, with a sudden increase occurring toward the end of the training session.

Count of Skin Conductance

Count vs Average of Skin Conductance Over Time

This graph shows the average and count of skin conductance over time. The average skin conductance is increasing over time, while the count of skin conductance is fluctuating. The average skin conductance is a measure of the overall level of arousal, while the count of skin conductance is a measure of the number of peaks in skin conductance.

Count of Skin Conductance Per Player Over Time

The graph shows the count of skin conductance per player over time. It reveals that this count fluctuates as the training session progresses. There are two noticeable peaks in skin conductance, one occurring approximately 15 minutes into the session, and another at around the 30-minute mark. Following these peaks, there is a subsequent decrease in skin conductance.

Count of Skin Conductance Per Measurement Over Time

This graph shows the count of skin conductance per measurement over time. Its worth highlighting that the count of skin conductance for the finger is consistently higher than that for the shoulder.

Its important to mention that both measurements were recorded and collected simultaneously.

There are several possible reasons for this difference:

It could be that during the training, the shoulder produces less sweat than the finger, leading to less stress peaks data recording by the sensor.

Alternatively, there might be variations in the frequency of measurements between the data collected for the finger and shoulder.

Lastly, the tools and software used to record these psychological responses could also contribute to the observed differences.

Count of Skin Conductance Per Training Over Time

The graph shows the count of skin conductance per training session over time. Similar to the count of skin conductance per player over time graph, it demonstrates fluctuations in the count of skin conductance during each training session. There are two prominent peaks observed at the 15-minute and 30-minute marks, and there are three corresponding valleys both before and after each peak.

Count of Skin Conductance Per Training Over Time
The image below shows three graphs of count skin conductance per training over time, for three different training types: Aristotle, Brain First 1, and Brain First 2.

Aristotle: Count of Skin Conductance Per Training Over Time

The AR graph shows a continuous pattern of fluctuating skin conductance counts over time. There are two distinct peaks and three valleys, indicating that players go through two significant stress peaks during the entire session .The highest peak reaches a significant level, reaching up to 150 peaks within a 5-minute timeframe.

Brain First 1: Count of Skin Conductance Per Training Over Time

The BF1 graph shows a continuous pattern of fluctuating skin conductance counts over time. Whats distinctive about this graph is the consistently high count of skin conductance, and it features three significant peaks occurring approximately every 15 minutes. Following each peak, there is a notable drop and the highest peak reaching as high as 250 counts within a 5-minute timeframe.

Brain First 2: Count of Skin Conductance Per Training Over Time

The BF2 graph display a continuous pattern of fluctuating skin conductance counts over time. Similar to the BF1 graph, it also features three distinct peaks, occurring approximately every 15 minutes. However, what sets it apart is that the peaks tend to increase over time. The last two peaks are notably the highest, with each reaching around 200 counts within a 5-minute interval.

Count of Skin Conductance Per Player Over Time
The picture below shows three graphs of count skin conductance per player over time. The graphs are labeled Aristotle, Brain First 1, and Brain First 2.

Aristotle: Count of Skin Conductance Per Player Over Time

The AR graph demonstrates a gradual fluctuation in skin conductance count over time, with several peaks and valleys throughout. The overall trend can be seen by this fluctuation, indicating that players experience 2 or 3 high skin conductance peaks during their session.

Brain First 1: Count of Skin Conductance Per Player Over Time

The BF1 graph displays a more pronounced fluctuation in the count of skin conductance over time, featuring several peaks and valleys. The overall trend is similar to AR1, with 3 distinct high skin conductance peaks occurring during the session.

Brain First 2: Count of Skin Conductance Per Player Over Time

The BF2 graph shows a gradual fluctuation in the count of skin conductance over time. The overall trend is characterized by a gentle upward slope, and it exhibits 3 to 4 notable high peaks.

Count of Skin Conductance Per Measurement Over Time
The picture below shows three graphs of count skin conductance per player over time. The graphs are labeled Aristotle, Brain First 1, and Brain First 2.

Aristotle: Count of Skin Conductance Per Measurement Over Time

In the AR graph, the skin conductance for the shoulder displays a steady increase, with the highest peak occurring after 30 minutes. On the other hand, the finger line exhibits fluctuations with two peaks recorded after 10 minutes and 30 minutes, respectively. This suggests that the finger is more responsive to stress peaks than the shoulder.

Brain First 1: Count of Skin Conductance Per Measurement Over Time

In the BF1 graph, the count of skin conductance for the finger reveals a consistent and

rapid fluctuation occurring roughly every 10 minutes throughout the entire training session, culminating in the highest peaks towards the end of the session. On the other hand, the count of skin conductance for the shoulder shows a gradual increase over time, with two distinct high peaks, and the highest one occurring after 30 minutes.

Brain First 2: Count of Skin Conductance Per Measurement Over Time

In the BF2 graph, theres a continuous increase in the count of skin conductance for both the shoulder and finger over time. Notably, the line for the finger consistently remains higher than the one for the shoulder, but both lines follow the same trend of having two prominent peaks.

Phase 4: Exploratory Data Analysis Conclusion
The exploratory data analysis (EDA) of the Peaks Per Minutes Datasets reveals several notable insights and trends.

Firstly, there is a notable upward trend in the average skin conductance levels, indicating a progressive increase in arousal levels throughout the sessions. Specific players exhibit distinctive behaviour, with some showing sharp increases in skin conductance levels towards the end of their sessions. Additionally, there is a late-session increase observed in shoulder measurements for certain players.

When considering skin conductance by training type, different patterns emerge. In Aristotle sessions, two significant stress peaks are identified, suggesting moments of heightened arousal during the training. In contrast, Brain First 1 session display a sharp drop in skin conductance within the first 30 minutes, followed by an unpredictable increase later in the session. Brain First 2 sessions, on the other hand, exhibit relatively stable readings for the majority of the session, with a sudden increase observed towards the end.

Furthermore, when examining skin conductance by player, players participating in Aristotle and Brain First 1 session both demonstrate increasing trends in their skin conductance levels. However, the rate of increase varies between individual players. In contrast, players in Brain First 2 sessions experience a gradual decrease in skin conductance levels over time.

The analysis also reveals variations in skin conductance counts over time, with two prominent peaks occurring around the 15 and 30-minute marks. These fluctuations in peak counts suggest that arousal levels may be influenced by the specific training activities and their timing within the sessions.

Conclusion
Sensor Comparison:

The data from the shoulder sensor and the finger sensor do not match closely, even though we used them in the same cognitive test under the same conditions. This was surprising because we expected them to be similar, but their readings are quite different.

Assumptions:

The sensors may measure different frequencies for shoulder and finger data.
The shoulder sensor may record fewer data points accurately due to less sweat.
Different tools may be used for the shoulder and finger sensors, resulting in different psychological responses.
Finger Sensor Reliability:

Assumptions:

The finger sensor data is more reliable as it contains more data and accurately captures cognitive stress peaks per minute.
This finding was confirmed during a discussion with our paramedic teacher, Manon.
Timing of Stress Peaks:

Assumptions: * Stress peaks in players primarily occur between the 30 to 40-minute mark. Its important to note that this doesnt necessarily mean exceptionally high stress levels during this time, but rather that players are more susceptible to stress during this specific period compared to other times in the test.

Impact on society
What impact is expected from your technology?

This category has not been filled yet.

Hateful and criminal actors
What can bad actors do with your technology?

This category has not been filled yet.

Privacy

Are you considering the privacy & personal data of the users of your technology?

This category has not been filled yet.

Human values

How does the technology affect your human values?

This category has not been filled yet.

Stakeholders
Have you considered all stakeholders?

This category has not been filled yet.

Data

Is data in your technology properly used?

This category has not been filled yet.

Inclusivity
Is your technology fair for everyone?

This category has not been filled yet.

Transparency

Are you transparent about how your technology works?

This category has not been filled yet.

Sustainability
Is your technology environmentally sustainable?

This category has not been filled yet.

Future
Did you consider future impact?

This category has not been filled yet.