Utilizing Bio-sensing To Measure Performance Across Diverse Tasks and Provide Feedback

Human Technology Interaction

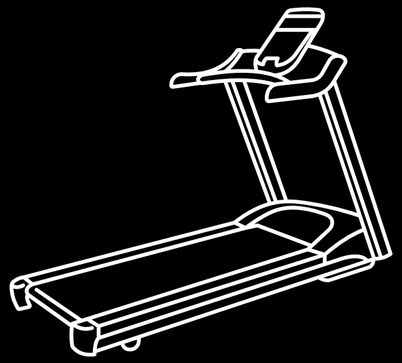
Affective computing bridges the gap between human emotions and technology, enabling machines to understand our hearts, not just our commands.

so says GPT...

PLAKSHA UNIVERSITY

Different Aspects of Study

Cognitive



Physical

Emotional

Literature Survey

Differences Between High vs. Low Performance Chess Players in Heart Rate Variability During Chess Problems

Published online 2019 Feb 26. doi: 10.3389/fpsyg.2019.00409

HRV was significantly higher in the high performance group than in the low performance group during chess problems.

Heart rate variability-guided training in professional runners: Effects on performance

Published online 2022 Feb . doi: 10.1016/j.physbeh.2021.11365

HRV-guided training allows profesional runners to achieve higher training intensities.

Literature Survey

Differences of Heart Rate Variability Between Happiness and Sadness Emotion States: A Pilot Study

Published online 05 June 2017. doi: 10.1007/s40846-017-0238-0

The key result was that 6/9 HRV indices wereidentified having significant differences between happiness and sadness emotion states.

Utilizing Deep Learning Towards Multi-modal Bio-sensing and Vision-based Affective Computing

Published online May 2019 . doi: 10.1109/TAFFC.2019.2916015

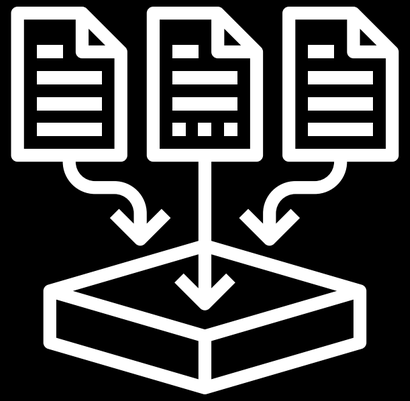
Helped us in finding different methodologies to extract the features out of different modalitites in bio-sensing data

Deliverables

- Find out areas where individual flourishes
- Try to find if there is any major impact between different aspects
- Find out if bio-sensing feedback actually helps

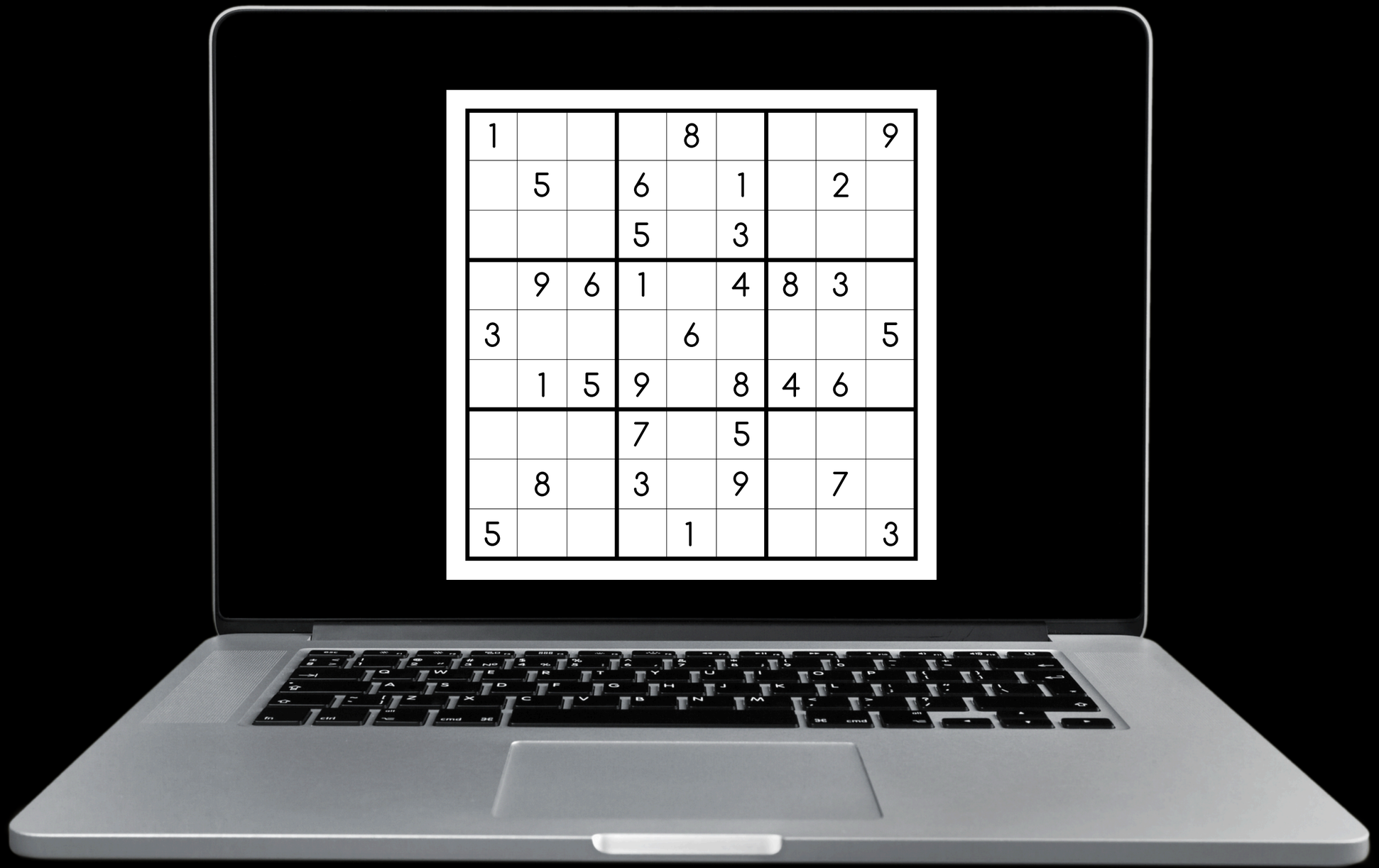
Privacy and Ethical Concerns

Informed Consent



Secure Data Storage

Anonymization

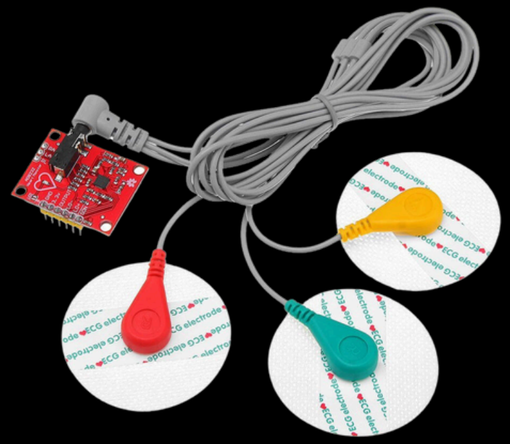

1 8 9
5 6 1 2
5 3
9 6 1 4 8 3
3 6 5
1 5 9 8 4 6
7 5
8 3 9 7
5 1 3

Measuring HRV

Unreliable Processing

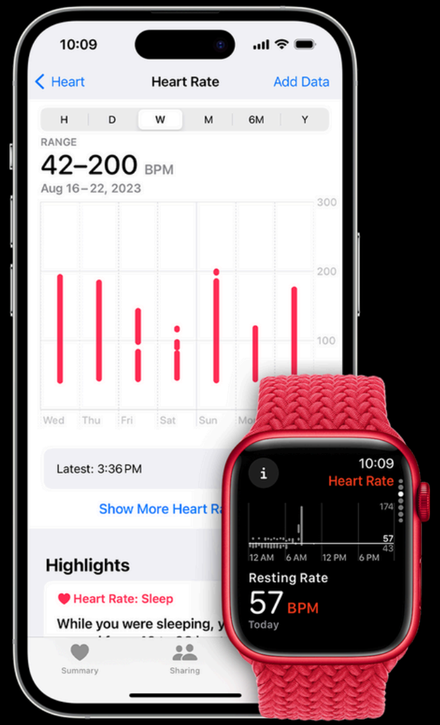
Too invasive to wear

Additional post-processing



ECG

less invasive



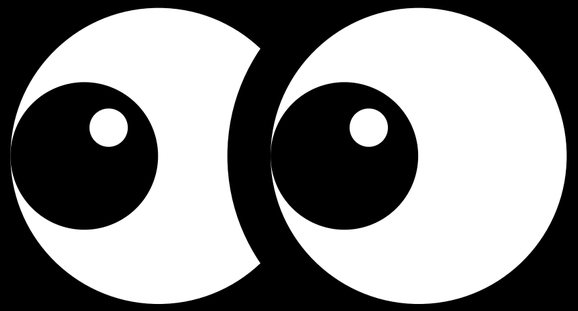
Access HRV Data directly for 1 min interval

Easy export of data for analysis

Powered by advance processing algorithms that also takes into consideration the acceleration data for noise removal from the signal

Apple Watch

Tracking the Eye Gaze



WebGazer.js

Track the user’s eye gaze across screen but can’t detect look aways directly. needs to be calibrated again and again.

GazeTracking

Provides the ratio of the eye gaze in the horizontal and vertical direction.

Task Engagement

Assess overall engagement during the task.

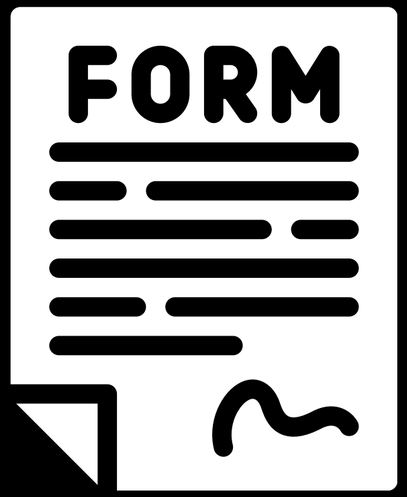
Method

Calculate the proportion of time the gaze stays within the central area.
(e.g., horizontal ratio: 0.3-0.7, vertical ratio: 0.3-0.7).

Interpretation

High central focus indicates engagement; frequent gazes outside the grid may indicate distraction.

Baseline



Subjective Questionnaire

Resting

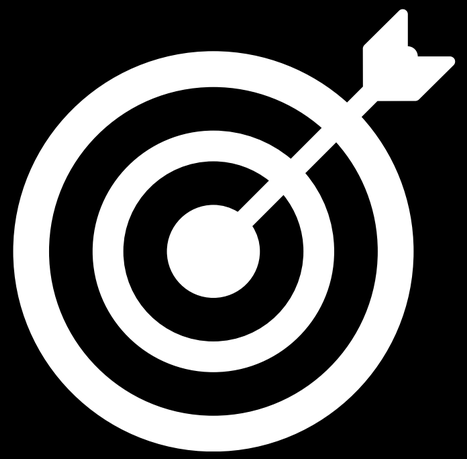
	7		5	8	3		2	
	5	9	2			3		
3	4				6	5		7
7	9	5				6	3	2
		3	6	9	7	1		
6	8				2	7		
9	1	4	8	3	5		7	6
	3		7		1	4	9	5
5	6	7	4	2	9		1	3

Easy

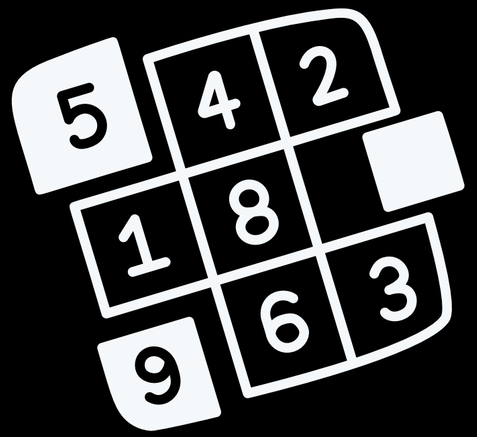
			5		7			
	4		2	6	3			
1		7	4					
3	6						4	5
		2		5		7		
7	9						6	2
					9	4		1
			1	3	4		9	
			6		5			

Medium

Performance

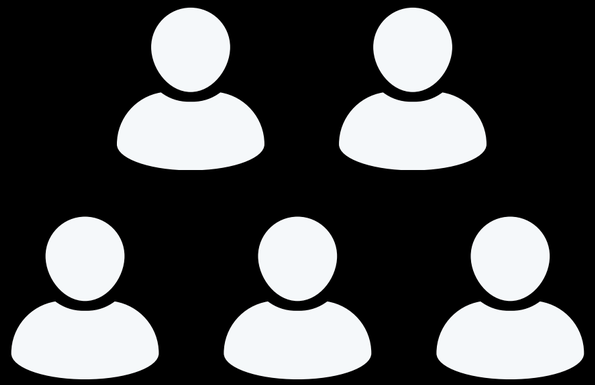


Accuracy



Correct Cells Count

Overview of Experiments



5 Participants

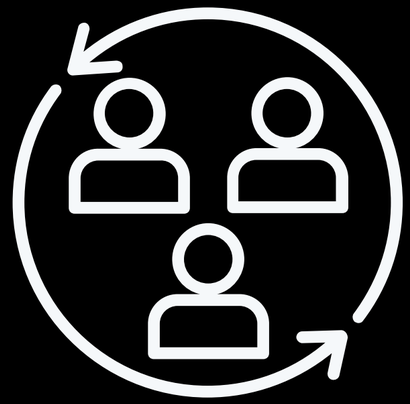
Noisy Environment

Emotions Induced

Physical Exercise

Feedback

4 Experiments



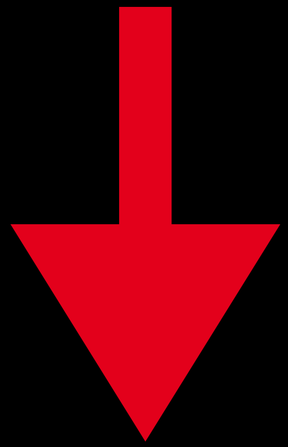
3 Sessions

Scenario 1 - Noisy Environment

1				8				9
	5		6		1		2	
			5		3			
	9	6	1		4	8	3	
3				6				5
	1	5	9		8	4	6	
			7		5			
	8		3		9		7	
5				1				3

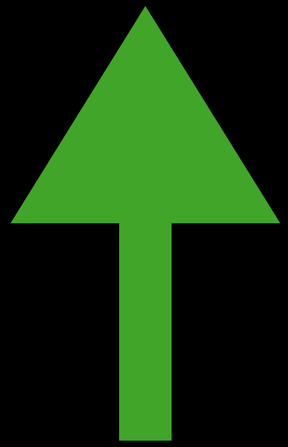
Heart Rate Variability (HRV)

Lower HRV: Noise can induce stress, which is often reflected in physiological measures like heart rate variability.



Eye Gaze - Engagement Time

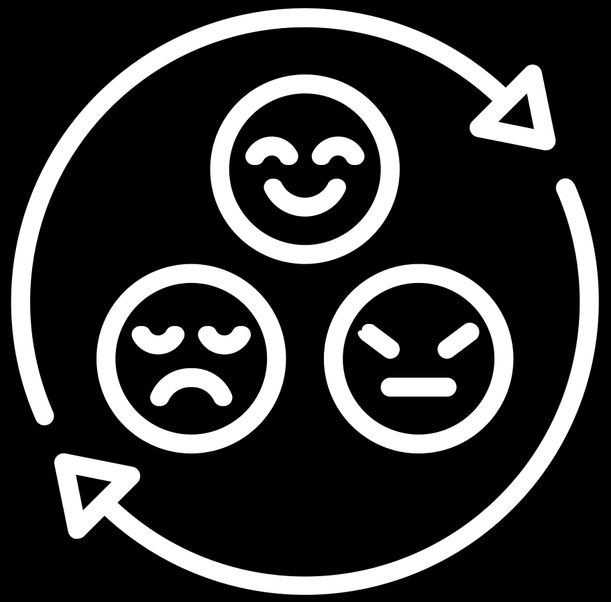
Engagement time generally increases, suggesting participants are taking more time to focus amid distractions.



Accuracy

Participants struggle to maintain focus, leading to more errors in filling out the Sudoku

Scenario 2 - Emotions Induced

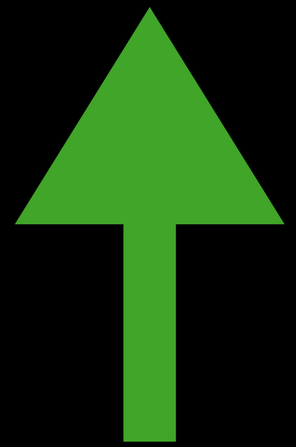


Watching Sad, Happy & Neutral Videos

1				8				9
	5		6		1		2	
			5		3			
	9	6	1		4	8	3	
3				6				5
	1	5	9		8	4	6	
			7		5			
	8		3		9		7	
5				1				3

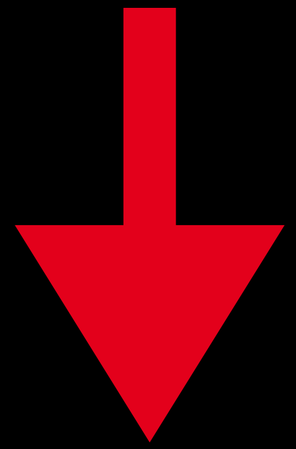
Eye Gaze - Engagement Time

Engagement time generally increases, with happy emotion induction.



Heart Rate Variability (HRV)

Lower HRV: Lower HRV due to physiological effects of sadness.



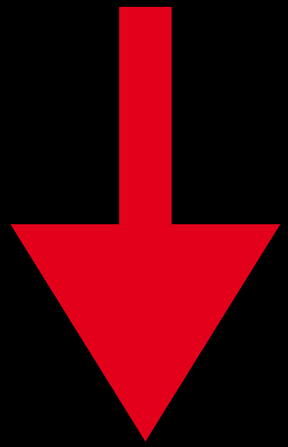
Scenario 3 - Physical Exercise

2 mins on Treadmill

1				8				9
	5		6		1		2	
			5		3			
	9	6	1		4	8	3	
3				6				5
	1	5	9		8	4	6	
			7		5			
	8		3		9		7	
5				1				3

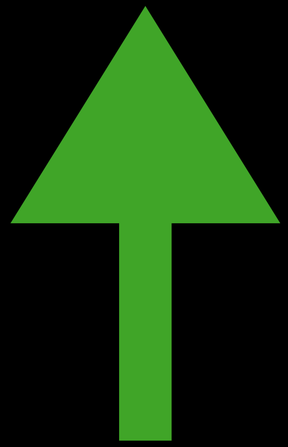
Heart Rate Variability (HRV)

Lower HRV: Immediately after exercise, HRV might decrease due to elevated heart rate.



Eye Gaze - Engagement Time

The physical activity lead to enhanced concentration, resulting in deeper cognitive processing, which manifest as longer fixations on specific cells.



Accuracy

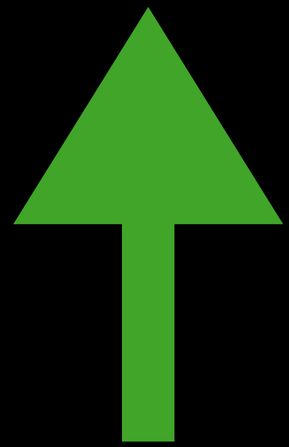
Not that significant change in the number of boxes attempted but the errors decreased.

Scenario 4

1				8				9
	5		6		1		2	
			5		3			
	9	6	1		4	8	3	
3				6				5
	1	5	9		8	4	6	
			7		5			
	8		3		9		7	
5				1				3

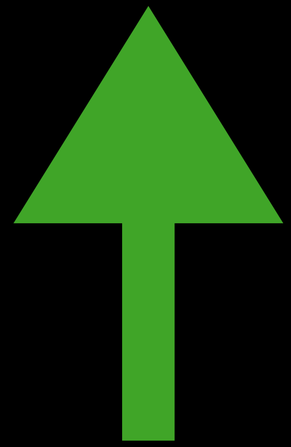
Heart Rate Variability (HRV)

shows initial fluctuations but improves after asked to do breathing exercises.



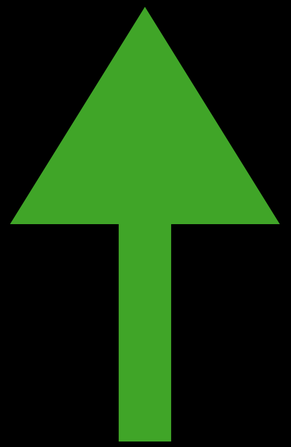
Eye Gaze - Engagement Time

Initially increased due to heightened focus but stabilize as efficiency improves.

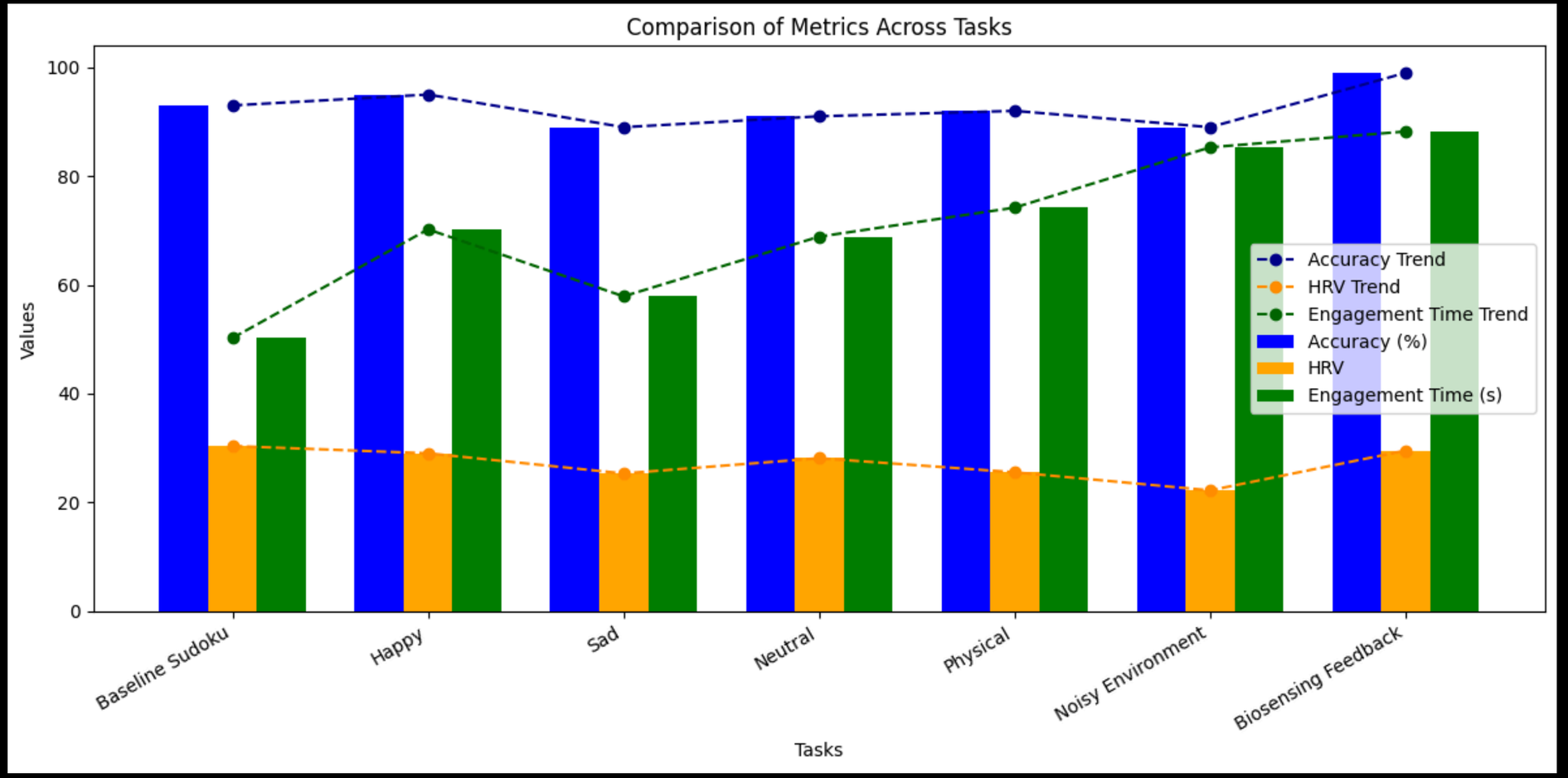


Accuracy

Providing participants with immediate feedback on their performance enhance their awareness and motivation.

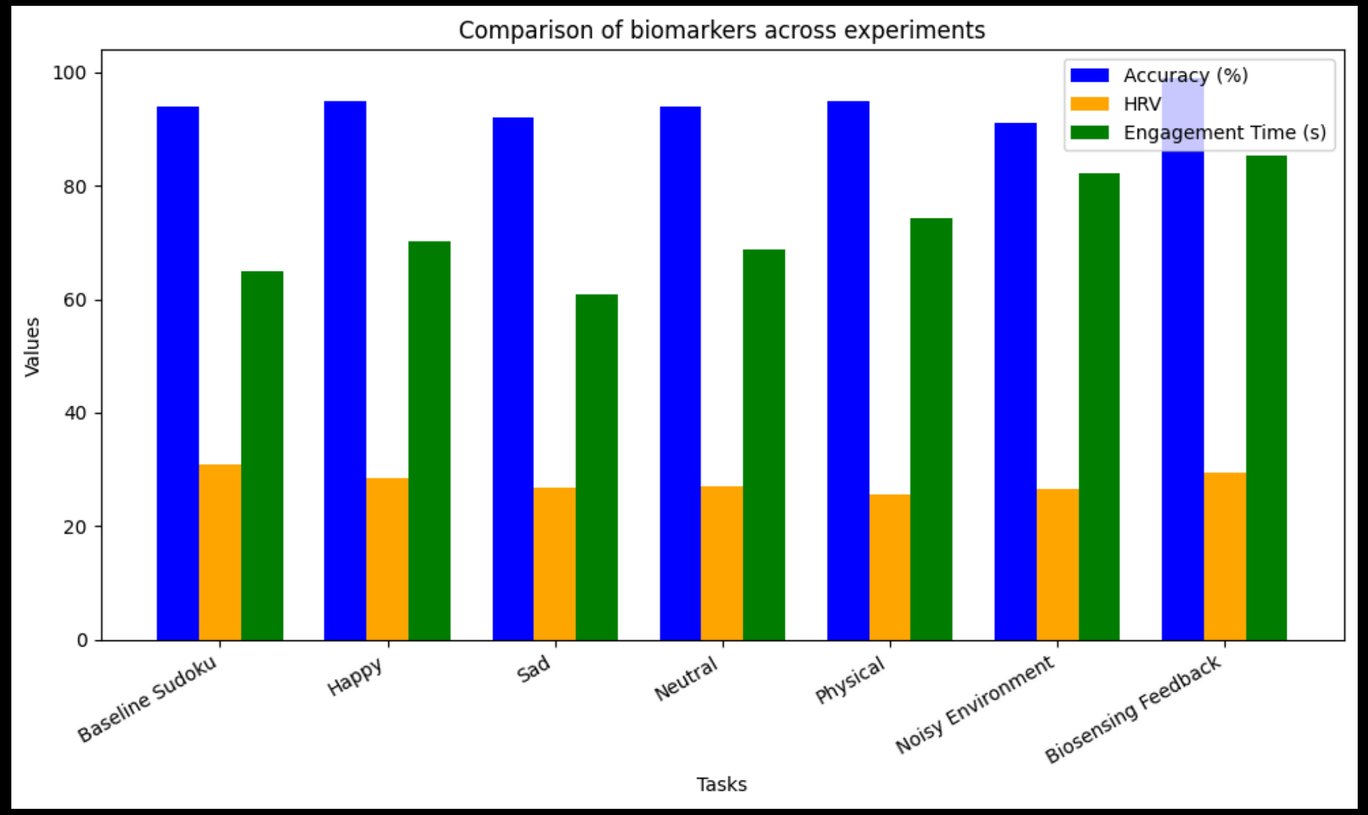


GRAPHS


Comparison of Metrics Across Tasks
Values
Tasks
0
20
40
60
80
100
Baseline Sudoku
Happy
Sad
Neutral
Physical
Noisy Environment
Biosensing Feedback
Accuracy Trend
HRV Trend
Engagement Time Trend
Accuracy (%)
HRV
Engagement Time (s)

PARTICIPANT 1

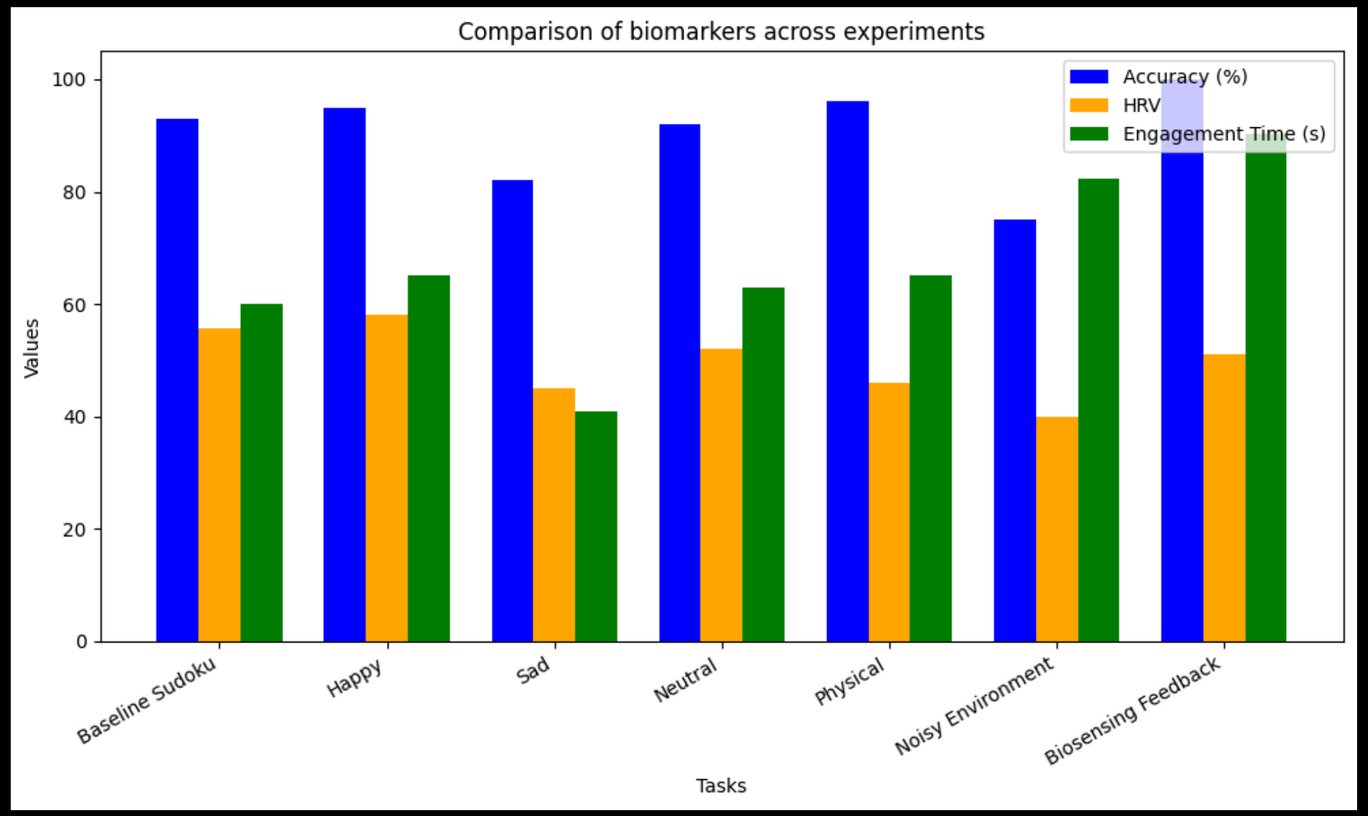
Resting HRV: 43.76
Resting Eye Gaze :15%
Sleep: 8 hours
Feeling calm and rested
Step Count:5k
Sudoku Type:Easy



maintains similar accuracy,not much affected by sound, emotions

PARTICIPANT 2

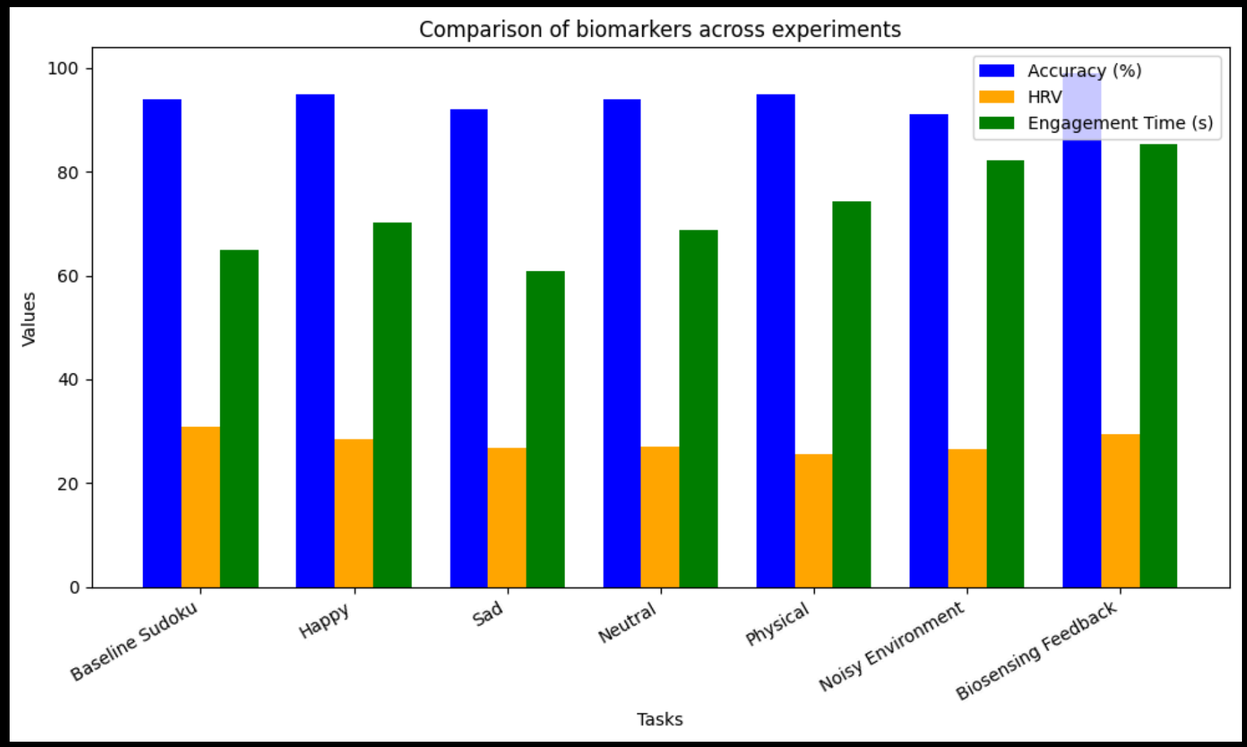
Resting HRV: 55.76
Resting Eye Gaze :10%
Sleep: 6 hours
Feeling calm yet stressed
Step Count:1k
Sudoku Type:Easy



accuracy drop too much when subjected to noise and sad video

PARTICIPANT 3

Resting HRV: 45.76
Resting Eye Gaze :15%
Sleep: 4 hours
stressed
Step Count:2k
Sudoku Type:Hard



becomes more aware after exercise,
less cells attempted overall (type hard)

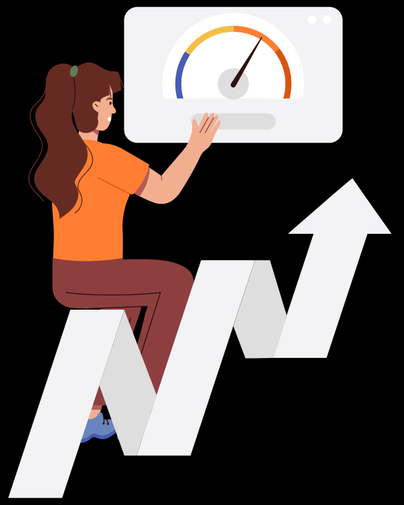
IS BIOSENSING USEFUL?

IS PHYSICAL AND COGNITIVE RELATED?

IS EMOTION AND COGNITIVE RELATED?

Applications & Impact

Personalized Health and Wellness



Holistic Performance Tracking

THANK YOU!