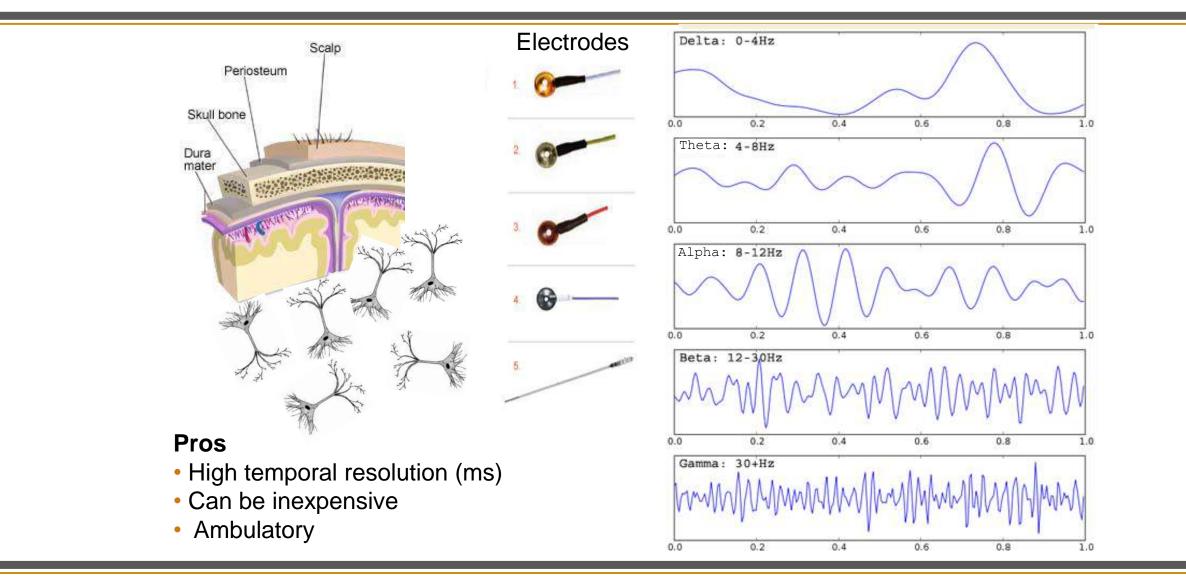
Clean. Mobile. Fast.

Practical, High-Fidelity Dry Electrode EEG





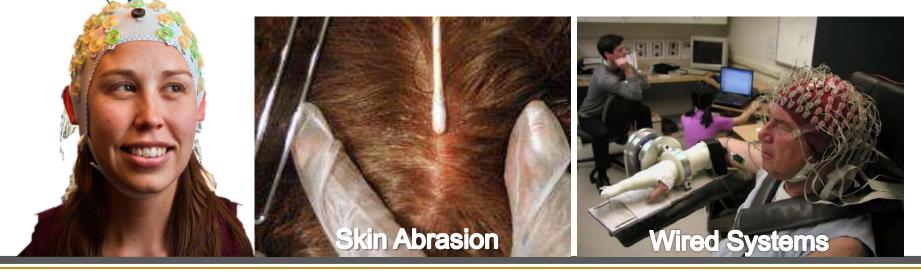
Electroencephalography (EEG)





Limitations to mainstream adoption:

- Requires skin abrasion & conductive gel or fluids
- Sensitive to motion and electrical artifacts
- Needs time-synchronized context information
- Advanced signal analysis
- Not Practical: Not portable and not ambulatory





Taking EEG to the Real World

- No skin abrasion
- No gels nor liquids
- High signal quality
- Low artifact
- Easy and Fast to put on
- Comfortable for long time
- Ambulatere

- Ultra-High Impedance Active Dry Sensor
- Through-hair Dry Electrodes
- Common Mode Follower
- Electrical & Mechanical Design and Shielding
- Headset Design
- Headset Design
- Wireless data acquisition

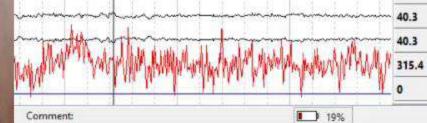


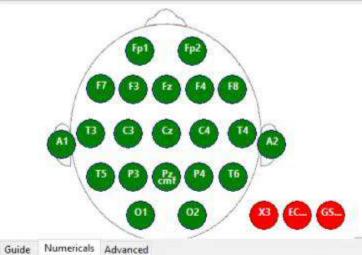
DSI-Streamer v.1.08.60

Data Source	Record Montage	Advanced	ERP TCP IP							
Source	-			Headset Type	Trigger Source	1	Timing	Filters	Battery	Scale
Headset	COM8		Power Off	DSI-24 🗸	(a) Wireless	Stop	Plot Length	HP Filter 1.0 🗘 Hz	0% 38%	Auto
(e) meadset	COMU	~	Poweron	SN: 112	1.	Pause	12 123	And the second s		
() File	Add Port	😑 Strea	ming		Wired	* stude		LP Filter 50.0 🚦 Hz	-	100 🗸
							sec	h	· · · · · · ·	

Fp1 - Vref	man man man man man man man	111.6
Fp2 - Vref	man man man and man and the second man and the second seco	89.8
Fz - Vref	man	71.2
F3 - Vref	man	90.3
F4 - Vref	much man man man man and a second man	66.0
F7 - Vref	many many many many many	136.4
F8 - Vref		83.1
Cz - Vref	man	53.9
C3 - Vref	man	63.1
C4 - Vref	monor many many many many many many	45.6
T3 - Vref	ment and the second second and the second se	70.6
T4 - Vref	man have a second and the second and the second sec	44.7
T5 · Vref	man man and a second and a se	44.6
T6 - Vref	month and and and a second and a	46.3
Pz - Vref	man marken marken marken and and and and and and and and and an	39.5
P3 - Vref	man	41.6
	mannenantering	43.2

11		
1	monorman	45.7
	mannamanan	40.0
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0

X Minimize

A_Reset

Diagnostic

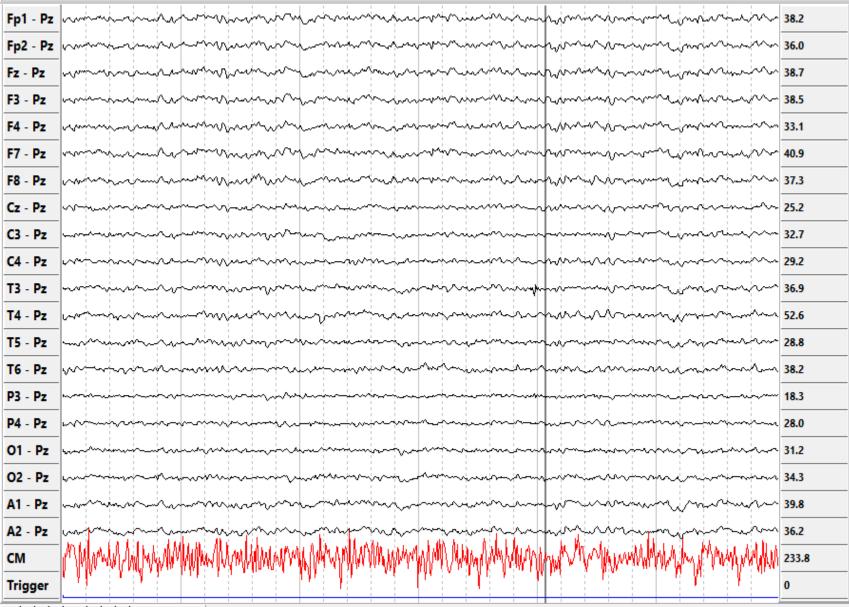
٧h	mpedanc	e ON	Record	Impedance		Hold A_ Reset			
	Z(M)	N(uV)	BL(uV)		Z(M)	N(uV)	BL(uV)		
A1	0.10	12.8	75.0	Fz	0.19	9.5	-17.6		
A2	0.11	14.5	-62.4	GSR2	0.00	0.2	-13.8		
C3	0.35	5.8	142.6	01	0.47	5,2	-17.4		
C4	0.34	6.7	69.4	O2	0.39	5,2	-114.6		
Cz	0.33	4.4	32.5	P3	0.32	3.0	2.9		
ECG2	0.00	0.2	-13.2	P4	0.31	3.3	-66.3		
F3	0.20	8.6	57.1	Pz	0.40				
F4	0.18	8.3	-160.7	T3	0.33	10.2	-69.8		
F7	0.18	14.0	211.3	T4	0.26	9.6	56.2		
F8	0.21	12.0	113.4	T5	0,40	5.6	97.2		
Fp1	0.11	10.9	222.7	T6	0.13	6.4	-33,7		
Fp2	0.11	11.4	212.7	X3	0.00	0.2	-8.6		

Zgnd= 0.16M; SNR= 2.77

Run Time = 3051.48 s 🔘 No Recording



Signal Quality: Eyes Open





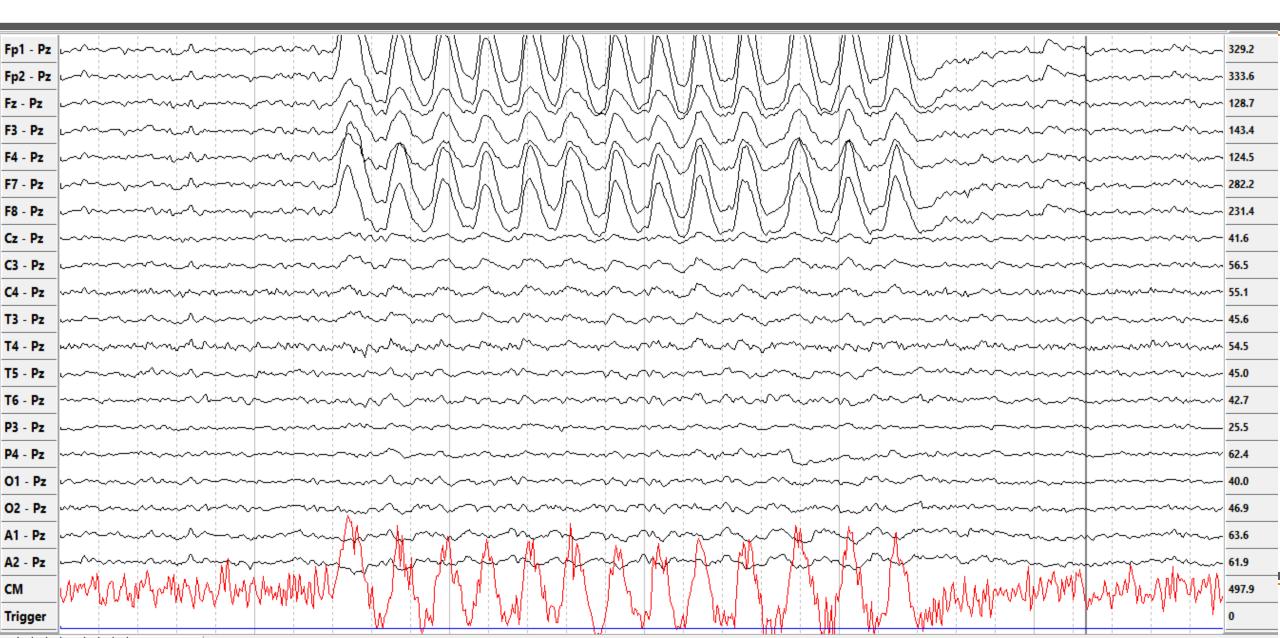
Guide	Numerical	ls Advan	ced				
	Z(M)	BL(uV)	N(uV)		Z(M)	BL(uV)	N(uV)
P3	0.39	-224.7	3.8	T3	0.37	131.3	9.9
C3	0.27	-254.3	7.8	T5	0.42	-162.2	7.0
F3	0.37	-237.3	9.4	01	0.42	-254.8	6.4
Fz	0.78	-19.3	8.4	O2	0.32	446.6	10.1
F4	0.37	-474.0	9.2	X3	0.00	-6.2	0.2
C4	0.19	-473.0	6.7	X2	0.00	-13.0	0.2
P4	0.33	-378.4	4.9	F7	0.13	173.8	10.5
Cz	0.24	-118.9	5.6	F8	0.16	30.5	8.2
CM	0.21			X1	0.00	-8.4	0.2
A1	0.11	221.9	10.6	A2	0.11	224.6	9.1
Fp1	0.10	352.4	9.0	T6	0.35	-383.2	7.8
Fp2	0.10	238.8	9.4	T4	0.32	-200.7	7.7
_	-	1	1				

Z(CMF)= NA

~



Signal Quality: Eye Blinks



WEARABLE Sensing

Signal Quality: Eyes Closed

Fp1 - Pz /how many March March March March March March March March March B6.1 T5 - Pz M_{M} $M_$ T6-Pz Www.Minning. Marken 194.9 01 - PzM2 - Pz www.Man. Marine Ma Marine Mar CM Trigger



Signal Quality: Foot Tapping



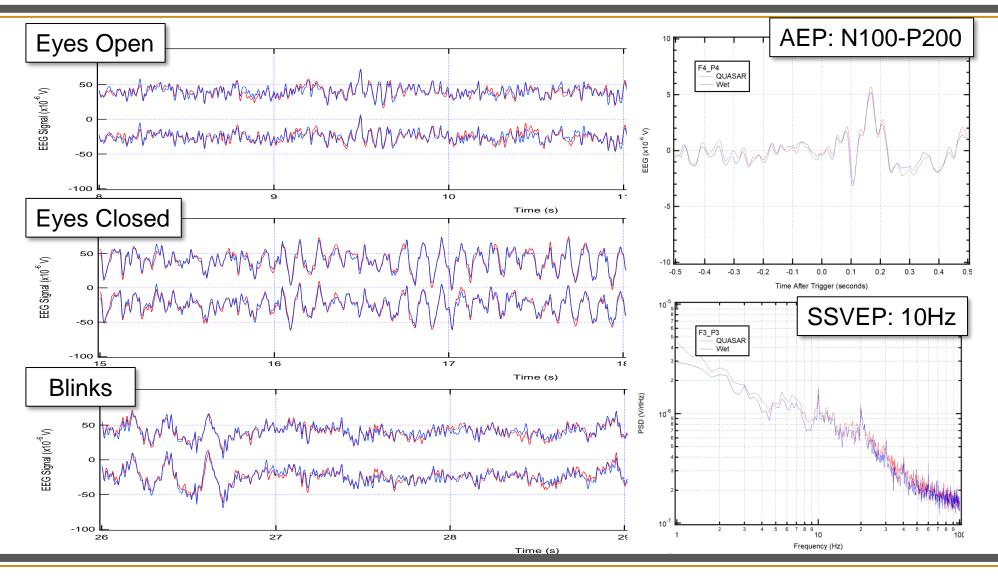


Signal Quality: Walking

Fp1 - Pz	han	47.1
Fp2 - Pz	have a second with the second of the second	46.2
Fz - Pz		44.1
F3 - Pz		40.3
F4 - Pz		37.5
F7 - Pz	hand hand hand hand hand hand hand hand	44.7
F8 - Pz		44.7
Cz - Pz	┟┉╦╞╍╍┾╍╍┾╍╍┾┉╍┾╍╍┾╍┉┿┉╍┾╍╍┾╍╍┾╍╍┾╍╍┾╍╍┾╍╍┾╍╍┾╍╍┾╍╍┾╍╍┾╍╍┾╍╍┾╍	31.7
C3 - Pz		43.5
C4 - Pz		25.1
T3 - Pz		33.9
T4 - Pz		36.4
T5 - Pz		39.4
T6 - Pz		53.9
P3 - Pz		66.5
P4 - Pz		31.4
01 - Pz		53.7
02 - Pz		33.5
A1 - Pz		41.8
A2 - Pz	ער אין	42.9
СМ	- 안에 이 이 이 있는 것 같이 있는 것 같은 것 같은 것 않아? 이 것 같은 것 같은 것 같은 것 같은 것 같은 것 같은 것 같이 있는 부	716.5
Trigger	- אין אין איז	0

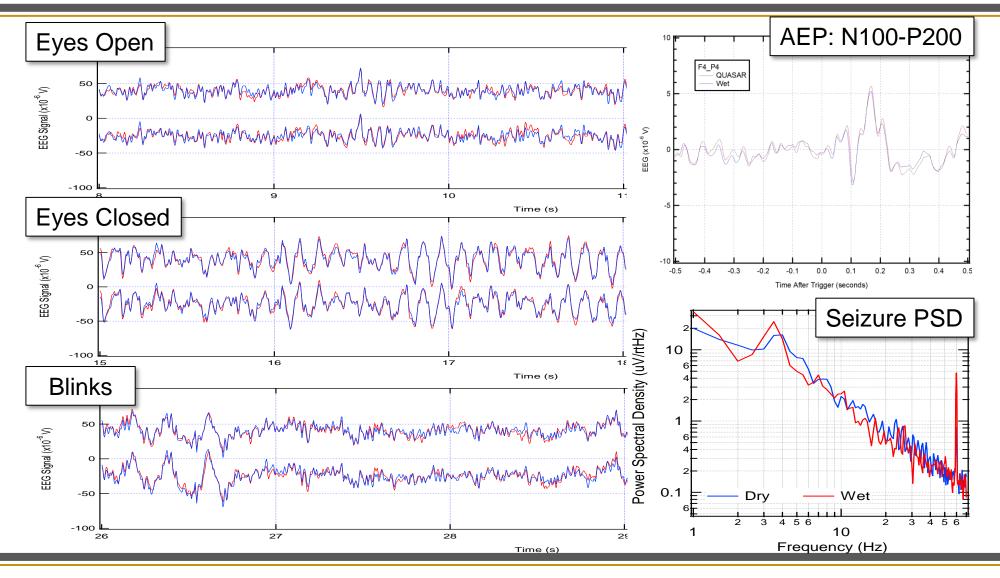


EEG Signal Comparison: QUASAR Dry Electrodes vs. Conventional Wet Electrodes





EEG Signal Comparison: QUASAR Dry Electrodes vs. Conventional Wet Electrodes





Dry Sensor Interface (DSI) READY FOR REAL-WORLD Applications

High Fidelity Sensors

- Through-hair dry electrodes
- High signal quality
- Artifact Resistant

Practical Headsets

- Rapid Set-up
- Comfortable for repeated long-term use
- Wireless and Ambulatory







Product Portfolio



DSI-24



- 21 EEG sensors + 3 channels for:
- EOG, EMG, ECG, GSR, respiration, skin temperature, 3D accelerometer, ...
- Adult and Child-sized Versions
- Wired, Wireless, or On-board Storage
- Wireless triggering for synchronization
- Acquisition Software, API, TCP/IP, LSL
- Raw data output as CSV or EDF
- Interfaced with 3rd Party applications
 - Eye-tracking / Motion capture
 - NeuroGuide / BrainSurfer
 - EEGLAB / ERPLAB /BCILAB
 - Mensia Neuro RT / OpenVibe / BCI2000
 - Various Presentation Packages
 - Applications in research, neurofeedback, BCI, neuromarketing, neuroergonomics,...

DSI-24 + VR Adapter : Setting Up





DSI-7



- Lightweight, ultra-fast donning
- 7 EEG sensors
- Factory customizable locations
- ECG option, 3D accelerometer, 600Hz
- Adult and Child-sized Versions
- Wired, Wireless, or On-board Storage
- Wireless triggering for synchronization
- Acquisition Software, API, TCP/IP, LSL
- Raw data output as CSV or EDF
- Interfaced with 3rd Party applications
 - Eye-tracking / Motion capture
 - EEGLAB / ERPLAB /BCILAB
 - Mensia Neuro RT / OpenVib / BCI2000
 - Various Presentation Packages
- Applications in research, neurofeedback, BCI, neuromarketing, neuroergonomics,...



Child-Sized Versions



DSI-7 + VR Adapter : Fast, Light and now with VR!



Features/Benefits:

- Customizable locations
- Easiest Set-up
- Lighter Weight
- Stabilization Headband

Compatible with:

- HTC Vive
- HTC Vive Pro
- HTC Vive Pro Eye
- Oculus Rift (NOT Rift S)
- Oculus Quest
- MORE (check with us!)



WEARABLE Sensing

DSI-7-FLEX



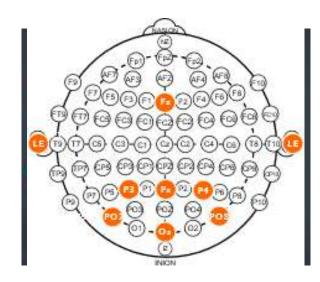
- 7 sensors on wires
- FLEXIBLE locations
- EEG, ECG, EMG, EOG
- Various Sensor Pods and sizes
- BraiNet mounting elastic harness
- 3D accelerometer
- SOON: CAPACITIVE SENSORS
- Wired, Wireless, or On-board Storage
- Wireless triggering for synchronization
- Acquisition Software, API, TCP/IP, LSL
- Raw data output as CSV or EDF
- Interfaced with 3rd Party applications
 - Eye-tracking / Motion capture
 - EEGLAB / ERPLAB /BCILAB
 - Mensia Neuro RT / OpenVib / BCI2000
 - Various Presentation Packages



DSI-VR300

Developed in Collaboration with

Same DSI Technology seamlessly integrated with HTC-Vive Records EEG while subjects are in Virtual Reality Optimized for P300 ERP



Super simple use

- One adjustment wheel
- Embedded through-hair tool
- HTC-Vive replaceable with headstrap



DSI-VR300 + DSI-VRVEP : Similar yet Different

(F5)(F3)(F1)(F2)(F2)(F4)(F6

FC2 (FC4) (FC6) (FC8)

(CP2) (CP4) (CP6) (CP8)

(PZ) (P2) (P4) (P6) (P8) (P10

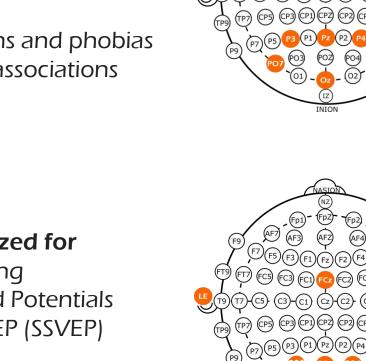
P4 (P6) (P8)



DSI-VR300

Locations optimized for

- Visual Stimuli
- P300 Experiments
- Alertness
- Strong emotions and phobias
- Some sensory associations



Compatible with:

- HTC Vive
- HTC Vive Pro
- HTC Vive Pro Eye
- Oculus Rift (NOT Rift S)
- Oculus Quest 2

VIVE



DSI-VRVEP

Locations optimized for

- Visual processing
- Visually Evoked Potentials
- Steady State VEP (SSVEP)

DSI-VR300 + DSI-VRVEP : Setting Up

- Same **DSI** Technology (*same signal quality and robustness to artifacts*)
- DSI headset integrated with VR Head-Mounted Display (HMD)
- VR headset replaceable with strap





OStates: Cognitive Gauges

BaseStation [RF]

Pacending 00/02/41 Style

Data Server

9

1.0

0.0

Extracts features from

- ► EEG
- **EMG, ECG, EOG**
- ► GSR
- Skin Temperature
- Respiration
- ► fNIR

Machine Learning Algorithm

- Partial Least Squares (PLS) core
- Individualized & Normative Models
- Fast training
- Automated Artifact Elimination
- Real-time & Offline Analysis

Validated

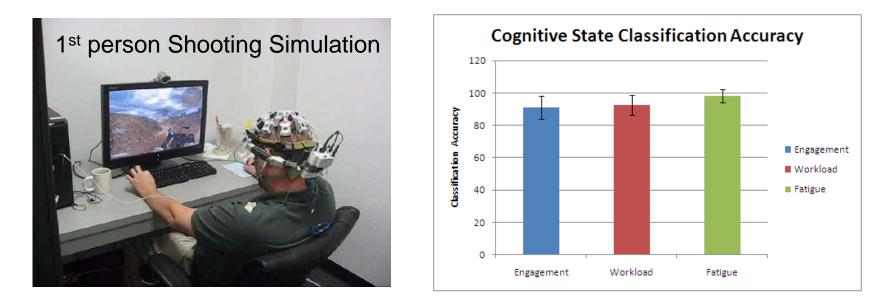
>90% Accuracy Workload, Engagement, Fatigue

Wearable Sensing © 2020

Cognitive State Monitoring

Cognitive Monitoring can be useful for training, fatigue monitoring, system evaluation, neuroergonomics, and workload management

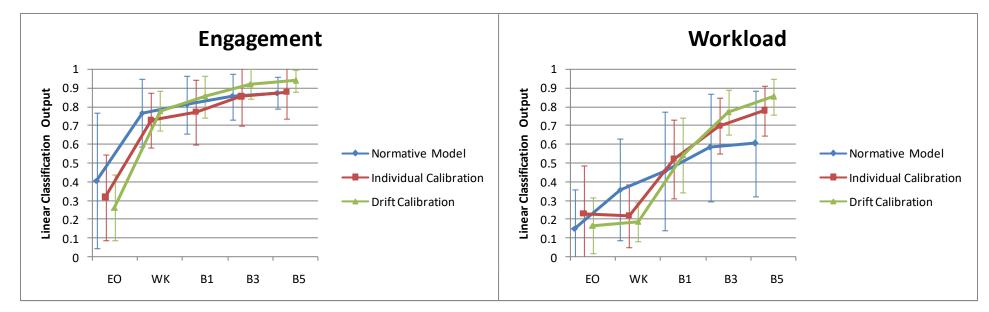
WEARABLE 🔅



QUASAR's Cognitive State Monitoring algorithm uses EEG features to classify Cognitive **Engagement**, **Workload**, and **Fatigue**, and yields **>90% accuracy**



Linear Classification Outputs



Engagement Model Trained: Eyes Open vs. (Walk+BF5) Workload Model Trained: Walk vs. BF5

Normative Model Trained on **all 18** subjects Individual Model trained using **1** calibration session per subject Drift Model trained using **2** calibration sessions per subject



Multimodal Sensing

Multi-Modal Physiological Sensors: The Suite



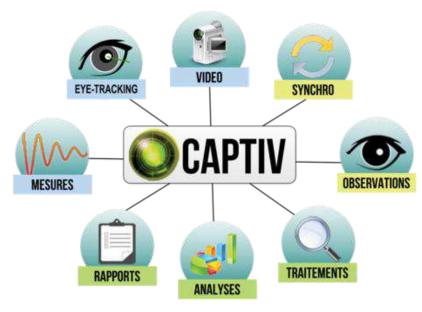


VR + EEG Applications

Interfacing EEG with VR

To integrate EEG signals with Unity or Unreal Engines

- Wearable Sensing's TCP/IP socket
- Wearable Sensing's c-based API
- Neurable SDK
- Lab-Streaming Layer (LSL) + Unity4LSL
- TEA-CAPTIV





Virtual Reality for Research and Beyond

VR Benefits

- Controlled simulation environment
- Rapid simulation development
- User immersion

VR Expansion Tools

- Eye Tracking in VR
- Haptic Body Suits
- Motion Tracking
- Diverse controllers

VR Applications

- Research
- Entertainment
- Neuromarketing
- Meditation
- Education
- And much much more



Neurofeedback in VR

VR immersion can improve

- Patient Retention
- Immersion (for Fear or Pain)
- DSI now Interfaced with
 - Zukor Air*
 - Healium* (coming soon)
 - DreamMachine (coming soon)

*Requires BrainMaster's Avatar or ANI's Neuroguide



HEALIUM: 360° VR clips for meditation with fade feedback



DreamMachine: Immersive mindfulness training

neurable Software Development Kit Demo





Multimodal + EEG Applications

Multi-Modal Physiological Sensors: ECG





Sensors

- Differential
 OR
- Referential

Electrodes

- Dry electrodes + harness
 OR
- Stick-on electrodes

- Heart Rate Variability
- Stress monitoring
- Fitness
- Medical research
- Biofeedback





Multi-Modal Physiological Sensors: EMG



Sensors

Differential

OR

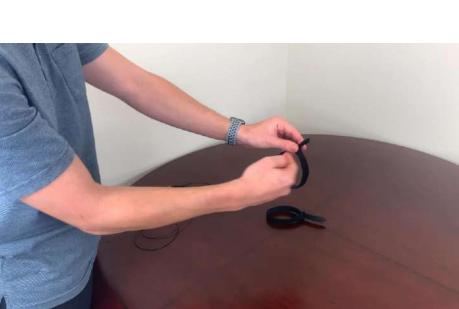
Referential

Electrodes

- Dry electrode + harnesses OR
- Stick-on electrode

- Biomechanics
- Ergonomics
- Medical research
- Biofeedback







Multi-Modal Physiological Sensors: EOG



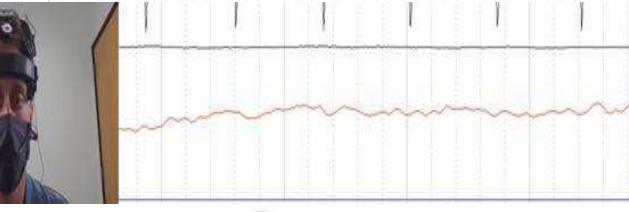
Sensors

- Differential
 OR
- Referential

Electrodes

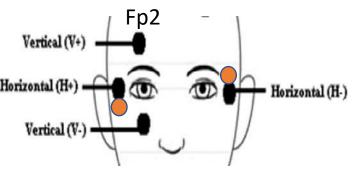
- Dry electrode + tape
 OR
- Stick-on electrode

- EOG artifact removal
- Eye-tracking
- Fatigue monitoring









Multi-Modal Physiological Sensors: GSR



Sensors

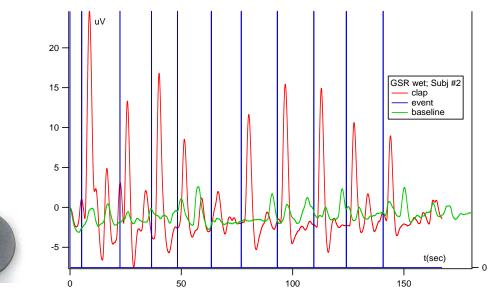
Two sensors

Electrodes

- Dry electrode (wrist)
 OR
- Finger electrode



- Stress monitoring
- Emotional arousal
- Lie detection



Multi-Modal Physiological Sensors: Respiration



Sensors

- Stretch Sensor
- Elastic strap

- Stress monitoring
- Emotional arousal
- Fitness
- Medical
- Biofeedback



Multi-Modal Physiological Sensors: Temperature



Temperature



Sensors

Thermistor Sensor

Output

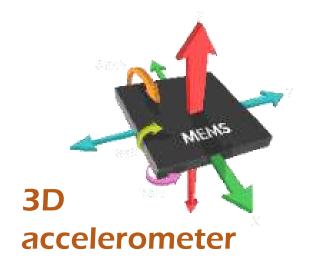
- Fahrenheit
 OR
- Celsius

- Stress monitoring
- Emotional arousal
- Fitness
- Medical
- Biofeedback





Multi-Modal Physiological Sensors: 3D Accelerometer



Sensors

MEMS Sensor in headsets

Output

- Ax in g
- Ay in g
- Az in g

- Movement tracking
- Activity decoding
- Artifact reduction
- Rehabilitation
- Biofeedback

0000	0000	Triggers			Comment:			37%	Run	Time = 98.93 s	No Recording	
Trigger												
Az												
Ау												
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Ax												
A2 - Vref	him				~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		++++++++++++++++++++++++++++++++++++					
A1 - Vref					~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		hi ha				man and a second second	
O2 - Vref	minim	name	man	mound	minim	mumm	minum	mannahin	munnin	mann	monter	and manufacture and a second s
O1 - Vref	mm	www.www	manne	mmmm	month	mumm	mutum	mountain	www.www.	manna	mmmm	man man man a providence of the second secon
P4 - Vref		mm	mound	mmun	mumm	mann	mun	mannen	wanner	month	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	mannen
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Pz - Vref	mining	minhow	mm	mmmmm	monomi	minim	minomin	minihin	rominimum	minim	minimum	an man an a
-	두 것 같은 것을 같이 ?	0.01.020.021				3 4 3 11 3 4 5 3						

Multi-Modal Physiological Sensors: EEG



DSI-Systems

- Dry Electrodes for EEG
- DSI-EEG+fNIR / DSI-24 have 3 auxiliary channels ready
- DSI-7/VR300/VRVEP can substitute up to 3 channels
- DSI-7-Flex can substitute any channel
- DSI-4 NONE

Electronics

- Synchronized Wireless Acquisition
- On-board storage for DSI-24 and DSI-7
- Power source
- 3D accelerometer On-Board



EEG, Motion Capture, & Eye-Tracking: Real-World Research Applications



- Cognitive Psychology
 - What drives our behaviors?
 - How do people interact
- Neuro-Ergonomics
 - How easy-to-use is this UI?
 - How is physical performance affected by cognitive states?
- Neuro-Marketing
 - What is engaging our attention?
- Neuro-Rehabilitation
 - Gait, dexterity, and attention post-injury and during rehabilitation
- Sports Science
 - Biomechanics
 - Cognitive load and focus monitoring
 - Peak performance training
- Biomarkers
 - Autism
- ► More...





