Interaction Between Virtual (Computer Gaming) Environments, Brain Activity, and the Schumann Resonance as the Next Evolutionary Step in Adaptation: Teilhard de Chardin's Noosphere

Brendan S. Lehman
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Laurentian University

The Journey

Introduction

- Emergence
- In Biology

Experiment #1 - Immersion in Games

- Mind and Digital Space
- EEG and ICA
- Experiment

Experiment #2 - Flow State Dynamics

- Discriminant Analysis
- Experiment

Experiment #3 - Game Skill Synchronization

- Excess Correlation
- Experiment

Applications & Conclusions

- Games and Technology
- Brain Stimulation
- Unified Consciousness

Introduction

Emergence

Manuel DeLanda

Definition

◄ The process by which larger, more complex patterns arise through the interactions of smaller, more simple entities which do not themselves display such properties

Example

Temperature – property of a body of molecules that has emerged from the motion of individual particles

Emergence

Manuel DeLanda

Emergence to Biology

◢ Evolution as a series of emergent processes

molecules → amino acids → RNA → protein → genetics → symbiosis → neural nets → conditioning

Computational Simulation

◢ Each step (or an analogue) is reproducible in the digital space

Emergence & Consciousness

Teilhard de Chardin

Emergence From Biology

Noosphere

◢ The sphere of human thought

◢ As life emerged from the geosphere, consciousness arises out of the biosphere

◢ Omega point

Examples

◢ **Morphic Resonance**

◢ Global Consciousness Project

◢ **Neuroscience Research Group**

◢ Social Science (for clues)

Schumann Resonance

Principle

- ◢ EM resonance generated by global lightning strikes between the earth's surface and the ionosphere

- ◢ Harmonics (Hz): 7.83 (fundamental), 14.3, 20.8, 27.3, 33.8 +
  Average: ~ 40 Hz

- ◢ Correlate with right parahippocampal gyrus activity (Saroka & Persinger, 2012)

Transhumanism

Definition

- Intellectual movement exploring the benefits and risks of augmenting the capacity and capability of the human being using technology

- The nanobiotechnological enhancement of human beings

- Evolution: shortcut or facilitator?

Relevance Into The Future

- Important for oversight of these findings and their applications

- Eventual applications of the technology

Experiment #1

Neurophysiological Dynamics Of The Flow State In Video Game Play: Embodied Cognition And Implications For Consciousness

Brain Physiology and the Digital Space

Flow State

Definition

◢ The feeling of complete and energized focus in an activity, with a high level of enjoyment and fulfillment (Csíkszentmihályi, 1990)

Neural Correlates

◢ Involving the hippocampal formation, and the parietal, temporal, and occipital cortices (Deitrich, 2004)

Brain Physiology and the Digital Space

Embodied Cognition

Definition

◣ The elements of cognition influenced by the body external to the brain, via motor and sensory systems, the feedback from their interaction with the external environment, and the ontologies these elements create

Experimental Methods

Technical Setup

- Lenovo Y580
  - Xbox 360 controller (3 players)
  - Keyboard/Mouse (1 player)
- Headphones in acoustic chamber

- Elder Scrolls V: Skyrim
  - Level 1 balanced stat character
  - All weapon/spell types available
  - First main questline dungeon
- Passive video
  - Fraps

Experimental Design

Experienced players

- 3 identified males
- 1 identified female

Two Segments

01. Active Game
02. Passive Video

- ~20 mins each
- ABAB presentation

Three Events

01. **Skill**
    - Technical tasks which contribute to experience level
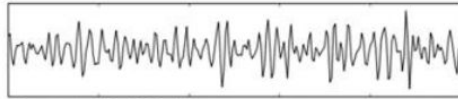   - Ex. combat, lockpicking
02. **Reward**
    - Completing tasks which improve player character
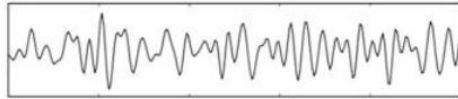   - Ex. receiving items, level up, completing objectives
03. **Planning**
    - Consideration of future actions
    - Ex. deciding among dialogue options, inventory and skill tree management
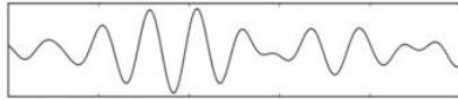
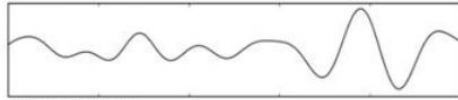# Quantitative Electroencephalography

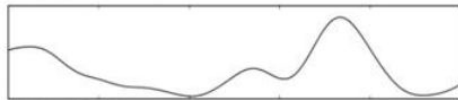Comparison of EEG Bands

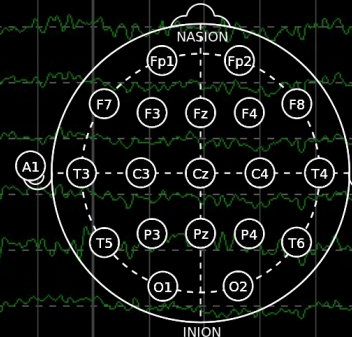Gamma: 30-100+ Hz

Beta: 12-30 Hz

Alpha: 8-12 Hz

Theta: 4-7 Hz

Delta: 0-4 Hz

Principle

▲ Measures voltage fluctuations resulting from ionic current within the neurons of the brain

▲ Area under curve: mV^2/Hz

Quantitative Electroencephalography

Mitsar 201 & WinEEG

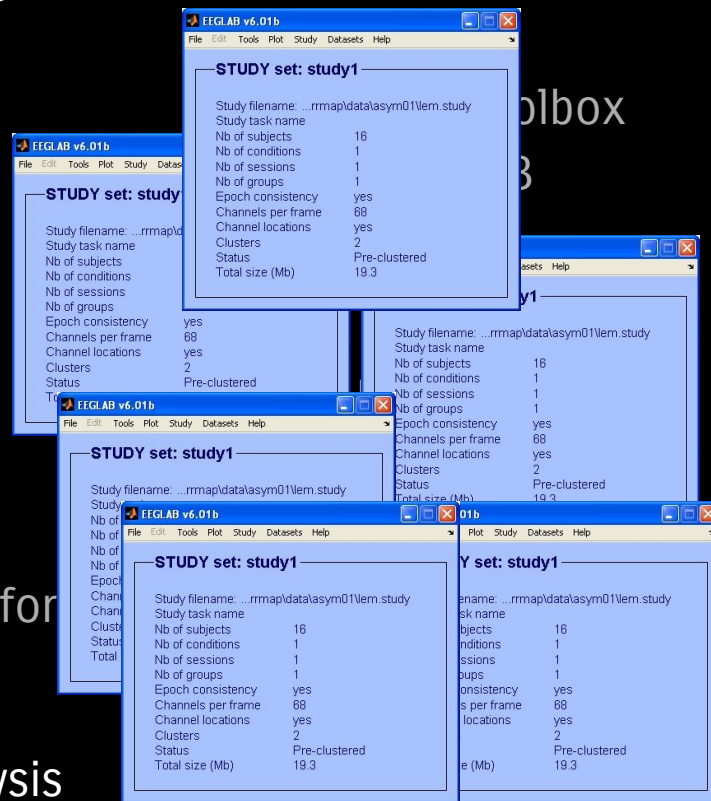# Independent Component Analysis

Principle

- ◢ Separating a multivariate signal into additive subcomponents

- ◢ "Cocktail party metaphor"

Infomax Algorithm

- ◢ Determines the maximum amount of shared infor... between 'random' variables
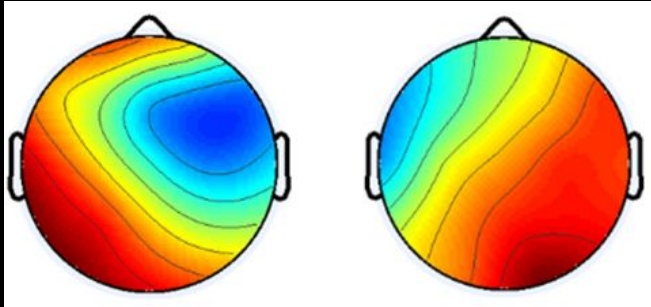
(# EEG electrode) iterations creates a useable analysis

Results

Parentcluster

Whole Segment
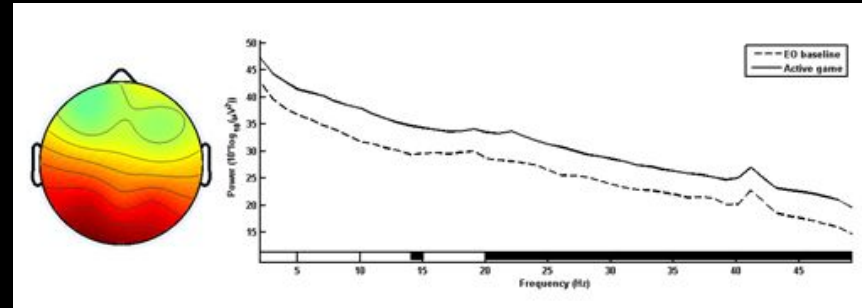
Results

Reward Events
↑ active
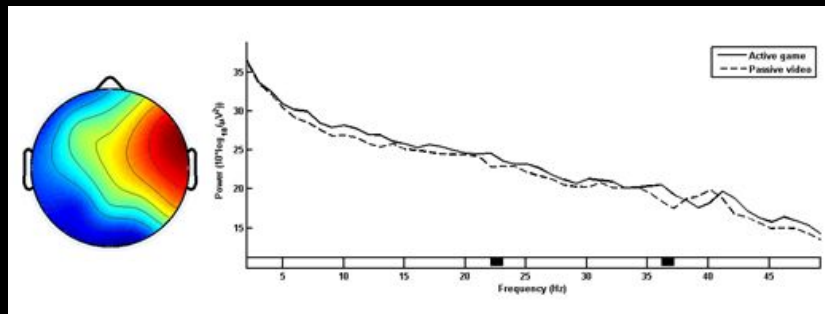
Reward Events
↑ passive
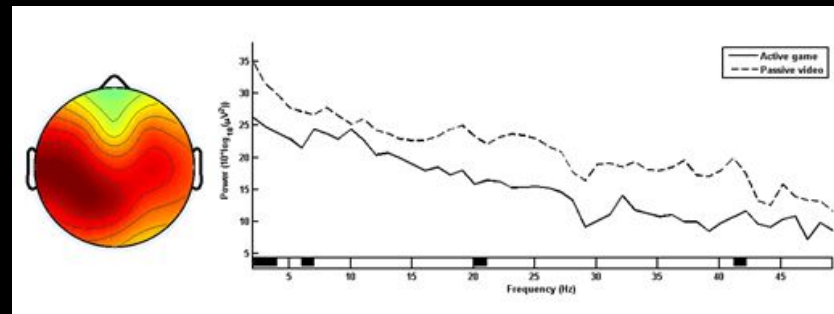
Results

Planning Events
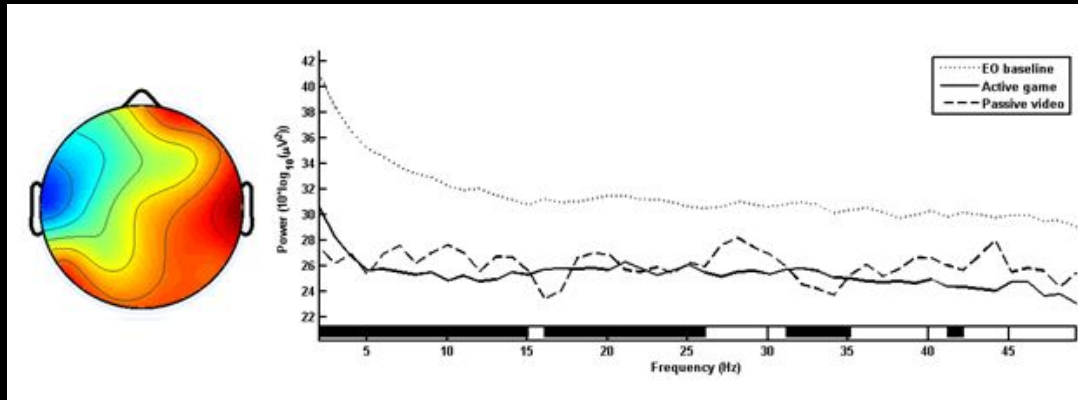
Results

Skill Events
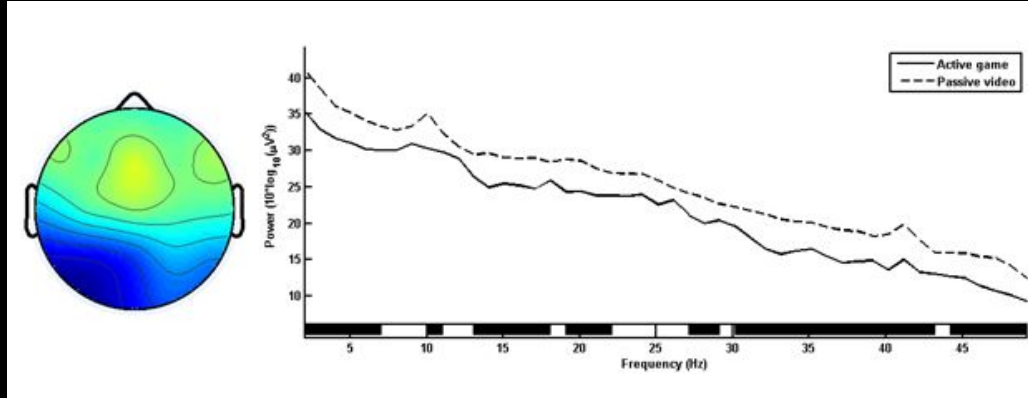
Summary

Whole-Brain

- Caudal, right hemispheric
- Dream states
  - Left frontal diminishment only

Flow State

- Maintained sense of "other"
  - Embodied cognition
- Diminished ideation, self-monitored thinking
- Requires attention task

Reward

- Right temporal/inferior frontal
- Passive = self-referential

Planning

- Left temporal
- 'Mental time travel' (Lavallee & Persinger, 2010)

Skill

- Left caudal deactivation
- 40 Hz spike

Experiment #2

Quantification Of The Temporal Domain of "Event Recordings" Of The Flow State

Linear Discriminant Analysis

Principle

- Searches for a linear combination of features that discriminate between two classes of events

- Provides data about the points where the signal-to-noise ratios of each class are optimally separate

ICA + LDA

- Very precise refinement of a meaningful multivariate signal

- Time = linear

- Returns ms-scale points of brain activation

- Caveat: Cannot (as yet) match LDA results with ICA components

Analysis Methods

Data from Experiment #1
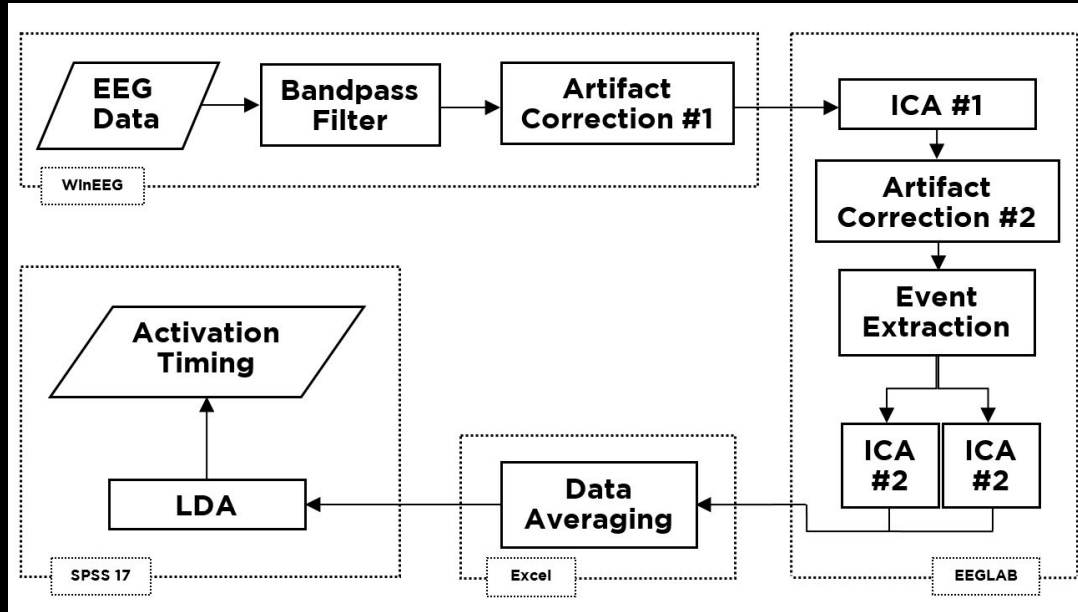
Results

Frequency distributions
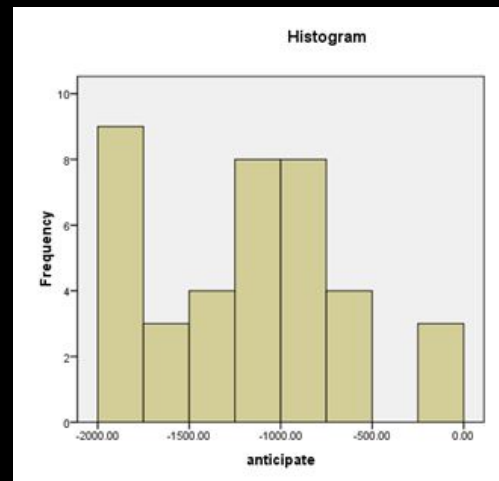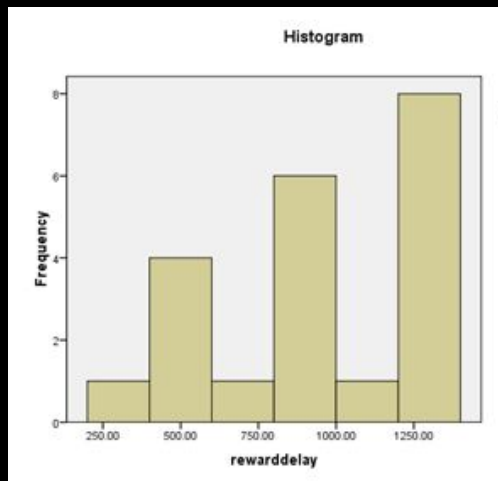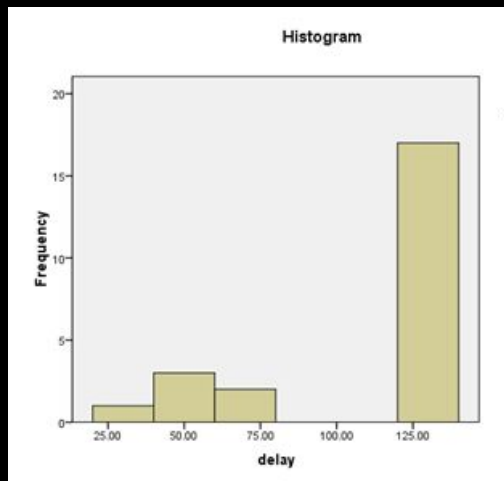
Summary

Post-Event

- ◢ 130 ms
- ◢ 7 - 14 Hz (including deviations)
- ◢ Length of a percept

Schumann Resonance Interactions

Pre-Event

- ◢ Evidence of Bereitschaftspotential
- ◢ "Stream of consciousness"
- ◢ Pre-Consciousness and non-local states

Experiment #3

The Potential For Excess Correlation "Entanglement"
Between Flow States In Pairs Of Gamers Sharing
Specific Circumcerebral Rotating Magnetic Fields

Understanding Excess Correlation

Laboratory term for 'entanglement' processes occurring in macro-systems within and beyond the quantum domain

➔ The presence of strong and significant correlations between systems and processes separated in xyz space (i.e. non-local) not classically explained

Examples

Dotta et al. (2013), *Brain Research*: Biophoton emission from cells separated by 10m

Persinger et al. (2010), *Neuroscience Letters*: Correlated cerebral events

Electromagnetic Conditions

Pulse-Patterned Electromagnetic Fields

◢ 3 ms point duration

◢ +2 or –2 ms to the base rest duration of 20 ms

◢ 1 - 2 μT average cross-sectional field intensity
   ◆ 1 - 5 μT at each solenoid

Presentation Order

1) Thomas (decelerating, 20 - 2 ms): **6 minutes** (360 s)

2) BurstX (accelerating, 20 + 2 ms): **12 minutes** (840 s)

Thomas   BurstX
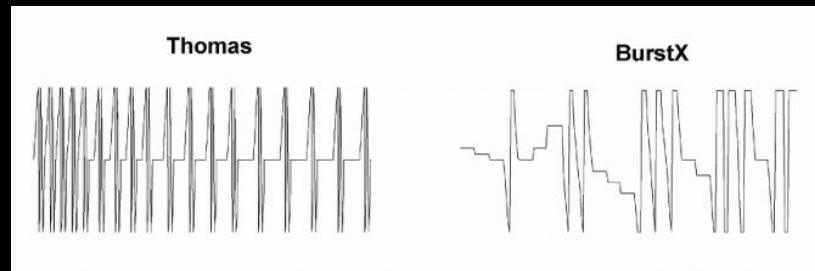
Experimental Setup

Super Hexagon (Cavanagh, 2012)
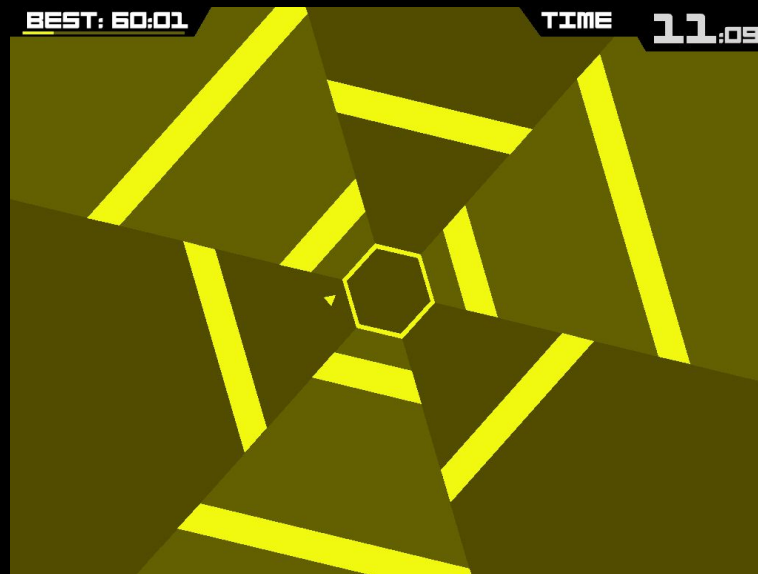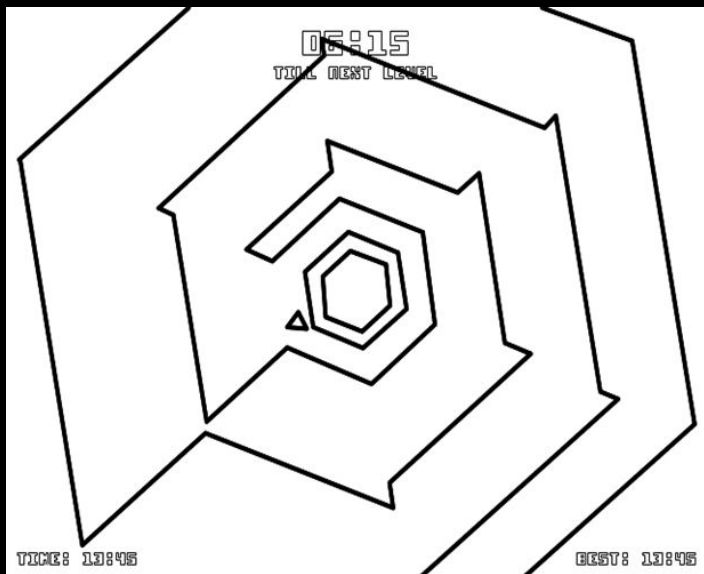
Experimental Setup

Room setup
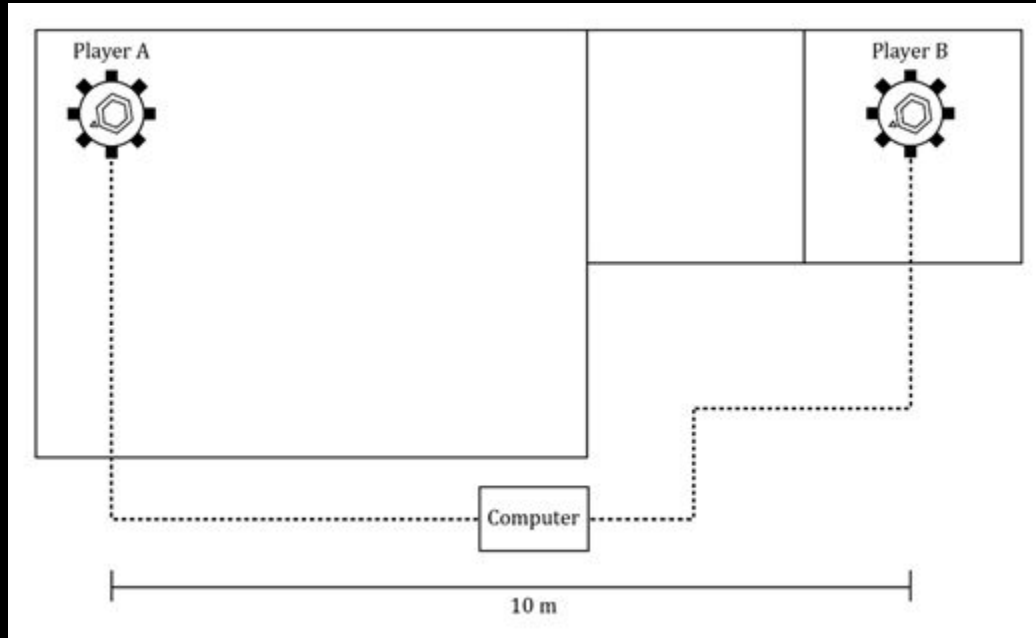
Experimental Design

Exposure Condition Groups

1) Experienced/Experienced
   - 4 trials
2) Experienced/Novice
   - 3 novices, 1 trial each

Control Conditions

1) Experienced/Experienced
   a) Identical setup, no fields
   b) 3 trials

2) Experienced/Novice
   - Identical setup, no fields
   - 1 trial
3) Negative Control
   - Isolated previous novice (1 trial)
   - Isolated new novice (1 trial)

Experimental Design

Game Play Structure

- ◢ 2 minute "runs"
  - ◥ Timed by assistant
- ◢ 22 minutes total

2 runs 4 minutes	Pre-Baseline
3 runs 6 minutes	Thomas (decelerating)
4 runs 8 minutes	BurstX (accelerating)
2 runs 4 minutes	Post-Baseline

Results

Field/No Field

$F_{(3, 32)} = 4.58$, p = 0.01, $\eta^2 = 0.32$
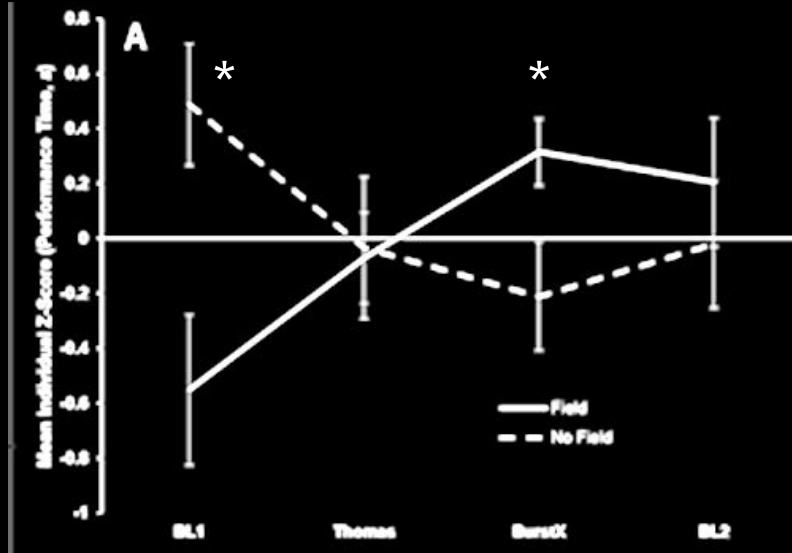
Experienced/Novice

(no significance)
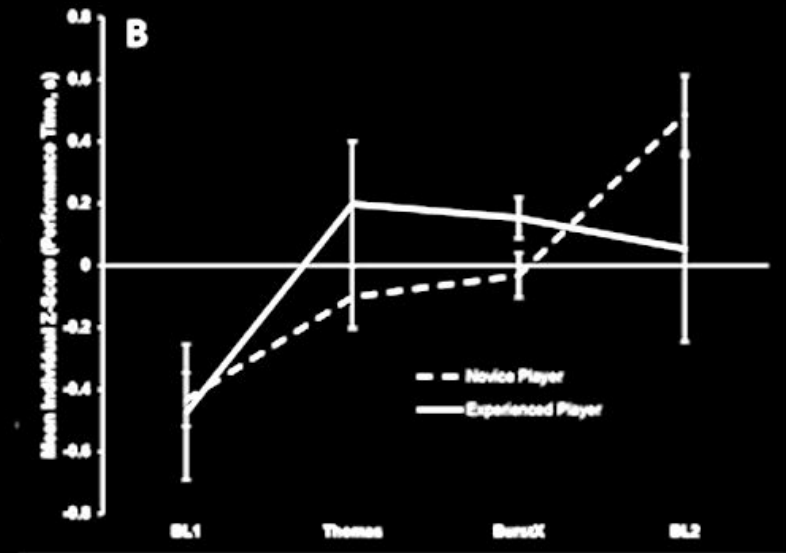
Results

Experienced/Experienced

$F_{(9, 29)} = 2.62$, $p = 0.035$, $\eta^2 = 0.54$
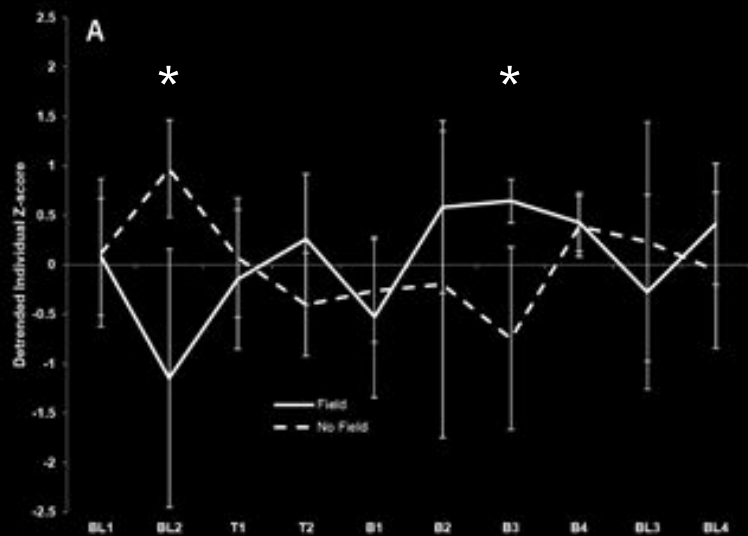
Experienced/Novice

$F_{(3, 16)} = 3.83$, $p = 0.036$, $\eta^2 = 0.37$
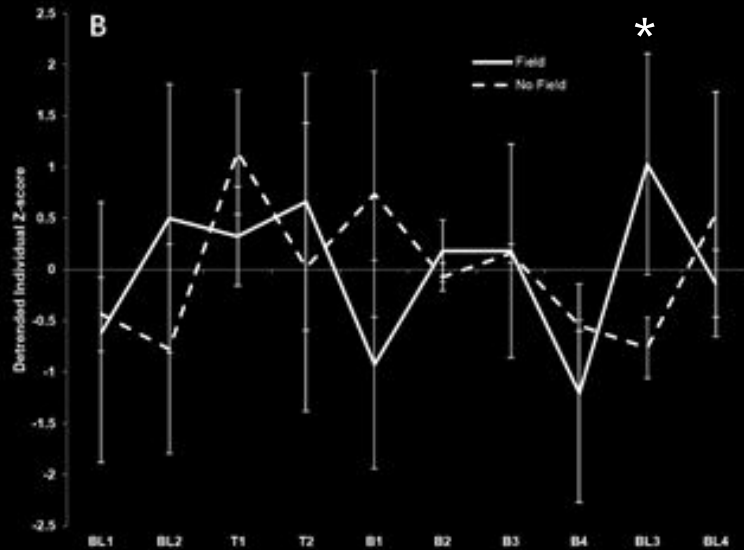
Discussion

'Parity' Effect

- ◢ Superposition of states
- ◢ Shared pre-conscious state

Memory Consolidation

- ◢ Most labile period
- ◢ Schumann Resonance

Energy Equilibrium

- ◢ "Skill transfer"
- ◢ Emergence from superposition

Huh?

Interactive Media and Games

Immersiveness is The Key

Virtual Reality

New School of Game Design

Transformative Technology

Brain Stimulation

Proven Technique   Communication?

Human Augmentation   Encryption

Risky Business

The New Human Biology

Unified Consciousness

de Chardin's Noosphere

Schumann Resonance

Non-Locality

Interactive Media = shortcut

Acknowledgements

Dr. Persinger

Mom

NRG

Sudbury Creative Community

Friendos

THANK YOU! <3

Questions

Experiment #2 Results

Level		Group		Pre-Event Significant Time (ms)									
		1	2	0	2	4	6	8	10	12	14	16	18
1	A	EO	skill avg										
			reward avg				744						
	B	EO	skill early										
			skill mid										
			skill late					950	1002				
	C	EO	reward early*	92			744	910	1002				
			reward mid*		236 268				1002				
			reward late*		340		746	910 950					1992
2	A	EO	P1 skill avg										
			P2 skill avg										
			P3 skill avg										
			P4 skill avg										
	B	EO	P1 reward avg										
			P2 reward avg										
			P3 reward avg										
			P4 reward avg										

I

Experiment #2 Results

II	1	A	skill avg	reward avg			856		
		B	skill early	reward early	82		814		
				reward mid	82				
				reward late					
		C	skill mid	reward early					
				reward mid					
				reward late					
		D	skill late	reward early*					1858
				reward mid*		386			1858
				reward late			954	1002	

Experiment #2 Results

III	1	EO	early*	196				1186	1250
			mid*			726		1186	1250 1288
			late	196				1186	1250
	2	A	skill avg	early					
				mid					
				late					
		B	reward avg	early	194				
				mid	194				
				late					
	3	A	skill early	early					
			skill mid	mid					
			skill late	late					
		B	reward early	early					
			reward mid	mid	194				
			reward late	late				1186	

Experiment #2 Results

Level		Group		Post-Event Significant Time (ms)										
		1	2	20	22	24	26	28	30	32	34	36	38	
I	A	EO	skill avg	2130										
			reward avg											
	B	EO	skill early											
			skill mid											
			skill late	2042										
	C	EO	reward early*	2038										
			reward mid*	2042										
				2132										
			reward late*	2122										
2	A	EO	P1 skill avg											
			P2 skill avg											
			P3 skill avg	2130										
			P4 skill avg	2130										
	B	EO	P1 reward avg											
			P2 reward avg	2130										
			P3 reward avg	2130										
			P4 reward avg	2130										

Experiment #2 Results

II	1		skill	reward								
		A	skill avg	reward avg	2120				3000	3328 3256		3898
		B	skill early	reward early	2130					3328		3900
				reward mid	2130							
				reward late	2130							
II	1	C	skill mid	reward early			2776					
				reward mid								
				reward late								
		D	skill late	reward early*		2320		2834		3254 3220		
				reward mid*						3256 3202	3764	
				reward late	2044					3310		

Experiment #2 Results

III								
III	1		EO	early*		2560	2864	
				mid*		2560		
				late		2560	2864	
	2	A	skill avg	early				
				mid				
				late				
		B	reward avg	early	2122		2964	
				mid	2122		2964	
				late	2122			
	3	A	skill early	early				
			skill mid	mid				
			skill late	late				
		B	reward early	early	2128 2062			
			reward mid	mid	2128 2066		2964	
			reward late	late		2560		