Digital Pharmakeia: Optimizing the Pleasure of Teaching and Learning

Andrew Doan, MD, PhD
The views expressed in this presentation are those of the author(s) and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the United States Government.
How do we focus our students’ attention like this?
Brain Reward Pathways

These brain circuits are important for natural rewards such as food, music, and sex.

DRUGS OF ABUSE TARGET THE BRAIN’S PLEASURE CENTER

Brain reward (dopamine) pathways

Typically, dopamine increases in response to natural rewards such as food. When cocaine is taken, dopamine increases are exaggerated, and communication is altered.

Drugs of abuse increase dopamine
Learning & Memory

I think.

I remember.

I feel.

I fear.

nimh.nih.gov
A

\[\text{Cortical volume} \quad \downarrow \quad \text{Gray Matter} \quad \uparrow\downarrow \quad \text{Connectivity with Hippocampus}\]

B Higher order chromatin folding

C Histone Modifications

- Acetylation
- Methylation
- Ubiquitination
- Phosphorylation

D DNA modifications

- DNA methylation
- DNA hydroxymethylation


https://doi.org/10.3389/fncel.2015.00088
Nature Reviews Neuroscience 10, 126-140 (February 2009)
Neuroendocrine Model of Addiction
Hypothalamic-Pituitary Adrenal (HPA) Axis

Reward/Stress
Release
Catecholamines

CHRONIC
REWARD/STRESS
Deplete
Catecholamines

Fight or
Flight

Down Regulates CRH
+ Corticotropin-Releasing Hormone (CRH)

+ Adrenocorticotropic Hormone (ACTH)

+ Cortisol
+ Adrenalin

Learning and Memory Centers

Adrenal Gland

- Optic chiasma
- Anterior lobe (adenohypophysis):
  - Pars tuberalis
  - Pars distalis
- Infundibulum
- Posterior lobe (neurohypophysis)
Possible Biological Explanations

- cortisol levels
- hippocampus is responsible for memory function
- FMS patients have lower salivary-free cortisol levels
- very low and very high cortisol levels affect hippocampal function
- selective effects on verbal declarative memory, selective attention, and divided attention

"Finally, a good excuse to goof off...a compelling case for the importance of [play] to success and creativity." — DISCOVER

play
How It Shapes the Brain, Opens the Imagination, and Invigorates the Soul

STUART BROWN, M.D., with CHRISTOPHER VAUGHAN
founder of the National Institute for Play
Games have been used by educators since the 1920s

Interactive Hangman teaches amino acid structures and abbreviations

Biochemistry and Molecular Biology Education
Review

Does playing video games improve laparoscopic skills?

Yanwen Ou\textsuperscript{a}, Emma Rose McGlone\textsuperscript{b}, Christian Fielder Camm\textsuperscript{c}, Omar A. Khan\textsuperscript{d, *}

\textsuperscript{a} UCL Medical School, UCL, Gower Street, London, WC1E 6BT, UK

\textsuperscript{b} Department of Upper GI Surgery, Royal London Hospital, London, E1 1BB, UK

\textsuperscript{c} New College, University of Oxford, Oxford, OX1 3BN, UK

\textsuperscript{d} Department of Upper GI Surgery, St George’s Hospital, London, SW17 0QT, UK
Published in final edited form as:


**Improved vision and on field performance in baseball through perceptual learning**

Jenni Deveau, Daniel J. Ozer, and Aaron R. Seitz

Department of Psychology, University of California Riverside, 900 University Ave., Riverside, California, 92521, USA
How do we know video games activate reward system and HPA?
fMRI Scans

Measure physiological responses
Valve’s Game Design Process

Goal is a fun game →
Game designs are hypotheses →
Playtests are experiments →
Evaluate designs off playtest results →
Repeat

Mike Ambinder, PhD
Experimental Psychologist
Physiological Measurements During Game Play
Hearth Rate

- Beat to beat interval
- Measure baseline rate and changes
- Most basic measure of arousal
- Fourier transforms to distinguish emotion
Skin Conductance Level

- Electrical resistance of the skin
  - Correlate with arousal
  - Maybe other emotions as well
- Can look for spikes (both responsive and anticipatory)
Eyetracking

- Camera focused on the eyes
- Determine where the eyes are looking
- Real-time insight into player thought processes
- Blink rate/pupil dilation
Face Recording

- Observation of facial expression
- Determination of player emotion
- Tied into gameplay

Mike Ambinder, PhD
Experimental Psychologist
EEG

- Measurement of electrical potentials in the brain
- Various frequencies are correlated with emotional state
  - Alpha (relaxation)
  - Beta (thinking, engagement)
  - Delta (fatigue)
EMG

- Sensors placed at varying points on the face
- Measurement of facial muscle contraction/relaxation
- Determinant of emotion based on ‘action units’
Other Techniques

- Body temperature
- Gesture recognition
- Muscle tension
- ...

Mike Ambinder, PhD
Experimental Psychologist
# Motivations of Play in MMORPGs

Results from a Factor Analytic Approach

**by Nick Yee**


<table>
<thead>
<tr>
<th>Achievement</th>
<th>Social</th>
<th>Immersion</th>
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<td><strong>Advancement</strong></td>
<td><strong>Socializing</strong></td>
<td><strong>Discovery</strong></td>
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<tr>
<td>Progress, Power,</td>
<td>Casual Chat,</td>
<td>Exploration,</td>
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<tr>
<td>Accumulation,</td>
<td>Helping Others,</td>
<td>Lore,</td>
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<td>Status</td>
<td>Making Friends</td>
<td>Finding Hidden</td>
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<td><strong>Mechanics</strong></td>
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<td>Numbers,</td>
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<td>Self-Disclosure</td>
<td>Character History,</td>
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<td>Templating,</td>
<td>Find and Give</td>
<td>Roles, Fantasy</td>
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<td>Analysis</td>
<td>Support</td>
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<tr>
<td><strong>Competition</strong></td>
<td><strong>Teamwork</strong></td>
<td><strong>Customization</strong></td>
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<td>Challenging</td>
<td>Collaboration,</td>
<td><strong>Appearance</strong></td>
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<td>Others,</td>
<td>Groups,</td>
<td>Color Schemes</td>
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<tr>
<td>Provocation,</td>
<td>Group Achievements</td>
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<td>Domination</td>
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<td><strong>Escapism</strong></td>
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<td></td>
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<td>Relax, Escape</td>
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<td></td>
<td>from RL, Avoid</td>
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<tr>
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<td></td>
<td>RL Problems</td>
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</table>
Cedar-Sinai rolls out VR pain relief

BY PRESS RELEASE · JUNE 28, 2016

Patients wear a GearVR headset fitted with a hygienic liner. (Image courtesy AppliedVR.)
Surgery at first, I was scared because I thought it was going to hurt. When I got to the hospital I saw Dr. Raven. He was wearing a blue shirt and he was nice. The nurse showed me the Virtual Reality. It was awesome! I saw red bears, blue bears, and bear with mustaches and hats. The game I played made me feel happy. I felt...
Over 3 pre-clinical studies, our Pain RelieVR products showed over 136% improvements in pain endurance performance.

**Methodology:** Respondents exposed themselves to pain twice, by dipping alternating hands into a tank of 0-4 Celsius water. They were instructed to leave their hands in as long as possible.

<table>
<thead>
<tr>
<th>AUG 15</th>
<th>NOV 15</th>
<th>JAN 16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st Exposure:</strong></td>
<td><strong>1st Exposure:</strong></td>
<td><strong>1st Exposure:</strong></td>
</tr>
<tr>
<td>VR first, then video</td>
<td>No stimulus</td>
<td>No stimulus</td>
</tr>
<tr>
<td><strong>2nd Exposure:</strong></td>
<td><strong>2nd Exposure:</strong></td>
<td><strong>2nd Exposure:</strong></td>
</tr>
<tr>
<td>Video first, then VR</td>
<td>Pain RelieVR Gaze, Smash Hit game, Pixar &quot;Birds&quot; Video, or No Stimulus</td>
<td>AVR Experience: Pain RelieVR or Shape Your Path</td>
</tr>
<tr>
<td>N=30</td>
<td>N=294 / Ages: 10-55</td>
<td>N=37</td>
</tr>
</tbody>
</table>

Users engaged with Pain RelieVR were able to tolerate 19% more cold pressor exposure than the 2D video.

Pain RelieVR increases pain tolerance by an average of 41%, nearly 20% more than Smash Hit, a polished VR app currently on the market with similar gameplay. Those who used Pain RelieVR were able to tolerate pain 45% longer than the Pixar video and 116% longer than those using no distraction.

Results: Pain RelieVR increases pain tolerance by an average of 45%, nearly 20% more than Smash Hit, a polished VR app currently on the market with similar gameplay. Those who used Pain RelieVR were able to tolerate pain 45% longer than the Pixar video and 116% longer than those using no distraction.

**41% PAIN TOLERANCE**

**45-62% PAIN TOLERANCE**
Creation of the Perfect "Digital Drug"
Gaming is a DIGITAL DRUG

POSITIVES ASSOCIATED WITH MODERATE USE

- Hand Eye Coordination
- Reduces Anxiety & Depression
- Enhances Memory Skills
- Training Tool
- Solving Science Problems
- Coping with PTSD
- Pain Management
Gaming is a DIGITAL DRUG

Negatives Associated with Overuse

- Addiction
- Sleep Deprivation
- Gamer Rage
- Depression, Anxiety, and Anti-social Behaviors
- Failure to Achieve Potential
- Family Abuse and Extreme Violent Behaviors & Self-harm

ALL ARE MENTAL HEALTH ISSUES
Internet addiction disorder and problematic use of Google Glass™ in patient treated at a residential substance abuse treatment program

Kathryn Yung\textsuperscript{a,b,c}, Erin Eickhoff\textsuperscript{a,c}, Diane L. Davis\textsuperscript{a,c}, Warren P. Klam\textsuperscript{a,b,c}, Andrew P. Doan\textsuperscript{c,d,*}

\textsuperscript{a} Substance Abuse Recovery Program (SARP), Naval Medical Center San Diego, United States
\textsuperscript{b} Department of Psychiatry, Naval Medical Center San Diego, United States
\textsuperscript{c} Department of Mental Health, Naval Medical Center San Diego, United States
\textsuperscript{d} Department of Ophthalmology, Naval Medical Center San Diego, United States
Case Report/Case Series

Tendon Rupture Associated With Excessive Smartphone Gaming

Luke Gilman, MD; Dori N. Cage, MD; Adam Horn, MD; Frank Bishop, MD; Warren P. Klam, MD; Andrew P. Doan, MD, PhD

Craving

Ritual

Emotional Trigger

Cycle of Addiction

Guilt

Using

REAL BATTLE
Too Much of Anything Is Harmful

Average American Child in 2010
7h 38m daily of digital media
(Kaiser Foundation)

Healthy

Dysfunctional
Neuroendocrine Model of Addiction
Hypothalamic-Pituitary Adrenal (HPA) Axis

Stress/Reward
Releases
Catecholamines

CHRONIC
STRESS/Reward
Depletes
Catecholamines

Fight or
Flight

Stimulates
Catecholamines
Dopamine
CRH

+ Corticotropin-Releasing Hormone (CRH)

Optic chiasma
Anterior lobe (adenohypophysis):
Pars tuberalis
Pars distalis
Posterior lobe
(neurohypophysis)

Infundibulum

Optic chiasma
Anterior lobe (adenohypophysis):
Pars tuberalis
Pars distalis
Posterior lobe
(neurohypophysis)

+ Adrenocorticotropic Hormone (ACTH)

Adrenal Gland

+ Cortisol

+ Adrenalin

CHRONIC STRESS
Reduces
Cortisol & Adrenalin

Addiction Cycle Increases
Neuroendocrine
Burnout!!!

CHRONIC STRESS
Dampens
HPA Response
1 in 11 are “Addicted” to Gaming

Pathological video-game use among youth ages 8 to 18: a national study.

Gentile D.

Department of Psychology, Iowa State University and National Institute on Media and the Family, Minneapolis, Minnesota, USA. dgentile@iastate.edu

Pathological video game use among youths: a two-year longitudinal study.

Gentile DA, Choo H, Liau A, Sim T, Li D, Fung D, Khoo A.

Department of Psychology, College of Liberal Arts and Sciences, Iowa State University, Ames, Iowa 50011-3180, USA. dgentile@iastate.edu

Evolution of Internet addiction in Greek adolescent students over a two-year period: the impact of parental bonding.


Hellenic Association for the Study of Internet Addiction Disorder, Larissa, Greece.
What happens when we remove people from their addiction?
Aaron Alexis: Washington navy yard gunman 'obsessed with violent video games'

Exclusive: The Washington Navy Yard gunman Aaron Alexis played violent video games including Call of Duty for up to 16 hours at a time and friends believe it could have pushed him towards becoming a mass murderer.
Excessive Video Game Use, Sleep Deprivation, and Poor Work Performance Among U.S. Marines Treated in a Military Mental Health Clinic: A Case Series

LT Erin Eickhoff, NC USN*†; LCDR Kathryn Yung, MC USNR*†; Diane L. Davis, MSN, RN, FNP-BC, PMHNP*††; CAPT Frank Bishop, MC USN‡; CAPT Warren P. Klam, MC USN, (Ret.)*†; CDR Andrew P. Doan, MC USN*†‡
Addicted: Suicide Over Everquest?

New Mexico mom gets 25 years for starving daughter

Published June 03, 2011 | Associated Press

Jacksonville mom shakes baby for interrupting FarmVille, pleads guilty to murder

Xbox tragedy

Game addict, 20, killed by deep vein thrombosis

By EMMA LITTLE, Health Editor

Last Updated: 01 Aug 2011
Prevention
Screening
Treatment
What to look for?

- Preoccupation with video games: that’s all they talk about.
- Irritability, anxiety, or sadness when video games are taken away.
- Spending too much time playing to the point of not getting enough sleep or continually showing up late for work.
- Unable to stop or cut back video game playing.
- Relationship problems because of too much gaming.
- Use of gaming to escape or relieve negative feelings.
What to do?

- Educate staff and students.
- Refer to University mental health.
- Teach respect for digital media and emphasizing moderation.
www.andrew-doan.com
www.realbattle.org
facebook.com/DrAndrewDoan