“Game of Neurons: Winning Strategies in Neuropathology Education”

John E. Donahue, M.D.
Professor of Pathology and Laboratory Medicine and Neurology
Rhode Island Hospital/Warren Alpert Medical School of Brown University

Disclosures

- I have no relevant financial relationships to disclose

Learning Objectives

- List the processes and strategies underlying learning, memory, and long-term retention
- Demonstrate the rationale for using games to assist learning in neuropathology education (and medical education in general)
- Discuss the differences between playing games with medical students and hospital residents/fellows

Outline

- Science of learning
- Gamification in neuropathology education
  - My experience using Jeopardy for educational purposes
  - My experience using poll questions (akin to the “Ask the Audience” lifeline in “Who Wants to Be a Millionaire”) during lectures
- Poll questions in lieu of a virtual slide

Science of learning

- Encoding (hippocampus)
  - Short-term working memory
  - Memory traces: new representations in the brain
- Consolidation (independent of hippocampus)
  - Reorganizes and stabilizes memory traces, giving them meaning
  - Connect to past experiences/prior knowledge in long-term memory
- Retrieval (strengthening neocortical memory pathways)
  - Updates learning
  - Applies learning when needed

Brown, Roediger, and McDaniel, 2014

AANP

To learn, retrieve!

- We lose about 70% of what we just heard or read
- The other 30% falls off more slowly
- To improve learning, the process of forgetting must be interrupted by retrieval

Brown, Roediger, and McDaniel, 2014

Ways to retrieve

- Practice, practice, practice
- To be most effective, practice must be repeated but **spaced out** and **varied**
  - "Massed practice" is ineffective: material is continuously looped through the hippocampus without becoming committed to long-term memory
  - Effective learning is difficult but more durable
  - Evaluations: "massed practice" is most popular

Brown, Roediger, and McDaniel, 2014

AANP

Ways to retrieve

- Testing
  - 2010 scientific study
  - Students read a passage of text
  - Those who took a test on that passage remembered 50% more of the content a week later than those who had not been tested
  - Online evaluation: those who were not tested were happier
- Homework
- Games!

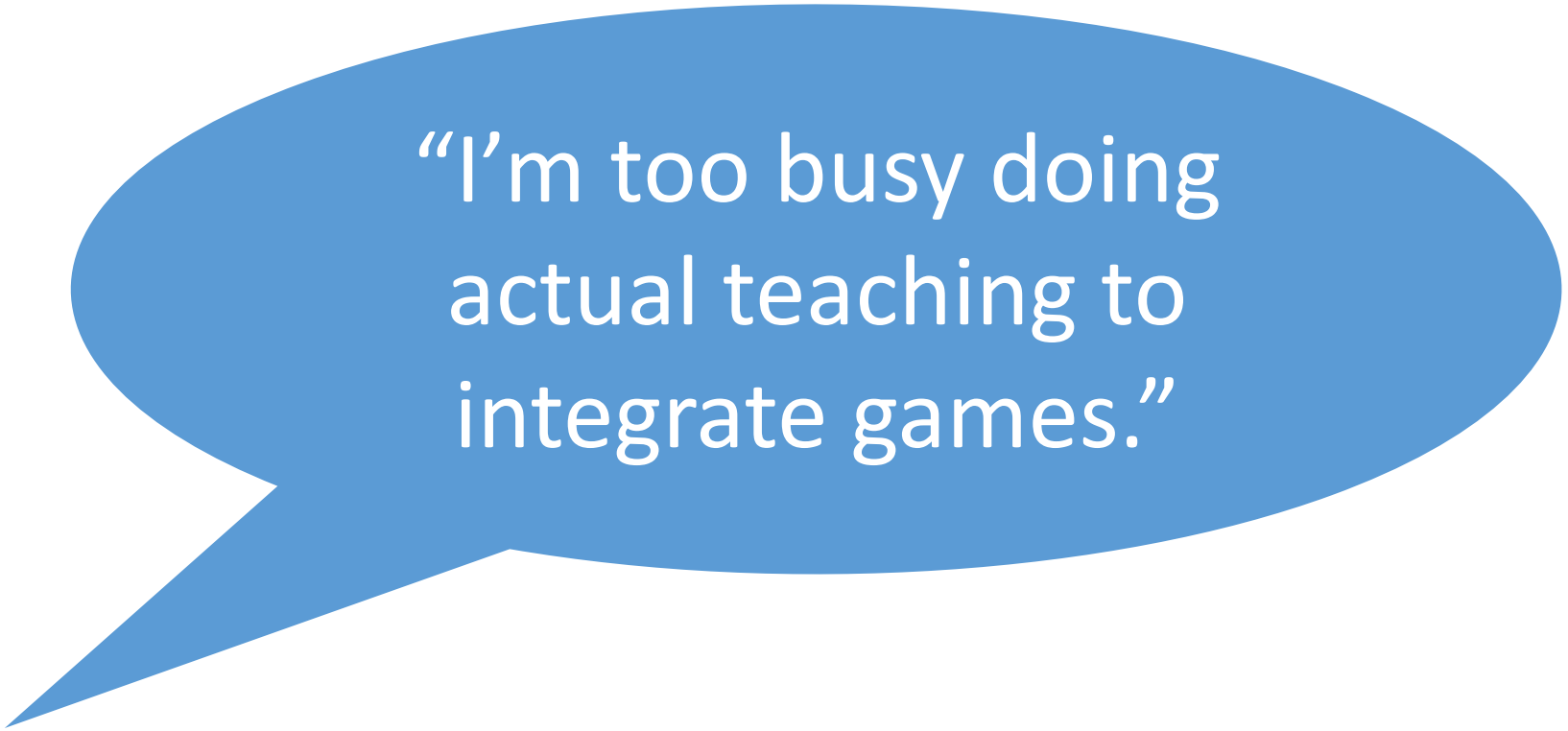
Brown, Roediger, and McDaniel, 2014

Why use games in neuropathology education?

- Increase engagement
- Create a positive learning environment
- Increase instructor enjoyment
- Reinforce content
- (Informally) assess knowledge
- Increase motivation to prepare ahead

Green and Donahue, 2017

AANP



Green and Donahue, 2017

"I'm too busy doing actual teaching to integrate games."

"But the whole point of teaching is to facilitate learning!"

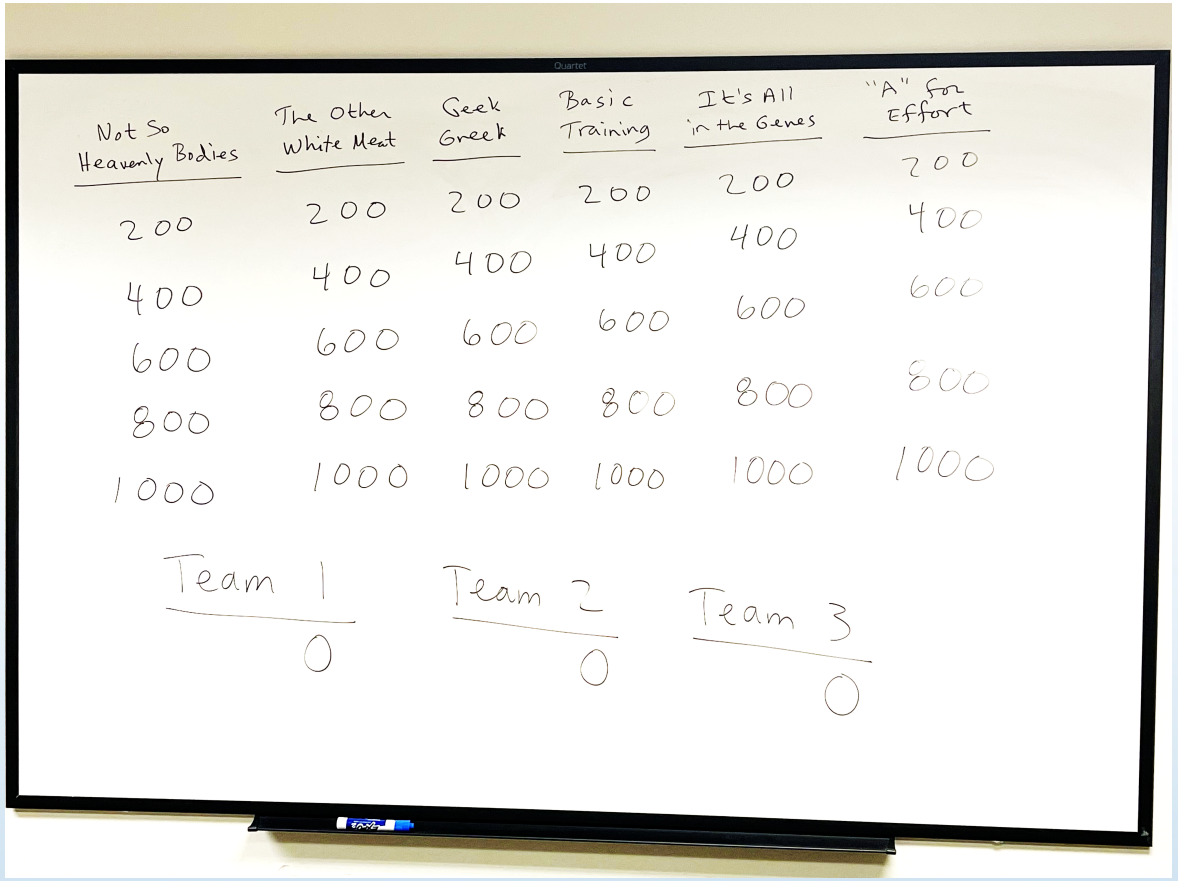
Green and Donahue, 2017

My history with Jeopardy in medicine

- Played as a contestant for the only time during third-year internal medicine rotation in December 1990
- Co-hosted for the first time during third-year psychiatry rotation in January 1991 (“Schizophrenia Jeopardy”)
- Started playing semi-regularly with neurology residents in 2000
- Played a couple of times with pathology and neurosurgery residents
- Started playing with medical students at Brown Medical School in 2011

AANP

My history with neuropathology Jeopardy



My history with neuropathology Jeopardy

https://www.survivingateacherssalary.com/classroom-jeopardy-by-educational-insights-review-fun-interactive-technology/

AANP

My history with neuropathology Jeopardy

- "Classroom Jeopardy" by Educational Insights
  - Electronic scoreboard with wireless buzzers
  - Authentic video graphics and sound effects, including the think music and voices of Alex Trebek and Johnny Gilbert
  - Comes prepackaged with elementary school-type games
  - Any clues can be input into the game's proprietary software
  - Version 1.0 debuted ~2008; version 2.0 debuted ~2010
  - Discontinued ~2012 because the company's license with Sony Entertainment expired ☹

My history with neuropathology Jeopardy

- Played dozens of games with hospital residents in the 2000's; highlight was the "Neurology-Neurosurgery-Neuropathology Challenge" of 2008
- Medical student games are played at a much higher level than hospital games
  - The vast majority of clues are responded to correctly
  - Very few clues go unanswered
  - Game moves along quickly, like watching it on TV

Jeopardy ideal context

- 1. Players are all at the same level
  - Medical students are all at the same level
  - In resident noon conference, any or all may be present: senior residents, junior residents, rotating residents, medical students, and observers
  - For hospital games, I usually create an advanced game and ensure that each team is captained by a senior resident. However…

Jeopardy ideal context

- 2. Players show up on time and play for the entire game
  - Medical students are a captive audience
  - Some residents don't show up—too busy in hospital or off-site
  - Many show up late—must get lunch
  - Some get paged out of a room in the middle of the game; this is a problem if a senior resident leaves

Jeopardy ideal context

- 3. Game involves a limited amount of material
  - Medical student courses involve well-delineated content
  - Resident games are often general knowledge of the subject (in my case, neuropathology and brain sciences)
  - In one game with pathology residents, the material was 15 pages in the neuropathology chapter of Robbins covering neurodegenerative and prion diseases
  - It was a very low-scoring game with many clues going unanswered

Jeopardy ideal context

- 4. Players are actively studying material that they are motivated to learn
  - Medical students studying for course exams—motivated to do well
  - Lack of significant motivation for residents to learn material
  - Residents show up for noon conference with lunch (often late) and then eat, listen, and leave
    - No repeated exposure to conference material
    - No studying and no testing

Brown, Roediger, and McDaniel, 2014

Suggestions for improving effectiveness of gameplay with hospital residents and fellows

- Account for the differences in knowledge among players
  - Use very basic topics that most will know about, OR…
  - Create teams with senior resident/fellow as captain
- Enforce a start time for the conference, and make it protected time for the attendees (but patient care comes first)
- Create games with a limited amount of material
- **Provide motivation to do well!**
- (Provide some form of informal quiz after the game?)

AANP

LET’S TRY TO BRING SOME SCIENCE INTO THIS!

Brain Sciences Jeopardy Groups

- Class is divided into three groups (approximately 45 students per group)
- Each group plays one game of Jeopardy
- Each game has three teams of five players each
- There will be five winners, ten non-winners, and around 35 observers per game
- Combined, there are 15 winners, 30 non-winners, and around 100-105 observers per block
- Jeopardy is played during the first two Brain Sciences blocks

AANP

Hypotheses

- Students who played Jeopardy did better on the exam than the students who watched from the audience or did not show up
- Students did better on the exam when they played Jeopardy compared to when they did not play
- Winning is irrelevant to exam performance

Simple Effect Comparisons of Group*Exam Least Squares Means By Exam Adjustment for Multiple Comparisons: Holm-Tukey													
Simple Effect Level	Group	_Group	Estimate	Standard Error	DF	t Value	Pr > |t|	Adj P	Alpha	Lower	Upper	Adj Lower	Adj Upper
Exam 1	a) Never Played	b) Played-Lost 1	0.002852	0.1473	139	0.02	0.9846	0.9846	0.05	-0.2885	0.2942	-0.4044	0.4101
Exam 1	a) Never Played	c) Played-Won 1	-0.1333	0.1489	139	-0.90	0.3722	0.8073	0.05	-0.4276	0.1611	-0.5447	0.2782
Exam 1	a) Never Played	d) Played-Lost 2	-0.3829	0.1371	139	-2.79	0.0060	0.0463	0.05	-0.6539	-0.1118	-0.7618	-0.00399
Exam 1	a) Never Played	e) Played-Won 2	-0.05023	0.1712	139	-0.29	0.7696	0.9673	0.05	-0.3886	0.2882	-0.5233	0.4228
Exam 1	b) Played-Lost 1	c) Played-Won 1	-0.1361	0.1576	139	-0.86	0.3891	0.8234	0.05	-0.4476	0.1754	-0.5716	0.2994
Exam 1	b) Played-Lost 1	d) Played-Lost 2	-0.3857	0.1465	139	-2.63	0.0094	0.0699	0.05	-0.6754	-0.09610	-0.7906	0.01915
Exam 1	b) Played-Lost 1	e) Played-Won 2	-0.05309	0.1788	139	-0.30	0.7670	0.9673	0.05	-0.4066	0.3004	-0.5472	0.4410
Exam 1	c) Played-Won 1	d) Played-Lost 2	-0.2496	0.1480	139	-1.69	0.0939	0.4456	0.05	-0.5422	0.04300	-0.6587	0.1594
Exam 1	c) Played-Won 1	e) Played-Won 2	0.08303	0.1800	139	0.46	0.6454	0.9673	0.05	-0.2729	0.4390	-0.4145	0.5806
Exam 1	d) Played-Lost 2	e) Played-Won 2	0.3326	0.1704	139	1.95	0.0530	0.2952	0.05	-0.00430	0.6696	-0.1384	0.8037
Exam 2	a) Never Played	b) Played-Lost 1	-0.1002	0.1347	139	-0.74	0.4581	0.9457	0.05	-0.3666	0.1661	-0.4726	0.2721
Exam 2	a) Never Played	c) Played-Won 1	-0.1611	0.1605	139	-1.00	0.3173	0.8534	0.05	-0.4784	0.1563	-0.6047	0.2826
Exam 2	a) Never Played	d) Played-Lost 2	-0.1989	0.1371	139	-1.45	0.1491	0.5961	0.05	-0.4701	0.07219	-0.5779	0.1801
Exam 2	a) Never Played	e) Played-Won 2	-0.1862	0.1999	139	-0.93	0.3533	0.8843	0.05	-0.5815	0.2091	-0.7388	0.3664
Exam 2	b) Played-Lost 1	c) Played-Won 1	-0.06084	0.1620	139	-0.38	0.7078	0.9819	0.05	-0.3811	0.2595	-0.5086	0.3869
Exam 2	b) Played-Lost 1	d) Played-Lost 2	-0.09870	0.1389	139	-0.71	0.4784	0.9457	0.05	-0.3733	0.1759	-0.4825	0.2851

Bottom line:

NOTHING IS SIGNIFICANT

☹ ☹ ☹

Explanations for nonsignificant data?

- 1. Though there are five players on each team, sometimes I see one or two dominating while the others are passive
  - It is as if the passive players were sitting in the audience, yet they were counted as “players”
  - If the game were single players competing, like on TV, that would have forced them to be more active at learning retrieval and could have made a difference

Explanations for nonsignificant data?

- 2. While names are drawn out of a bag randomly, students have the option of not participating
  - This creates a slight selection bias that favors extroverts being players and introverts sitting in the audience
  - True randomization may have produced significant results

Explanations for nonsignificant data?

- 3. There's very little variation in exam scores
  - Most students score above 80%, so there is not much room for improvement
  - It's possible that the sample size would have to be much larger to see any significant difference in improvement
  - If the mean scores were in the 30's and 40's (like advanced physics and organic chemistry in college), there could have been a significant result with this sample size

Explanations for nonsignificant data?

- 4. Those sitting in the audience could have had the game demonstrate their knowledge deficits
  - This could have caused audience members to re-double their study efforts and bring their exam performance closer to that of the players
  - If the game were played without an audience, there may have been a significant difference between players and non-players

Study design changes to show significant differences between players and non-players

- Have single players compete head-to-head
- True randomization—students must play if selected to play
- Increase the size of the class or make the exam questions more difficult
- No audience for the games
- NONE OF THESE ARE LIKELY TO HAPPEN IN A REAL-WORLD SCENARIO

DOES THIS MEAN THAT GAMIFYING EDUCATION HAS NO BENEFIT?

Bottom line

- Most students love it, have a lot of fun with it, and it makes for a great, effective review, and that's what's most important!
- In evaluations, Jeopardy has a 94% approval rating

Donahue, John E

ID	Comments (IDs randomly assigned)
1	Lecturer was very enthusiastic about course content. His jeopardy sessions were very helpful in solidifying information and injecting fun into the studying process.
2	Dr. Donahue's lectures were very clear in terms of what we were required to know for the exam and I appreciated that he gave warnings before the graphic content was shown. I love the Jeopardy sessions and thought they were a great way to have fun with the content as well as identify areas that needed more studying.
3	One of the most entertaining and engaging lecturers I have had the pleasure of learning from. Also, please keep doing jeopardy in future years. They were very educational and useful for studying, even though certain of my peers play like there's an AOA membership as an award for winning. In all seriousness, excellent instructor and course leader
4	I thought Professor Donahue was an incredible lecturer and I enjoyed his teaching style throughout our block. I particularly enjoyed the Jeopardy sessions during reading week!
5	Excellent and engaging lecturer, jeapordy was a highlight of each brain sciences block.
6	Dr. Donahue has been an amazing instructor. It is evident that he really cares about student's success and is extremely passionate about the material. He took his time explaining things and his lectures slides and objectives were very clear. I also really enjoyed his jepordy review game. It was evident he put an enormous amount of time into preparing for the game, and it was very helpful for review. It also gave me time to step away from studying alone and work with classmates on something fun. Dr.

AANP

GAMIFICATION DURING LECTURES—POLLING SOFTWARE

Benefits of using polling software during lectures

- Enhanced audience engagement
- Real-time feedback and assessment
- Increased knowledge retention (due to retrieval)
- Better data for decision-making
- Reward your audience: it's fun!
- Good to ask questions about prior lectures—helps with long-term retrieval

Jackson E, 2024
Brown, Roediger, and McDaniel, 2014

Examples of polling software

- Poll Everywhere
- Top Hat
- Mentimeter
- Wooclap
- Slido
- Others; all of the above have Power Point integration
- Zoom has a polling feature

Gamifying polling software

- Polling software reminds me of the “Ask the Audience” (ATA) lifeline in the game show “Who Wants to Be a Millionaire”
- As I introduce the first set of questions, I play the “Let’s Play” music ripped from the official UK WWTBAM CD.
- I take my polling to the next level by playing the official ATA music as the question is displayed
- Leaves no doubt how long to leave the question displayed

https://decider.com/2020/04/08/who-wants-to-be-a-millionaire-jimmy-kimmel-how-to-watch-time/

AANP

“VIRTUAL SLIDE”: POLL QUESTIONS FOR YOU!!!

References

- **Brown PC, Roediger HL III, McDaniel MA. "Make It Stick: The Science of Successful Learning." Cambridge, MA: The Belknap Press of Harvard University Press, 2014.**
- Roediger HL III, Putnam AL, Smith MA, "Ten Benefits of Testing and Their Applications to Educational Practice." In: Mestre JP, Ross BH (eds.), "The Psychology of Learning and Motivation: Cognition in Education." Elsevier Academic Press, 2011, pp. 1-36.
- Roediger HL III, Karpicke JD, "Test-enhanced learning: taking memory tests improves long-term retention," *Psychol Sci* 2006; 17: 249-255.
- Singhal S, Hough J, Cripps D, "Twelve tips for incorporating gamification into education," *MedEdPublish (2016)* 2019; 8: 216. doi: 10.15694/mep.2019.000216.1
- van Gaalen AEJ, Brouwer J, Schönrock-Adema J, Bouwkamp-Timmer T, Jaarsma ADC, Georgiadis JR, "Gamification of health professions education: a systematic review," *Adv Health Sci Edu Theory Pract* 2021; 26: 683-711.
- Green EP, Donahue JE, "Gamification: Integrating Active Learning into Medical Education Through the Use of Games." Program in Educational Faculty Development, 2016-2017 series, Warren Alpert Medical School of Brown University, Providence, RI (1/30/2017).
- Jackson E, "The 5 Benefits of Integrating Polling Software into Educational Webinars." 2024: https://www.digitaljoy.media/the-5-benefits-of-integrating-polling-software-into-educational-webinars/

AANP