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PROMISES AND PERILS OF REWARDS: THE ROLE OF INTRINSIC MOTIVATION IN EDUCATION

Kou Murayama

Department of Psychology, University of Reading, UK



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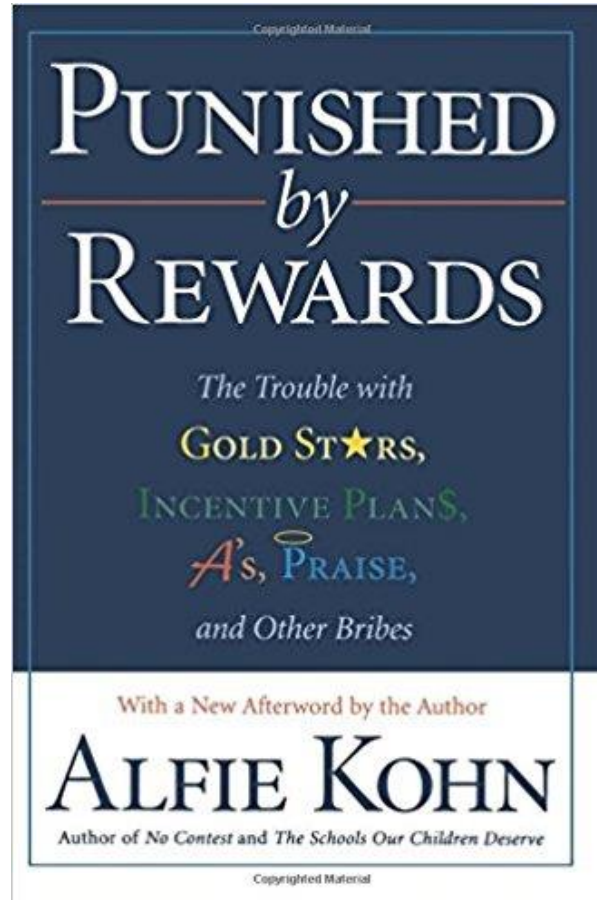


Question

- Is giving rewards or incentives a reliable and effective way to increase students' motivation and performance?

- Opinions are divided...
 - Some argue rewards work pretty well.

- Opinions are divided...
 - Some strongly oppose to rewards.



Aim of the talk

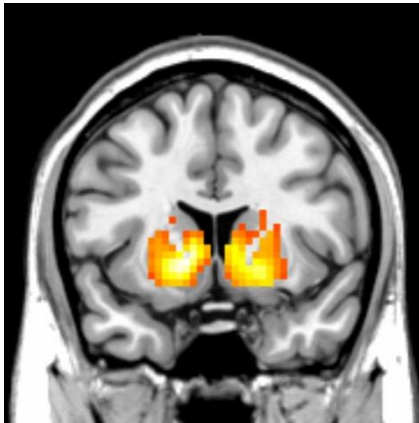
- Provide a balanced discussion on the potential benefits and danger of using rewards in education, based on scientific (both psychological and neuroscientific) evidence.

Main points

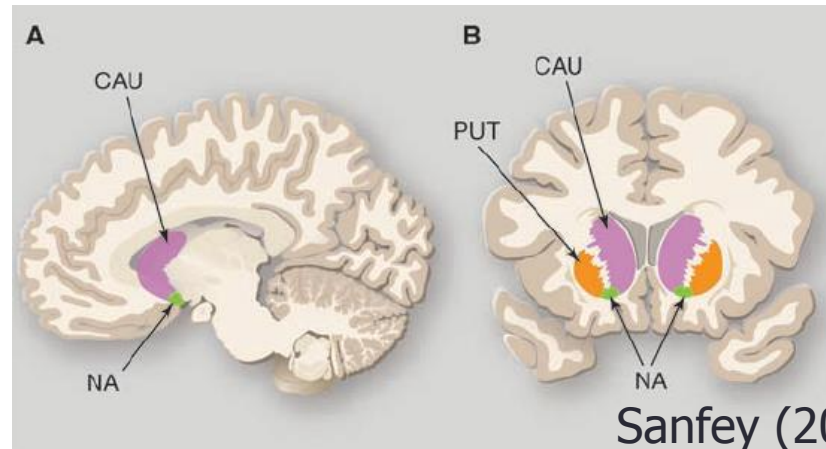
- 1. Rewards do indeed have positive effects: They help the consolidation of learning.

Reward and Learning Consolidation

- One of the hot topics in cognitive neuroscience (Gruber et al., 2016; Shohamy & Adcock, 2010; Wittman et al., 2005; Mather & Schoeke, 2011; Adcock et al., 2006).
- Rewards (i.e. money) enhance memory consolidation through the activation in the striatum (reward network).



Responses to monetary cue



Sanfey (2007)

Mechanisms

Lisman & Grace (2005)

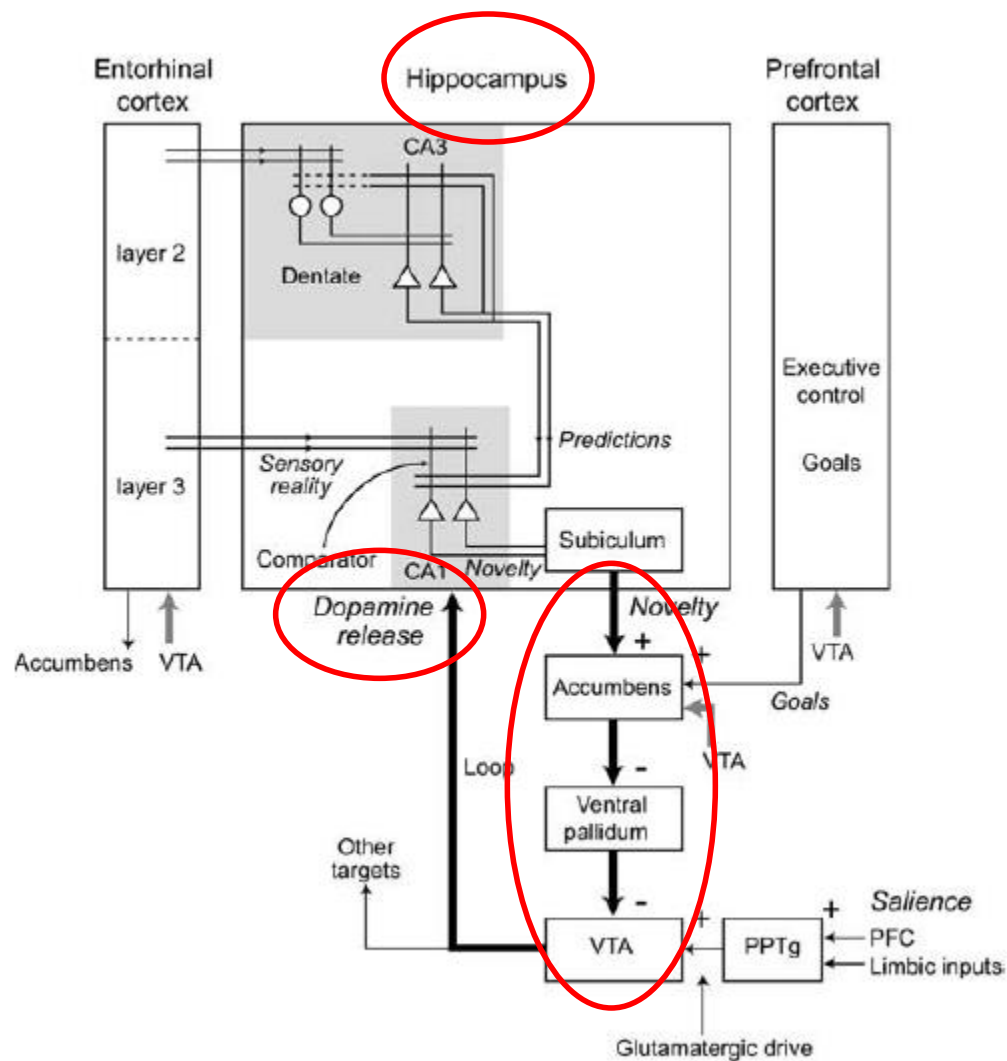
Reward
(e.g., money)

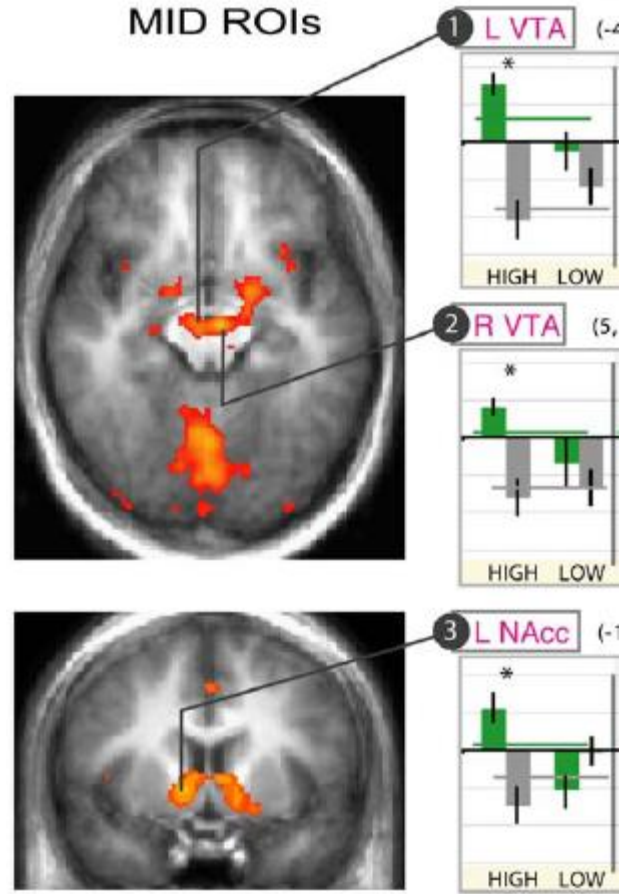
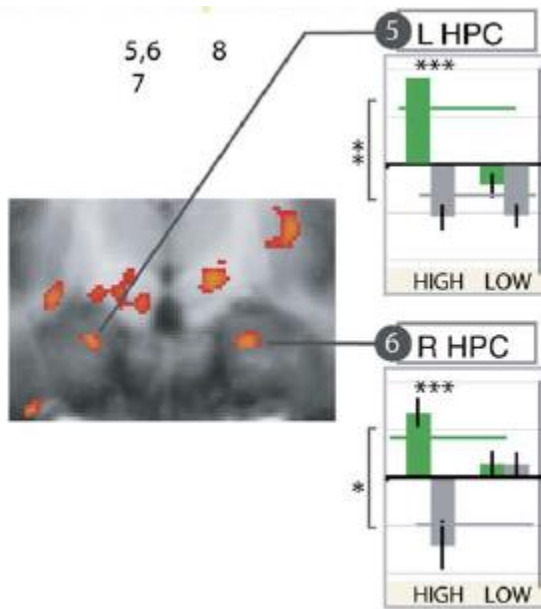
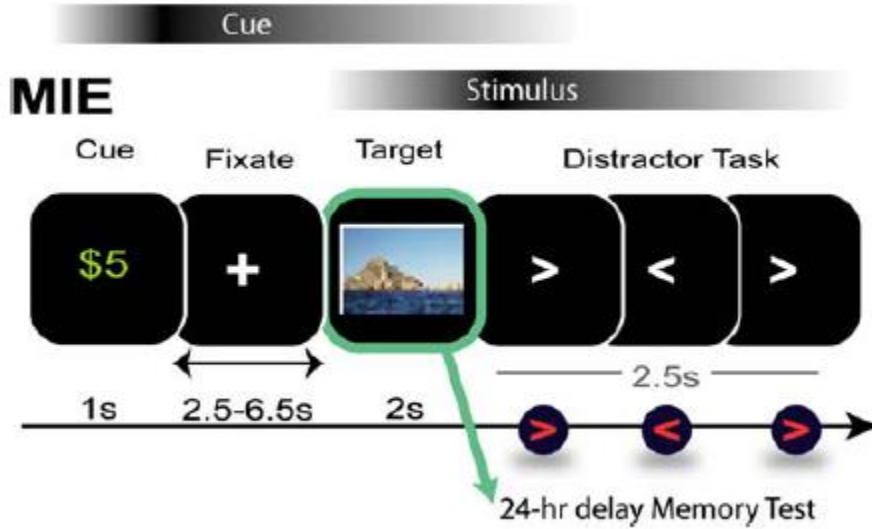
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Reward network
in the brain is
activated

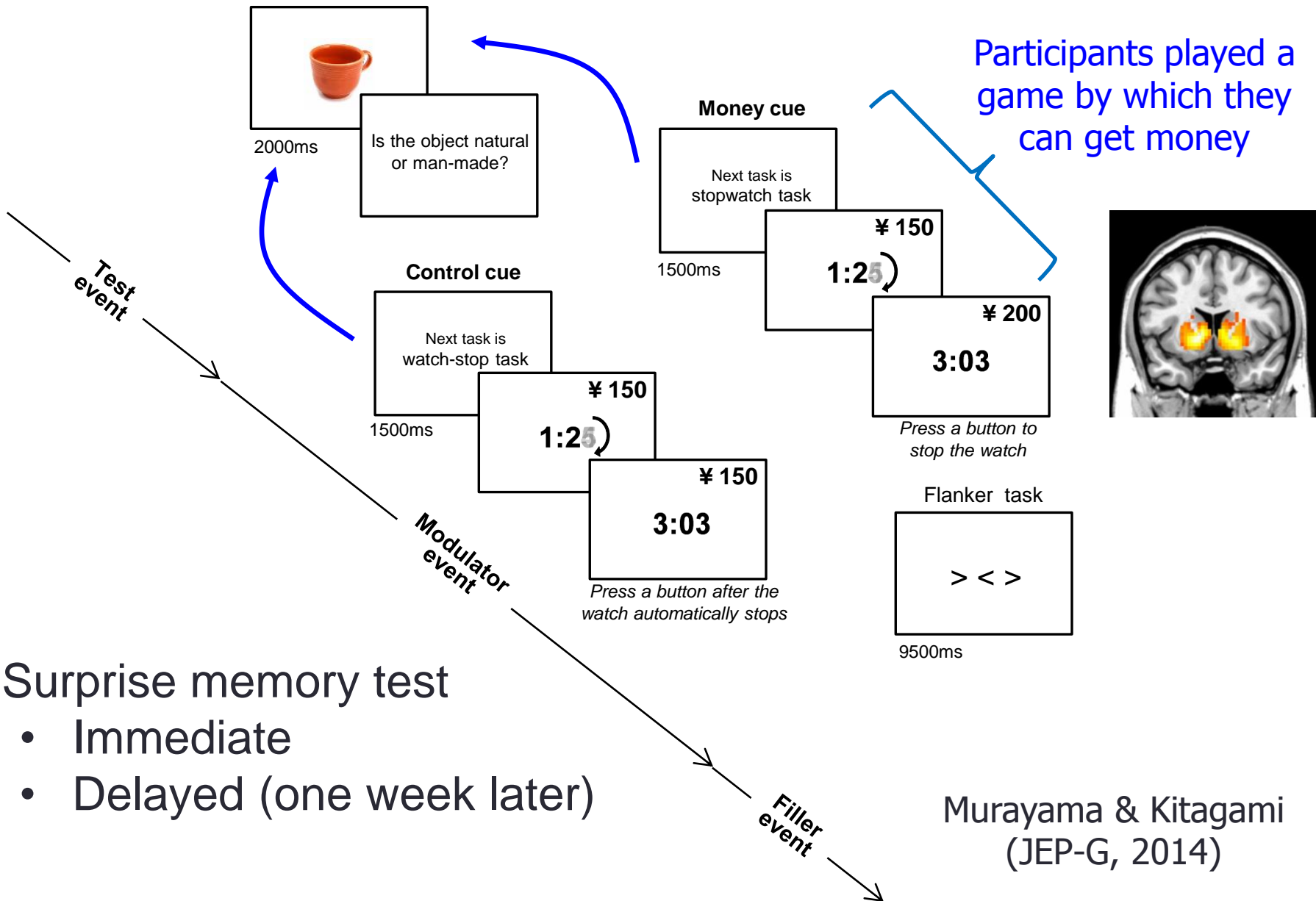
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Memory
consolidation
(hippocampus)



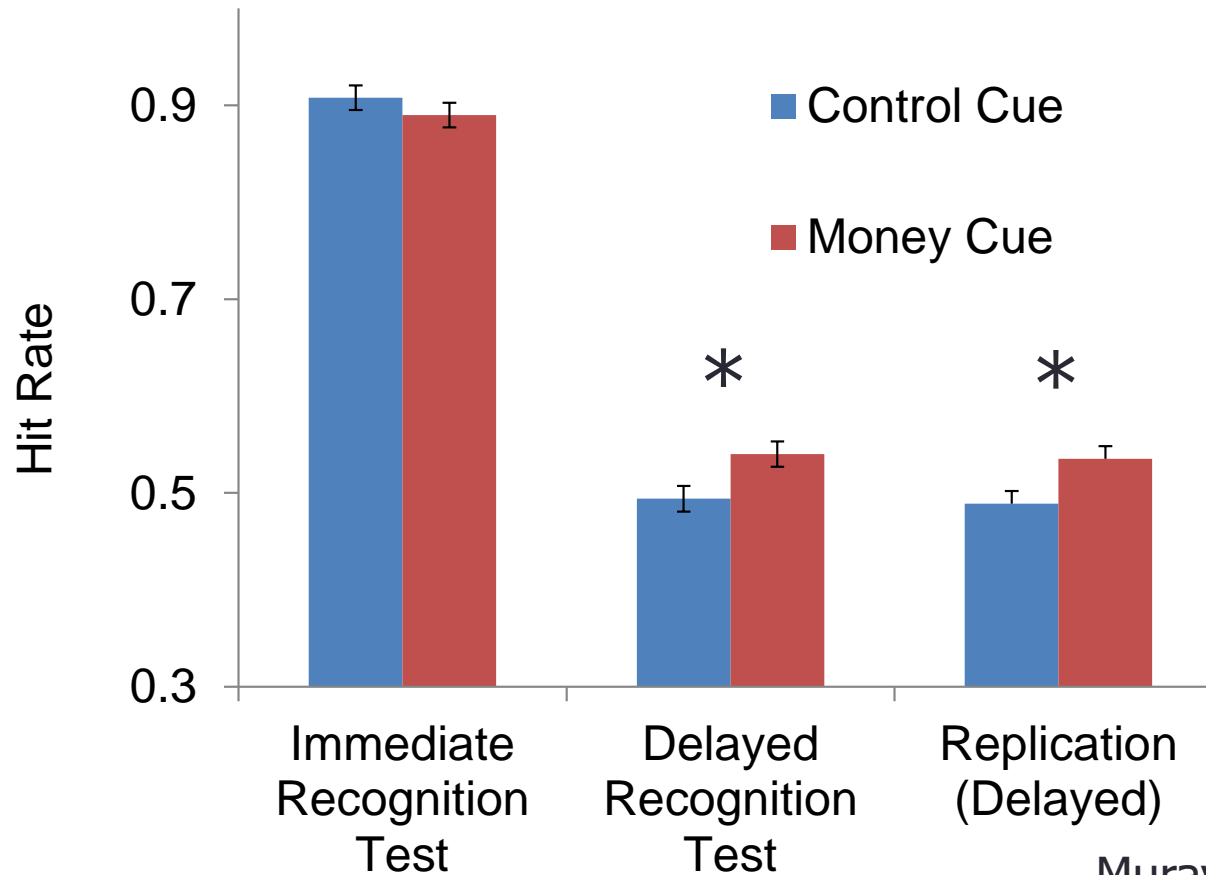


Adcock et al. (2006, *Neuron*)



- Surprise memory test
 - Immediate
 - Delayed (one week later)

Results



Murayama & Kitagami
(JEP-G, 2014)

- Rewards enhance memory consolidation even for the materials that are *irrelevant* for the rewards.
 - Rewards might have a hidden positive effect to enhance learning consolidation in general.

Main points

- 1. Rewards do indeed have positive effects: They help the consolidation of learning.
- 2. “Intrinsic rewards” have the same positive effects.

- What are the rewards?
 - Food
 - Money
 - Gold stars
 - Teachers'/parents' praise
 - Friends' recognition
 - Feeling of value (importance)
 - Satisfaction from the success
 - Task enjoyment

Most previous research

“Extrinsic” rewards

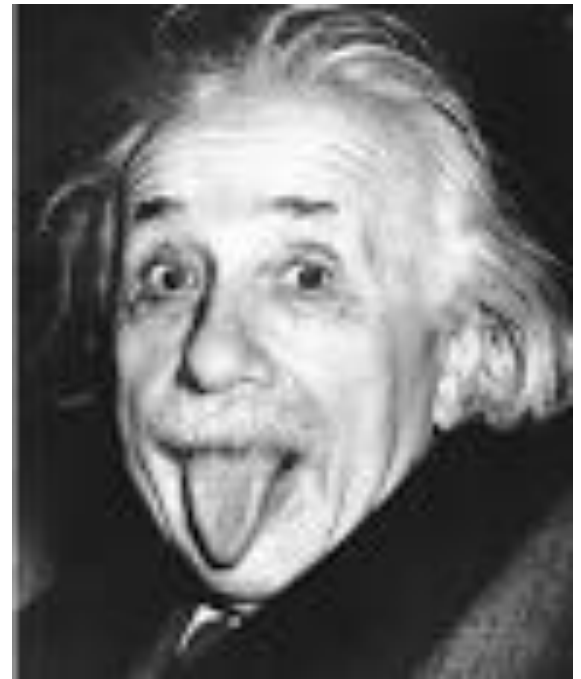
“Intrinsic” rewards



Motivation based on intrinsic rewards is often called “intrinsic motivation”

Do intrinsic rewards work like extrinsic rewards?

- One type of intrinsic rewards = interest and/or curiosity.

- *I have no special talents. I am only passionately curious*



	Extrinsic rewards	Intrinsic rewards (e.g., curiosity, interest)
Activate the reward network in the brain?		
Enhance the learning consolidation?		

Orpheus



Eurydice

Orpheus

Curiosity-based decision making paradigm

Curiosity condition



Scanned

Rating

Want to know the secret?



Decision

Take lottery?



You passed

You lost...

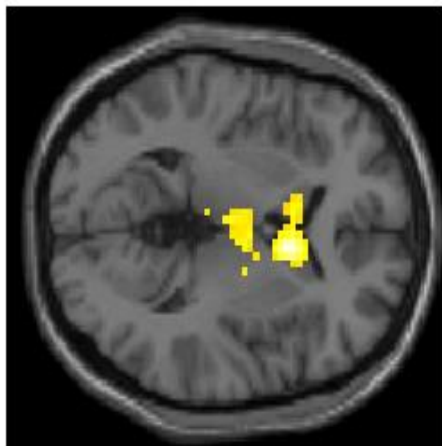
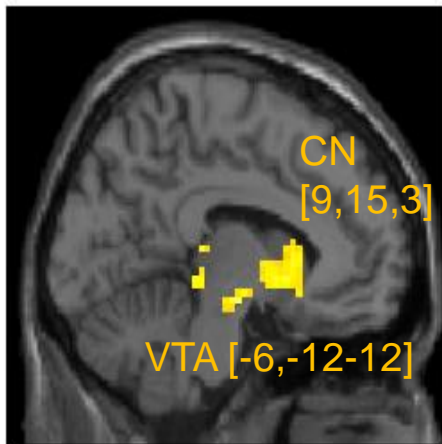
You won!

Got a ticket to the secret!



Food condition

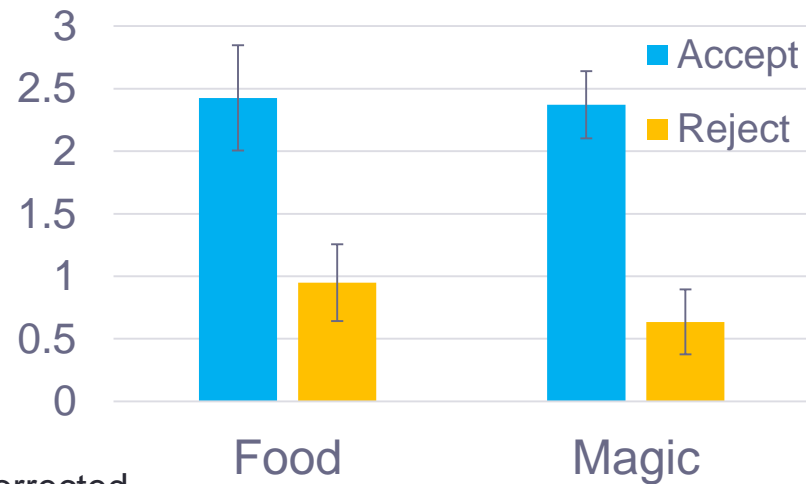
Reward network is related to the decision of accepting electric shocks for *both* magic tricks and foods.






$p < 0.05$, FWE-corrected
at cluster level

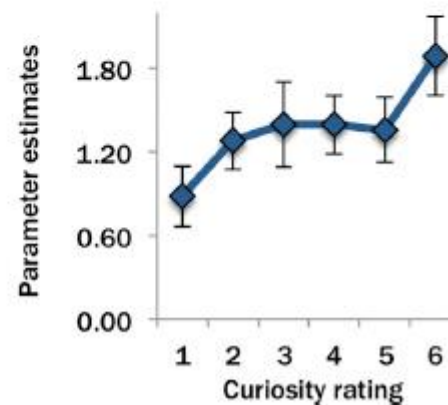
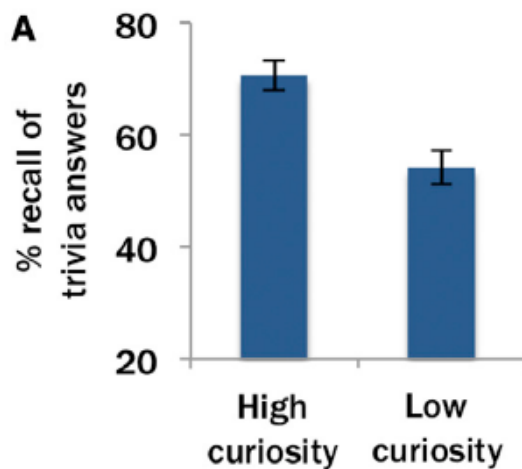
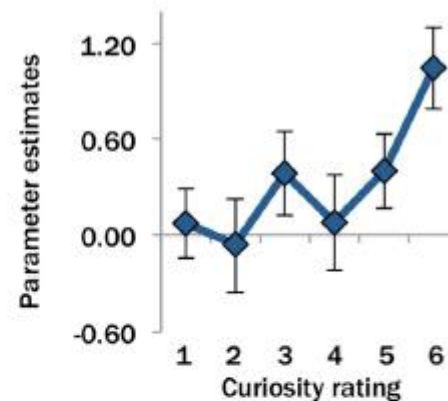
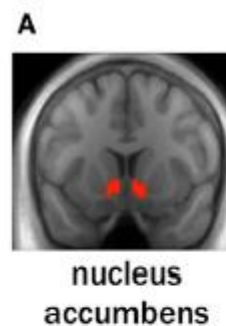
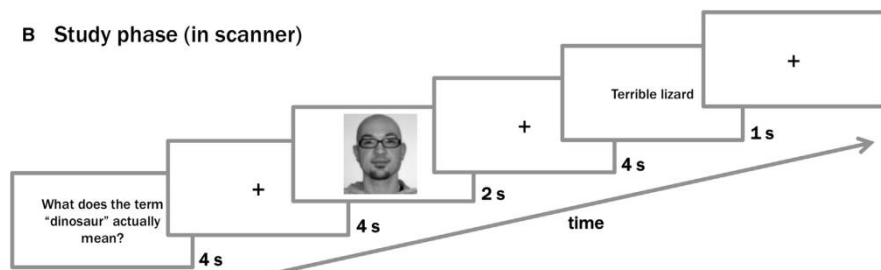
Greater activities in:





- Caudate nucleus (dorsal striatum) &
- Midbrain/VTA (ventral striatum)



	Extrinsic rewards	Intrinsic rewards (e.g., curiosity, interest)
Activate the reward network in the brain?		
Enhance the learning consolidation?		

Curiosity and reward processing



	Extrinsic rewards	Intrinsic rewards (e.g., curiosity, interest)
Activate the reward network in the brain?		
Enhance the learning consolidation?		

Main points

- 1. Rewards do indeed have positive effects: They help the consolidation of learning.
- 2. “Intrinsic rewards” have the same positive effects.
- 3. Extrinsic rewards can undermine intrinsic motivation.

- Extrinsic rewards have strong power to enhance memory consolidation.
- This may be driven by the dopaminergic activation in the reward network (e.g., striatum).
- BUT, are there any downsides?

Undermining effect

- Extrinsic reward can *undermine* intrinsic motivation, because intrinsic motivation is easily crowded out by external forces (Deci & Ryan, 1985)
- Undermining effect happens only when the task is interesting (Deci et al., 1999).

- Imagine you enjoy solving maths problems. You voluntarily work on maths problem solving without being told by anyone.
- One day, a teacher said to students: “I will give you gold stars if you solve many math problems”.
- Because you wanted to get gold stars, you worked hard to solve maths problems to get gold stars. You actually got a lot of gold stars.

- Clearly, you were motivated by extrinsic rewards.
- But would you be still motivated for maths *after* the gold star scheme is over and teacher no longer gives you gold stars?
- Undermining effect indicates that your enjoyment for maths would *be lost* after the gold star scheme is over.

Murayama et al. (*PNAS*, 2010, featured in BBC)

Reward instruction



1st session

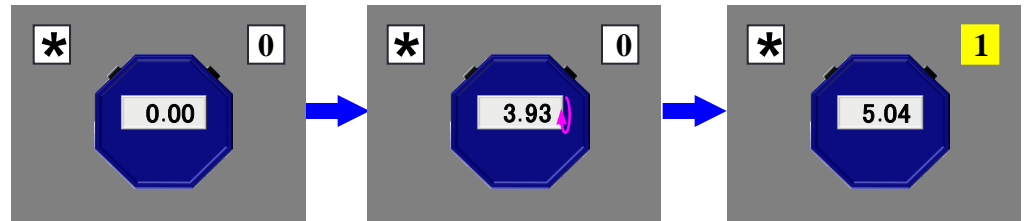
SCAN

← { Reward group: 1.2GBP/success
Control group: no bonus



Reward payment

Task: Stopwatch task (interesting task)



Waiting period



SCAN

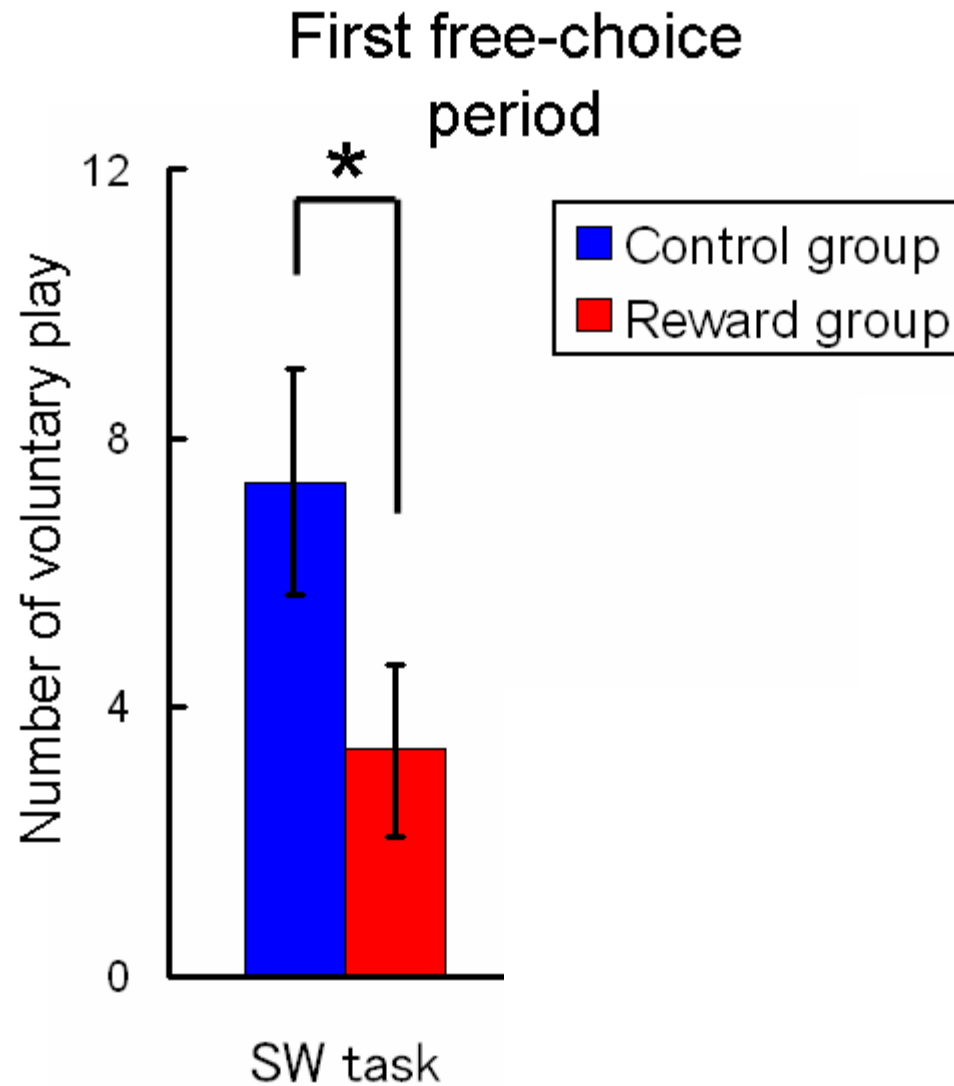
← { Reward group: no bonus
Control group: no bonus

Intrinsic motivation



2nd session

Behavioral Results (Waiting period)

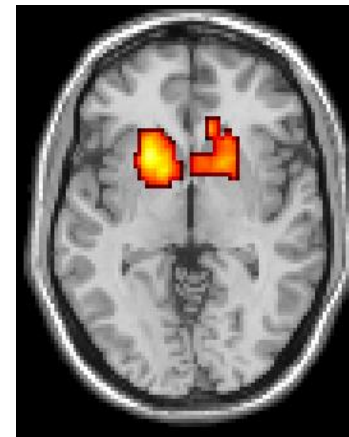
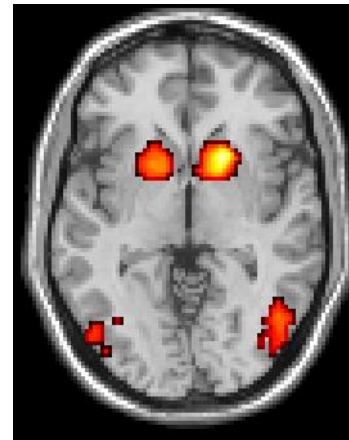


Striatal activation (in response to success feedback)

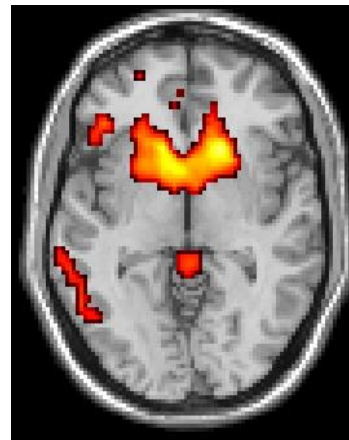
Murayama et al. (*PNAS*, 2010, featured in BBC news)

1st session 2nd session

Control group



Reward group



Reward promised

Reward removed

Extrinsic rewards and learning reconsidered

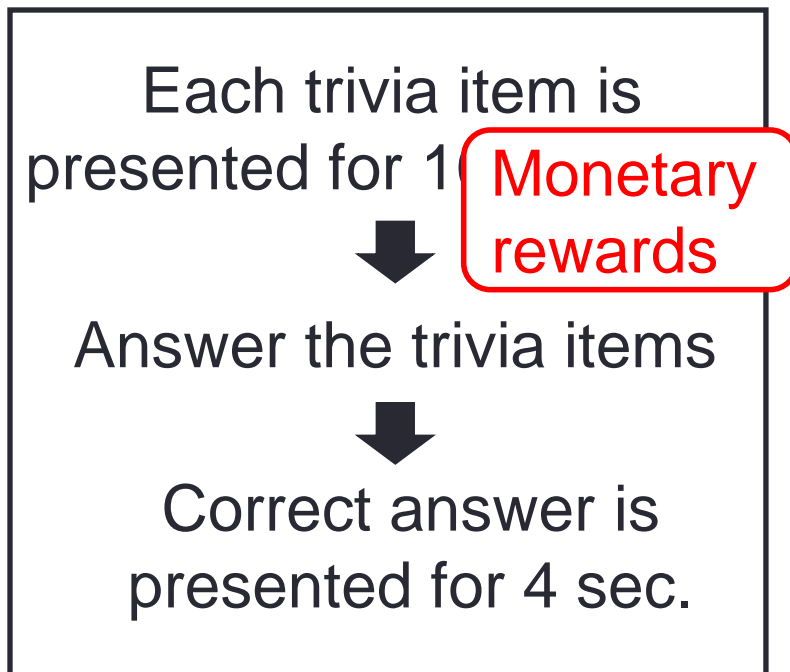
Murayama & Kuhbandner (2011, *Cognition*)

- Extrinsic rewards can undermine intrinsic motivation.
- Does the undermining effect have implications about learning?
- When a student is enjoying a task, is it a good idea to give rewards to the student with the aim to boost learning?

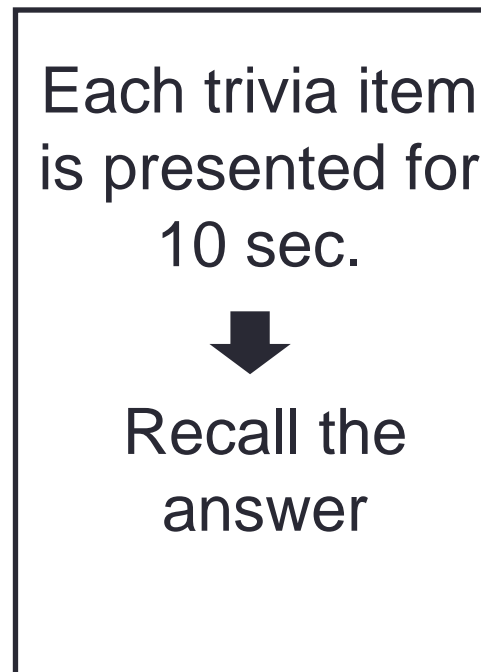
- Task: Trivia question paradigm
 - Uninteresting trivia items: “What is the name of the author of the book "1984"?” “What is the national flower of Spain?”
 - Interesting trivia items: “What is the animal that has the shortest sleep a day?” “What is the only consumable food that won’t spoil forever?”

- Participants: Assigned to one of the two groups.
 - Reward group
 - No-reward group

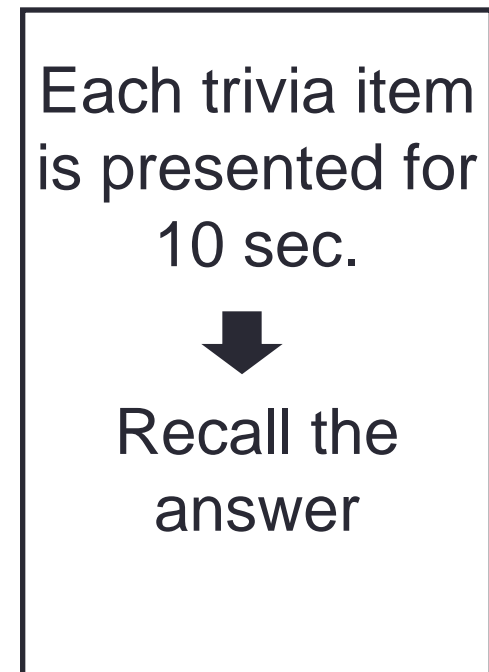
Learning session



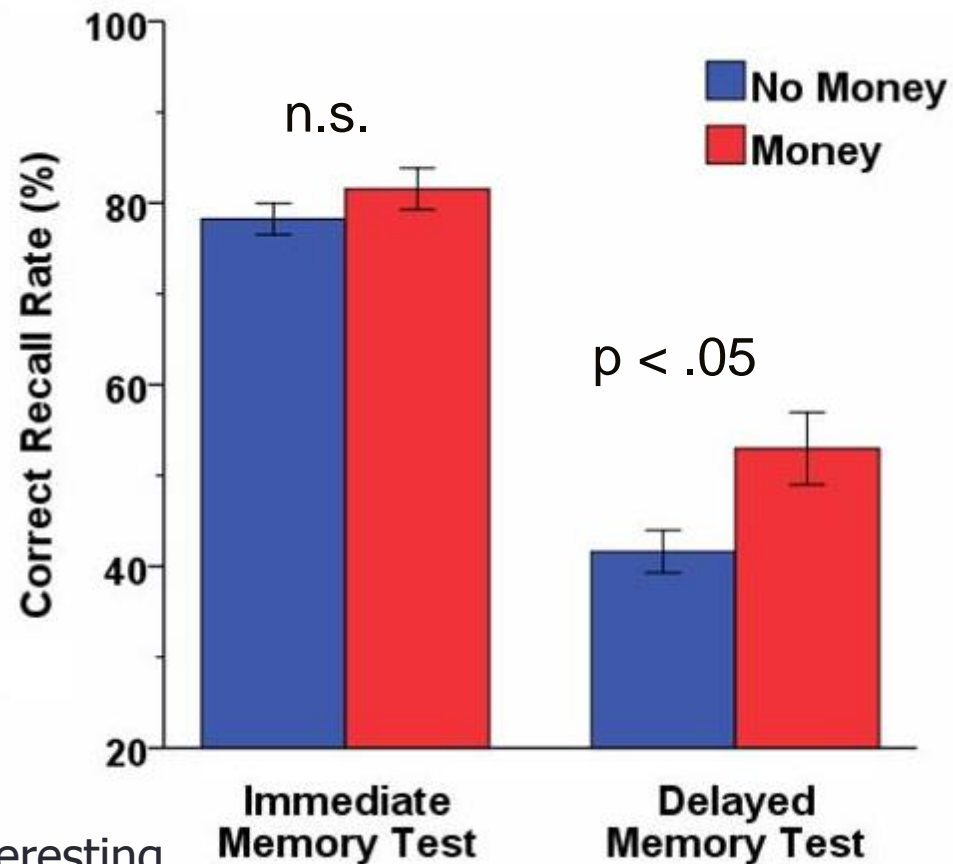
Immediate memory test



Delayed memory test (1 week later)

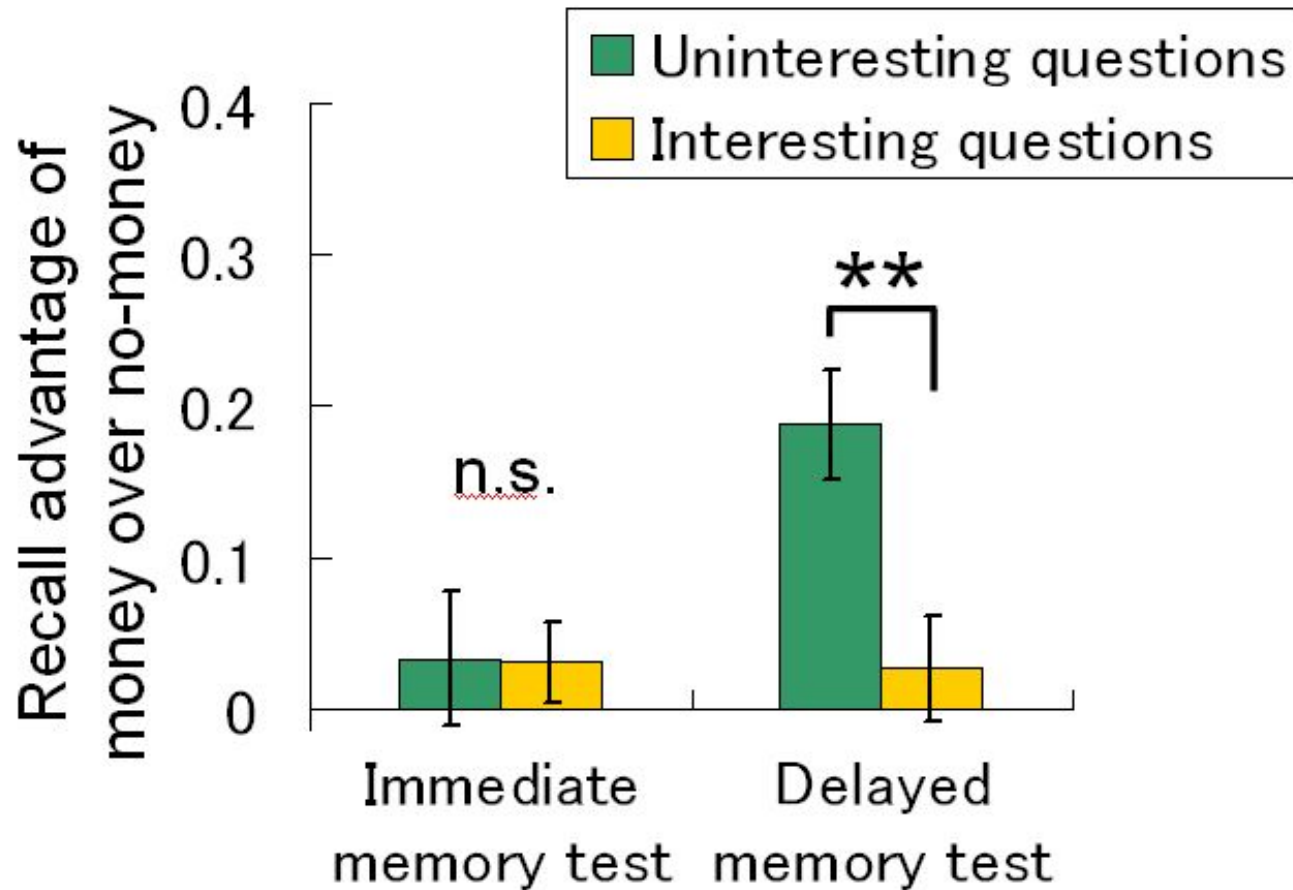


Reward enhances memory after a delay (i.e., memory consolidation)



* Collapsing both interesting and uninteresting questions

But it is limited to boring materials!



- Extrinsic incentives are not effective to facilitate learning when students are enjoying the task.
- If someone is interested in a learning material, giving rewards is just a waste of money.

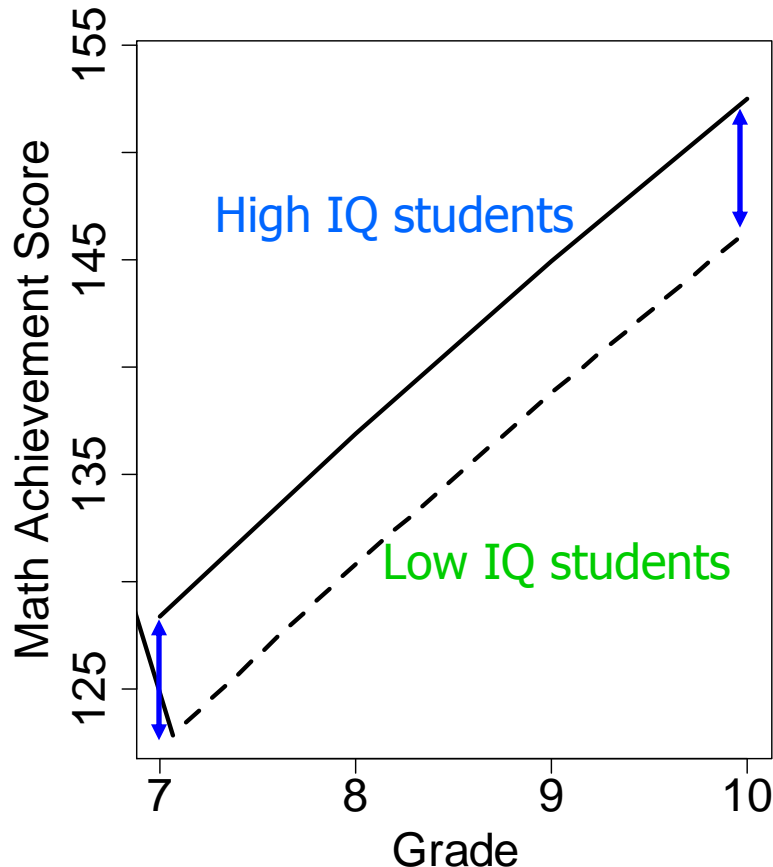
Main points

- 1. Rewards do indeed have positive effects: They help the consolidation of learning.
- 2. “Intrinsic rewards” have the same positive effects.
- 3. Extrinsic rewards can undermine intrinsic motivation.
- 4. Intrinsic rewards have sustainable effects.

- Extrinsic rewards are effective to motivate learning, “as long as you keep giving rewards”.
- Once rewards are removed, students may no longer be motivated (and intrinsic motivation may be decreased).
- In other words, the positive effects of extrinsic rewards are not sustainable.
 - E.g., do they study out of the school context?

- What about intrinsic rewards?
- When you enjoy studying, you can find another interest in the topic, which would further strengthen your enjoyment.
- In other words, intrinsic rewards are sustainable and even boost over time.

5-Year Longitudinal Study of Math Achievements in German Schools ($N = 3,530$)



IQ is strongly related to math achievement at the baseline

However, growth in math achievement is unrelated to the IQ.

IQ is related to concurrent achievement, but not to learning.

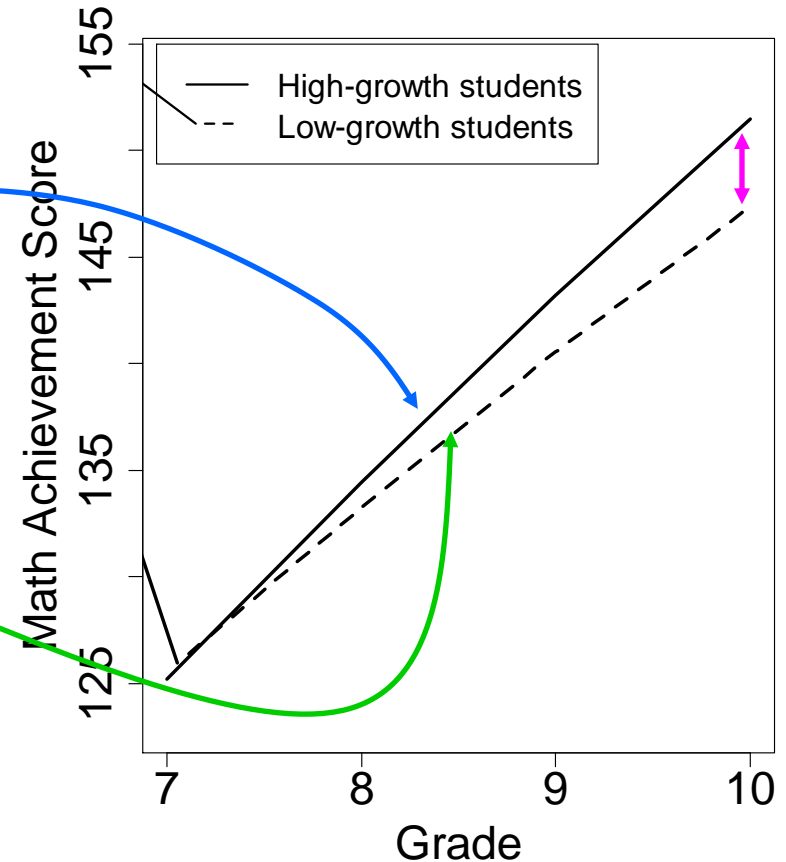
5-Year Longitudinal Study of Math Achievements in German Schools

* IQ is controlled







Students with high intrinsic motivation for mathematics.

Students with low intrinsic motivation for mathematics.

Unlike the IQ, intrinsic motivation facilitates long-term consolidation of learning.



Murayama, Pekrun et al., (2013, *Child Development*; featured in *Time Magazine*, *Wall Street Journal*, etc.)

	Extrinsic rewards	Intrinsic rewards (e.g., curiosity, interest)
Activate the reward network in the brain?		
Enhance the learning consolidation?		
Sustainable effect?		

Main points

- 1. Rewards do indeed have positive effects: They help the consolidation of learning.
- 2. “Intrinsic rewards” have the same positive effects.
- 3. Extrinsic rewards can undermine intrinsic motivation.
- 4. Intrinsic rewards have sustainable effects.
- 5. We can use extrinsic rewards as “an entry to intrinsic motivation.”

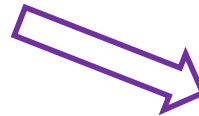
- It seems that intrinsic rewards have better features.
- Why not pursuing intrinsic motivation in education then?
- A problem.

There is no robustly established method to facilitate intrinsic motivation.

Self-determination theory (Deci & Ryan, 1985)

Feeling of
competence

Self-efficacy belief



Feeling of
relatedness



Feeling of
autonomy

(self-determination)



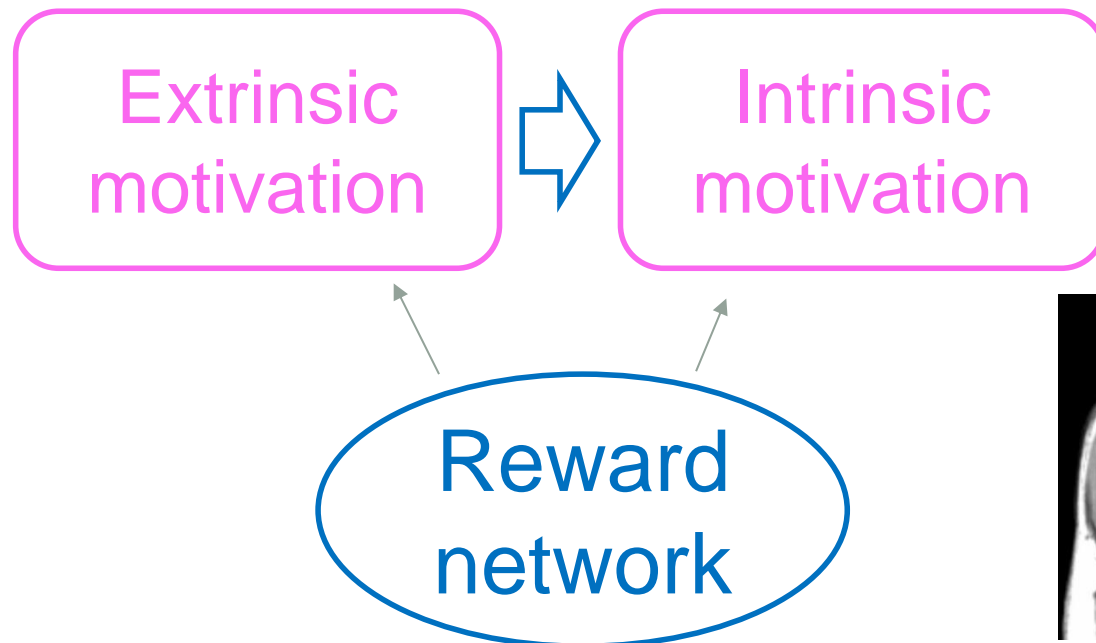
Intrinsic motivation

It is easy to say, but...

- Feeling of competence, feeling of relatedness, and feeling of autonomy are important to facilitate intrinsic motivation, but in reality, it is not easy to enhance the feelings of students.
- If a student is completely unmotivated for mathematics, how can we increase the feeling of competence of that student?

Potential strategy

- Both extrinsic rewards and intrinsic rewards are supported by the same neural substrates.
- Then, it should be possible to transform extrinsic motivation into intrinsic motivation.



“Extrinsic rewards as an entry point to intrinsic motivation”

- When students are not motivated at all, it is not a bad idea to give rewards to motivate them.
- At the same time, try to support students' feeling of competence, relatedness, and autonomy.
- Then it is possible that initial extrinsic motivation eventually transforms to intrinsic motivation.
- Strong scientific support for this idea has not been provided yet, but several theories suggest that this is very likely (Ryan & Deci, 2000; Renninger & Hidi, 2016).

Main points

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Postdoc/Student/RAs

Dr. Johnny Lau

Dr. Lily Fitzgibborn

Dr. Carolyn McNabb

Greta Fastrich

Laura Burgess

Stef Meliss

Emmanuel Daveau

Collaborators

Andrew Elliot (Uni. Rochester)

Reinhard Pekrun (Univ. Munich)

Alan Castel (UCLA)

Kenji & Madoka Matsumoto
(Tamagawa University)

Fumiko Hoeft (UCSF)

Potential Ph. D. studentship and
postdoc position will be available

For more info, please contact
k.murayama@reading.ac.uk