

Time-dependent effect of acute stress on decision-making under the risk

Kaori YAMAKAWA Tokaigakuen University
Hideki OHIRA Nagoya University



“I’m stressed. So I can’t decide.”



“Now is NOT the best time. I should decide later.”

Acute stress response



Sympathetic-adrenal-medullary system

Adrenaline

Hypothalamic-pituitary-adrenal system

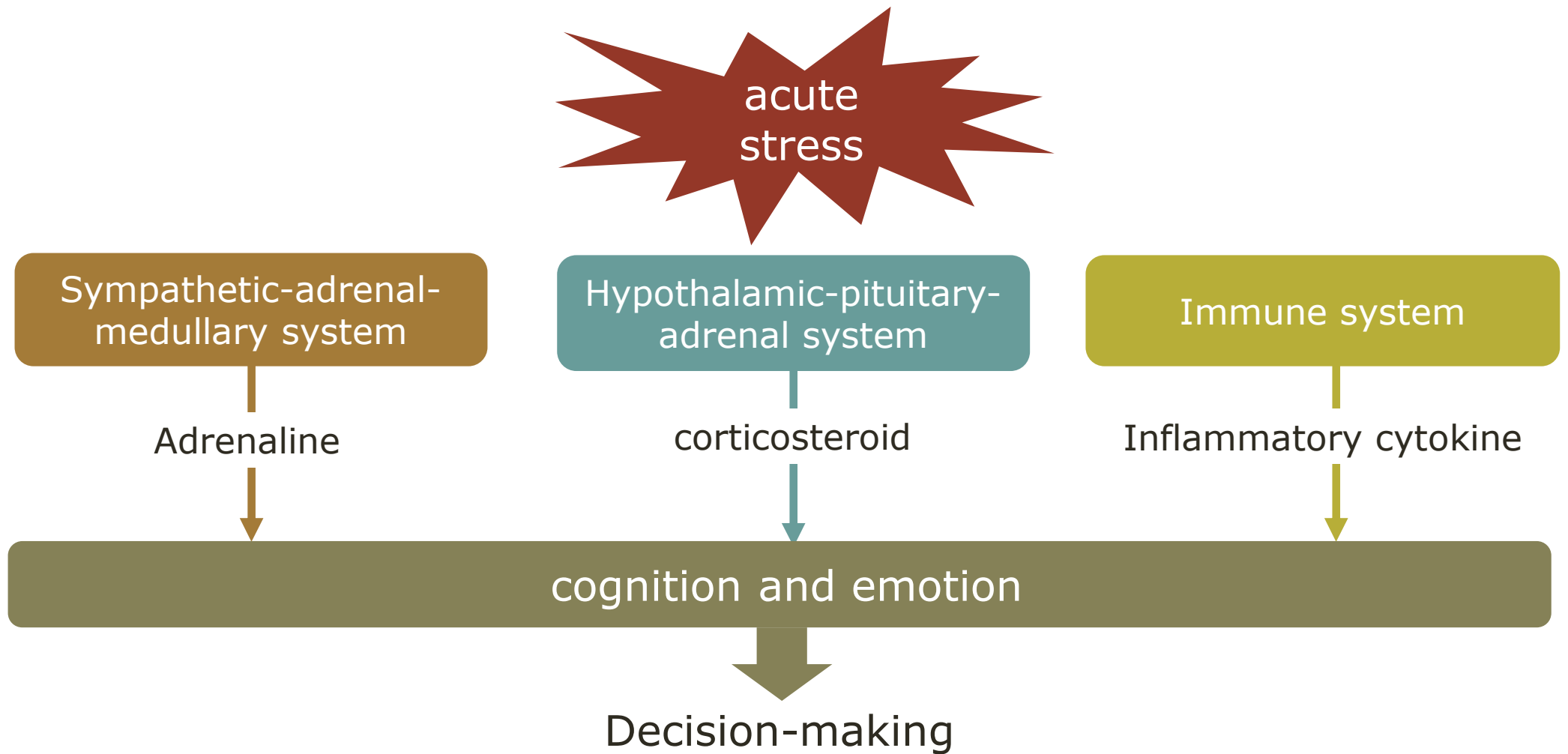
corticosteroid

Immune system

Inflammatory cytokine

cognition and emotion

Acute stress response



Acute stress response



Sympathetic-adrenal-medullary system

Adrenaline

Hypothalamic-pituitary-adrenal system

corticosteroid

Immune system

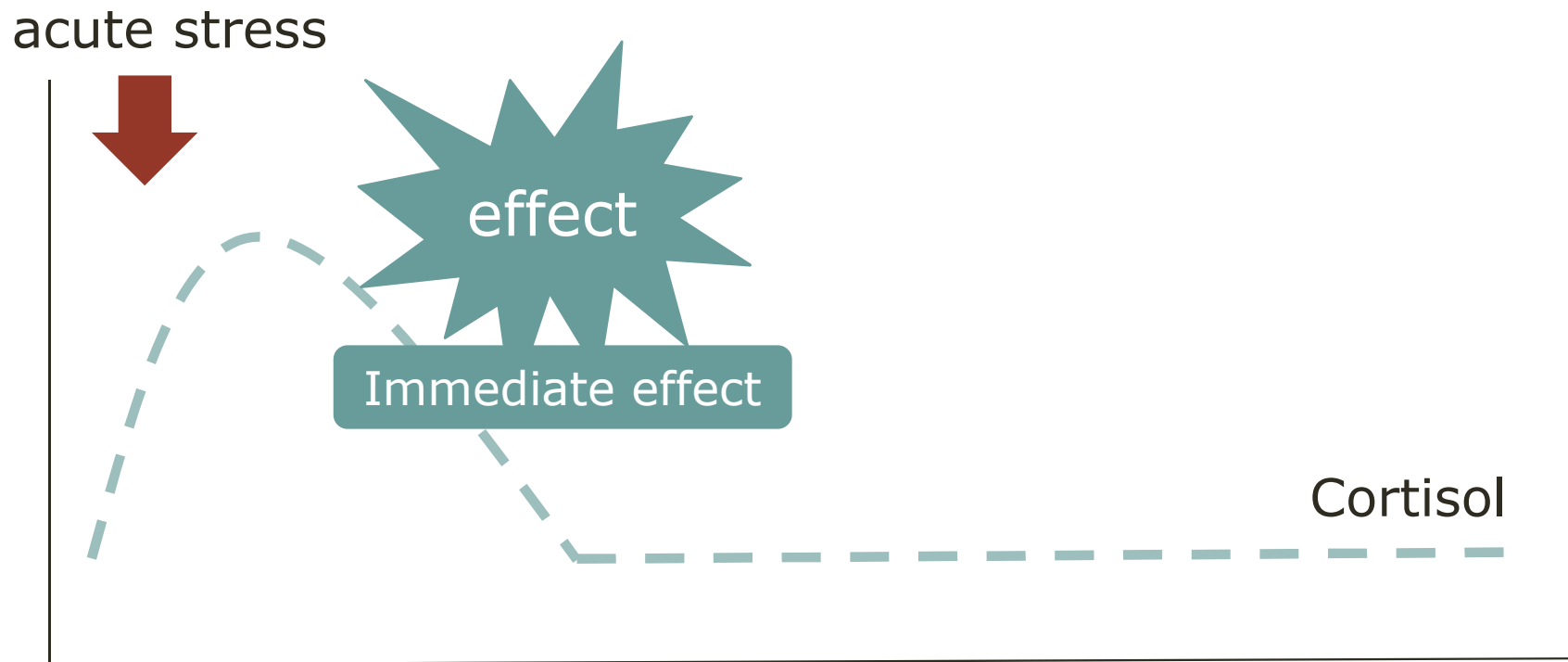
Inflammatory cytokine

cognition and emotion

Decision-making

Time-dependent effect of glucocorticoid response

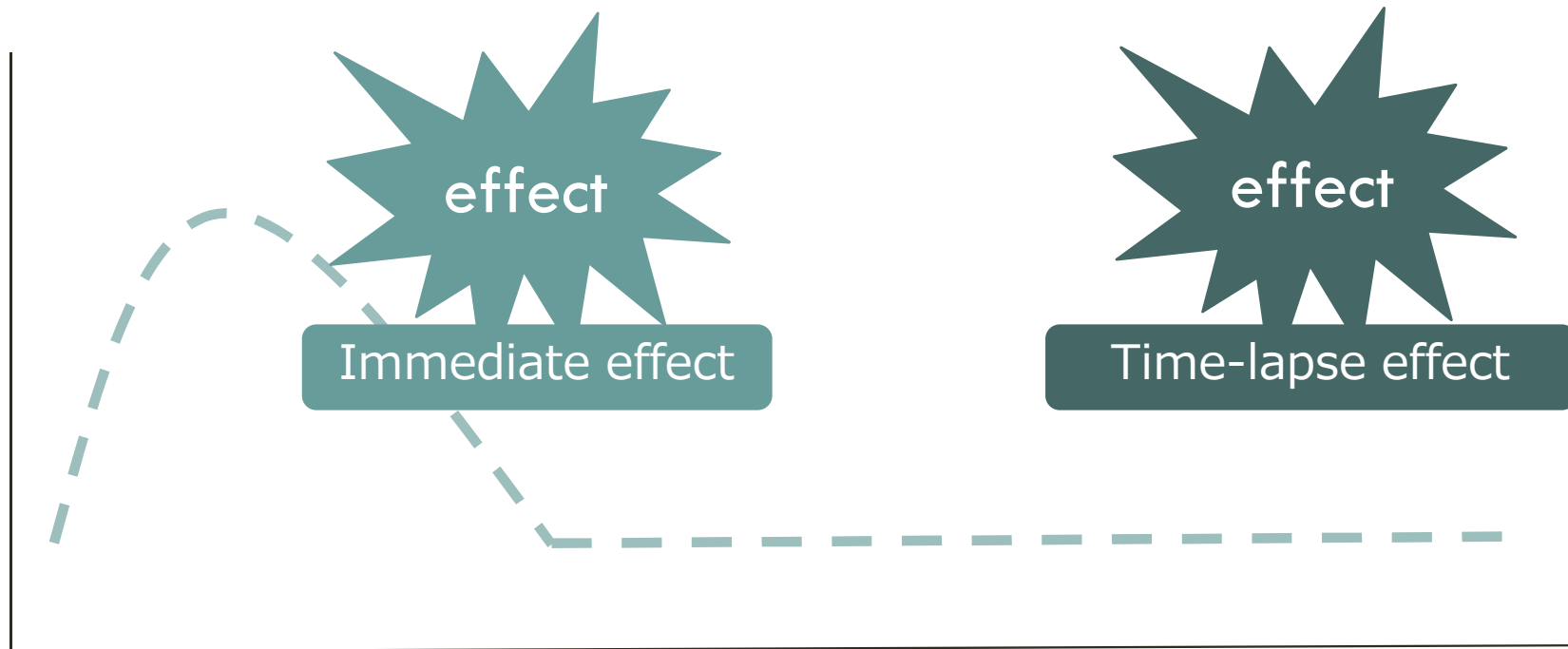
- Until now: investigating the immediate effect



Time-dependent effect of glucocorticoid response

- Diamond et al (2007)

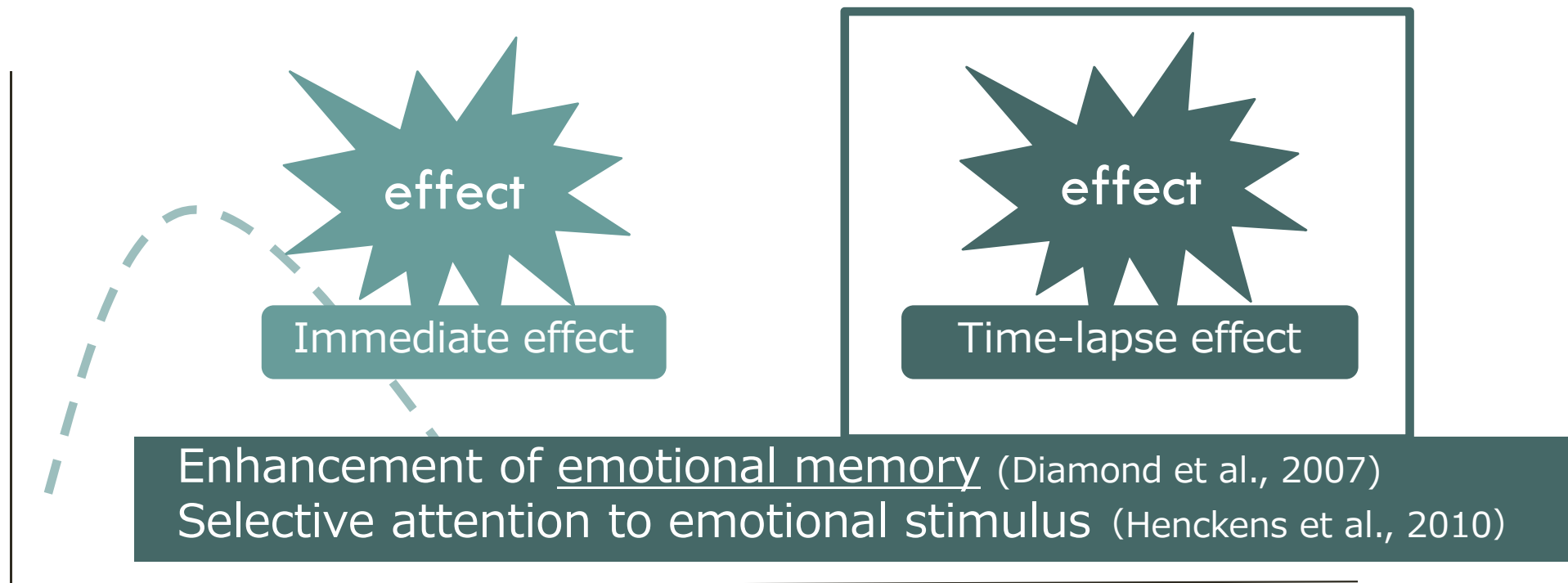
- Different effects on CNS depending on elapsed time



Time-dependent effect of glucocorticoid response

- Diamond et al (2007)

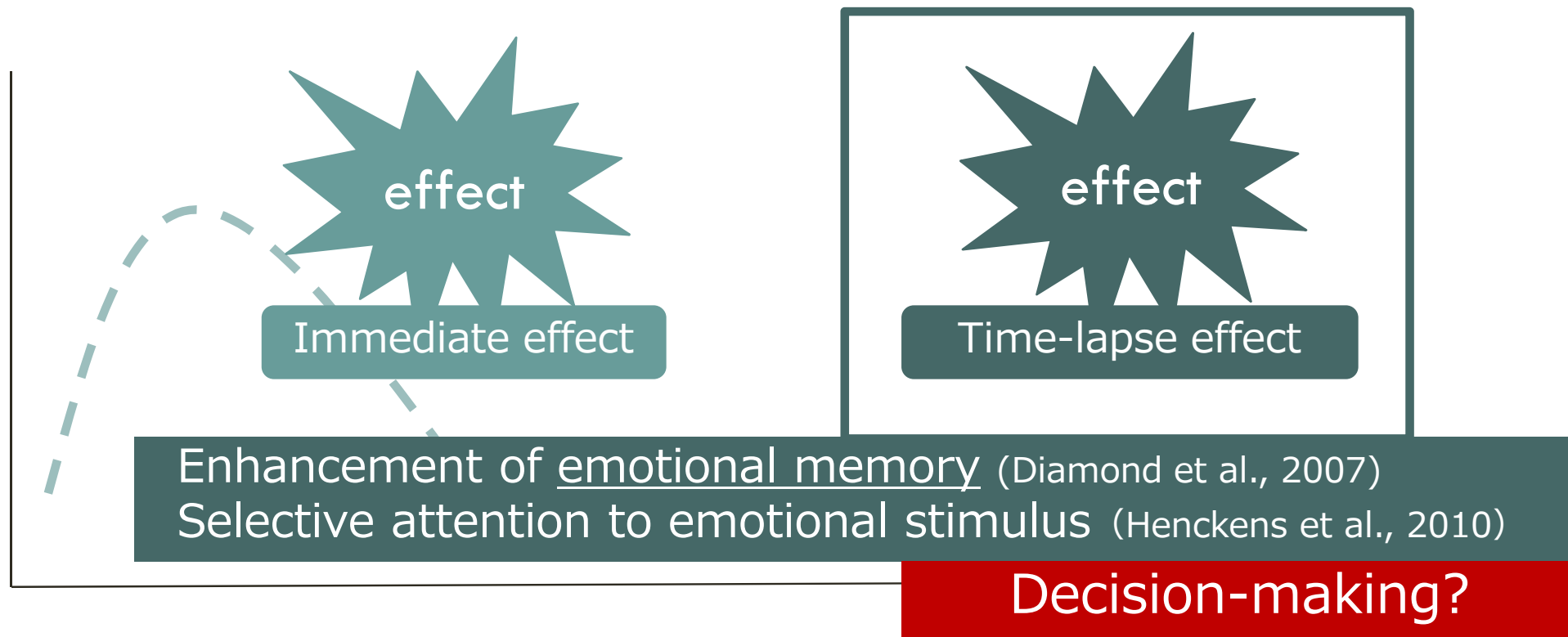
- Different effects on CNS depending on elapsed time



Time-dependent effect of glucocorticoid response

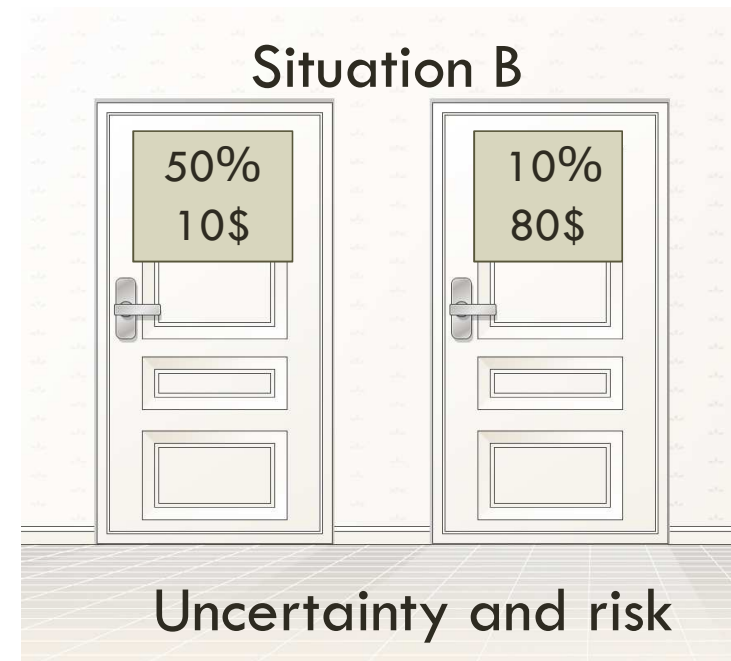
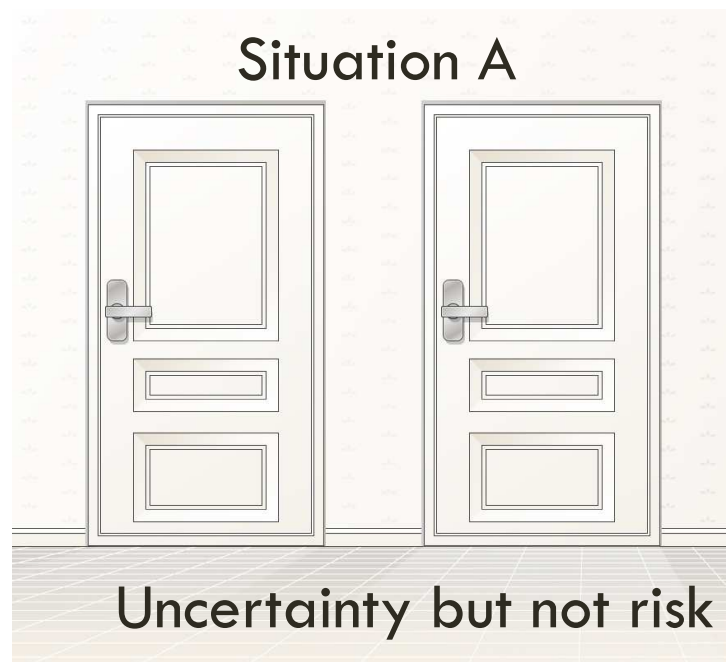
- Diamond et al (2007)

- Different effects on CNS depending on elapsed time



Acute stress and Decision-making under risk

- What is risk? (Knight, 1921)
 - Uncertainty of relationship between selection and result
 - the clear outcome and probability depend on option



Acute stress and Decision-making under risk

- Effect of acute stress on decision-making under risk
 - A lot of research reported immediate effects of acute stress on risk-taking (Lighthall et al., 2009; Starcke et al., 2012)

- Effect on cortex related to decision-making (Starcke & Brand, 2012)
 - Decline of cognitive function
 - Dorsal lateral prefrontal cortex (DLPFC) : Decrease
 - Promotion of motivation
 - Striatum : Increase

Different effects depending on emotional frame

■ Gain frame

- likely to increase rewards of gamble option
- instruction: try and get high reward

■ Loss frame

- likely to decrease rewards of gamble option
- instruction: avoid losing

Gain frame

you have

20 \$

sure
+10\$

or

gamble
+20\$ or +5\$



$20 + 10 = \$30$



$20 + 20 = \$40$



$20 + 5 = \$25$

Loss frame

you have

50 \$

sure
-20\$

or

gamble
-10\$ or -25\$



$50 - 20 = \$30$



$50 - 10 = \$40$



$50 - 25 = \$25$

Gain frame

you have

20 \$

sure
+10\$

or

gamble
+20\$ or +5\$



$20 + 10 = \$30$



$20 + 20 = \$40$



$20 + 5 = \$25$

||

Loss frame

you have

50 \$

sure
-20\$

or

gamble
-10\$ or -25\$



$50 - 20 = \$30$



$50 - 10 = \$40$



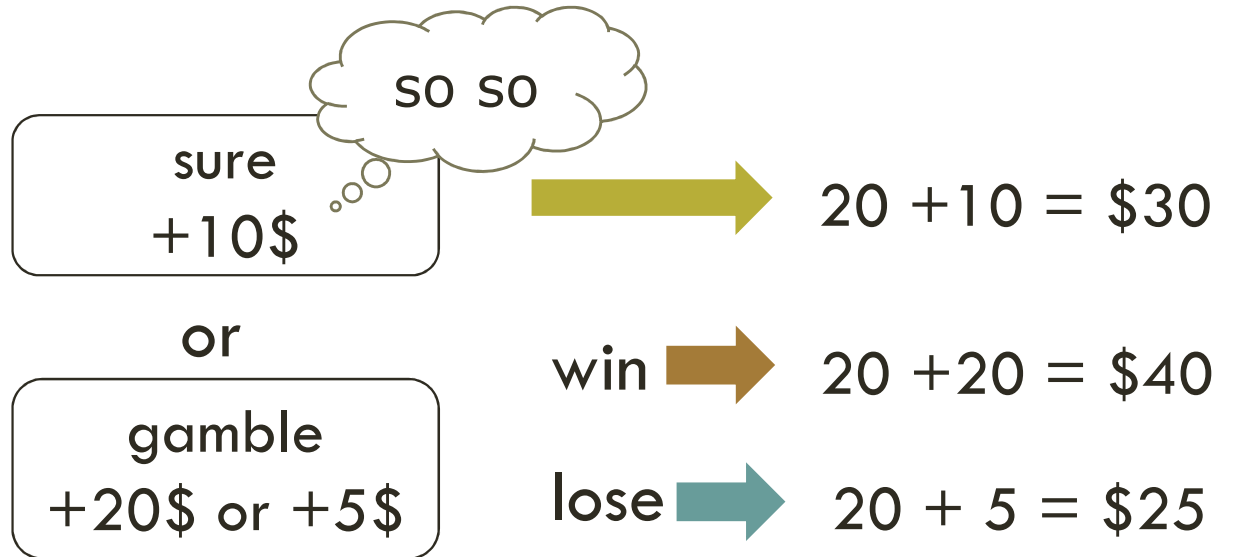
$50 - 25 = \$25$

Stressful situation

Gain frame

you have

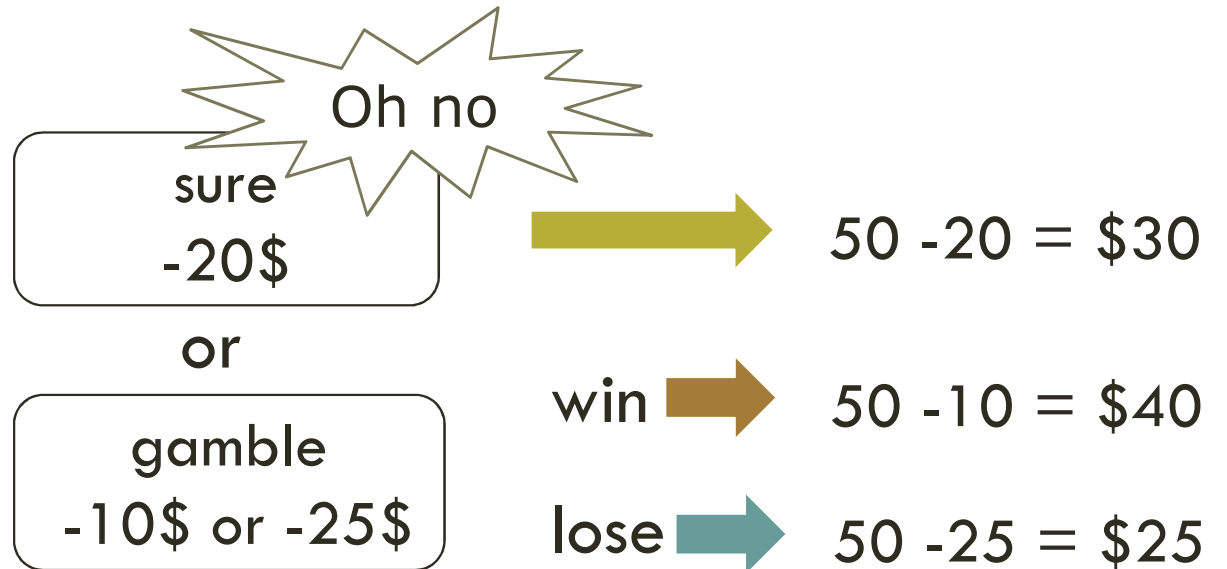
20 \$



Loss frame

you have

50 \$

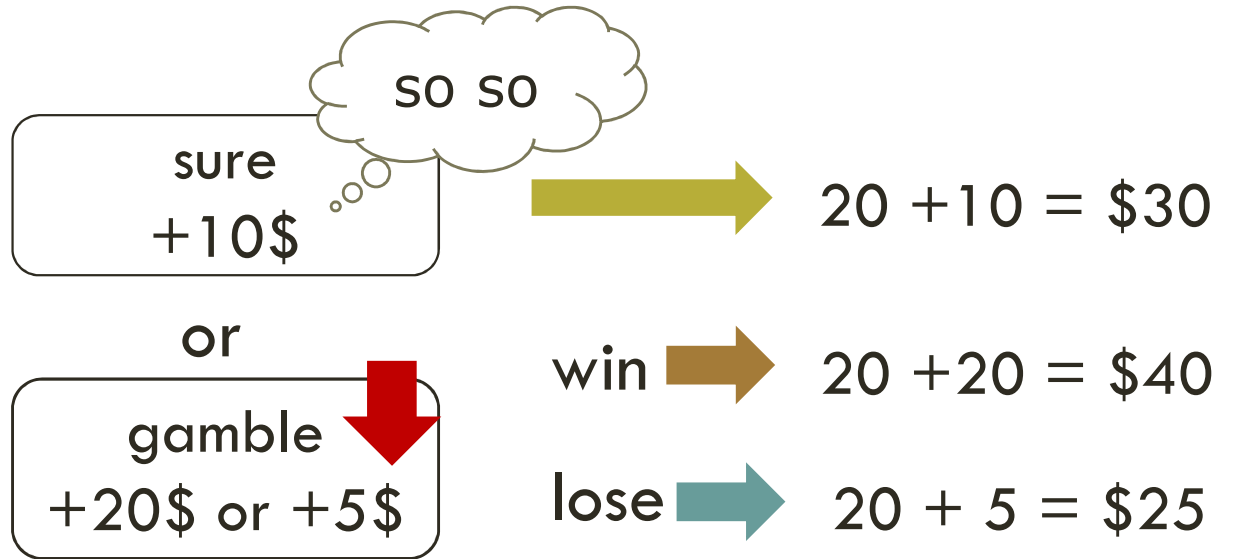


Stressful situation

Gain frame

you have

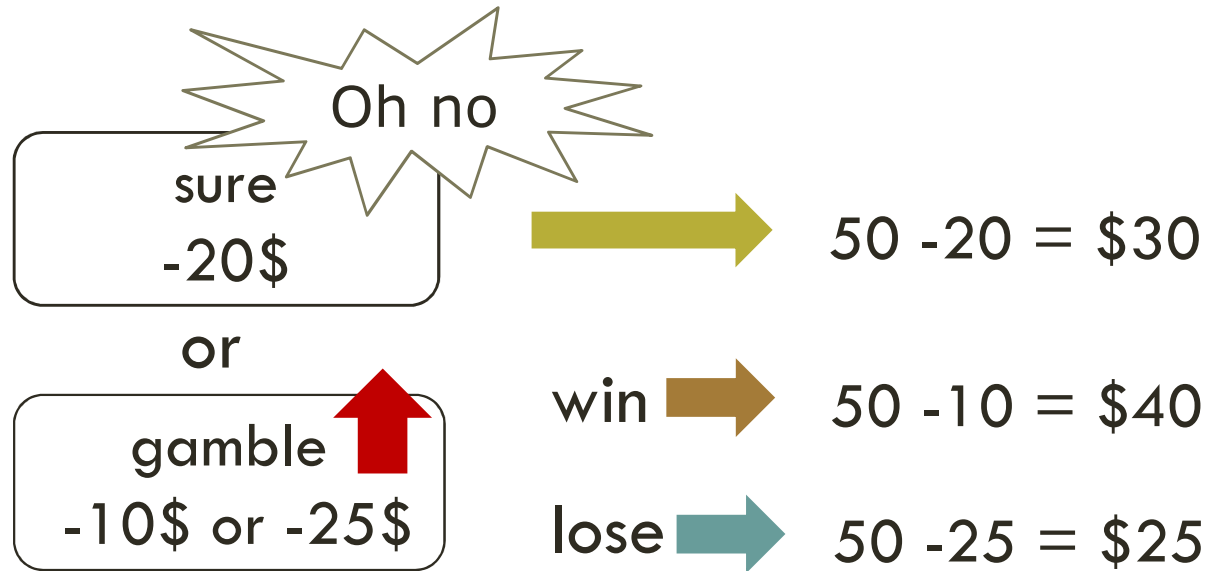
20 \$



Loss frame

you have

50 \$

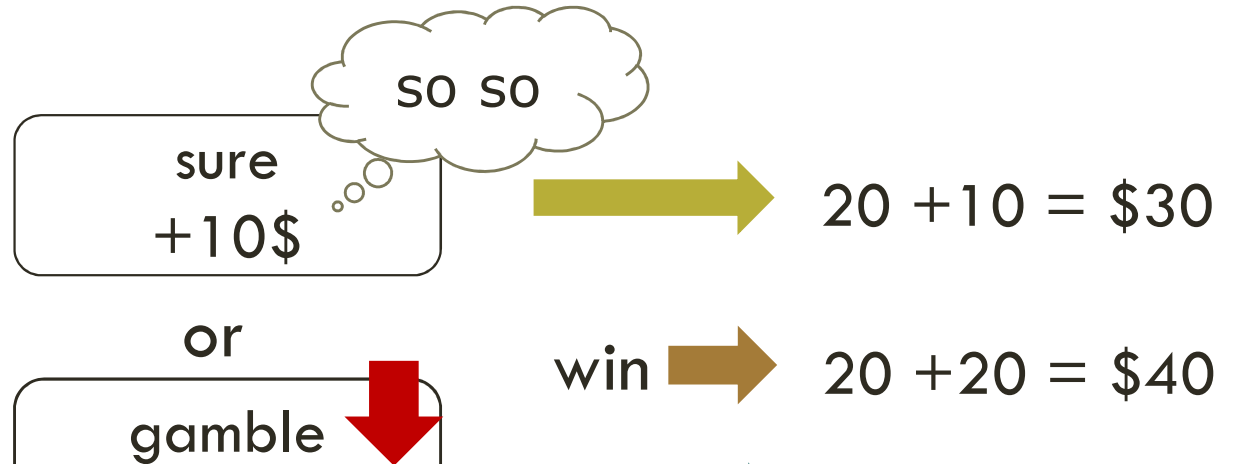


Stressful situation

Gain frame

you have

20 \$

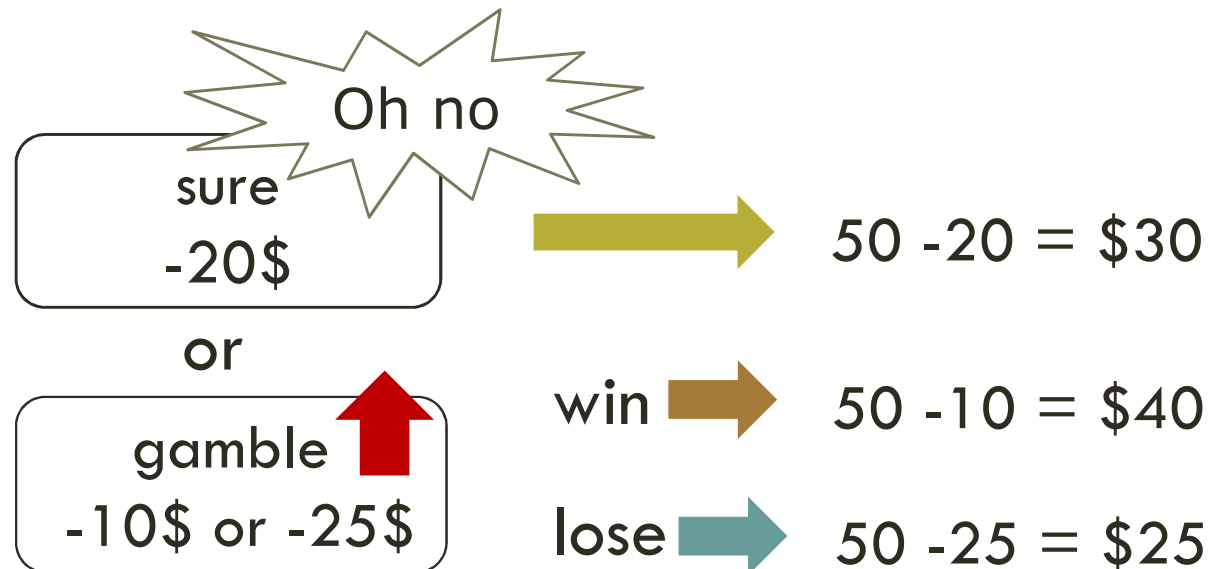


Risk-averse

Loss frame

you have

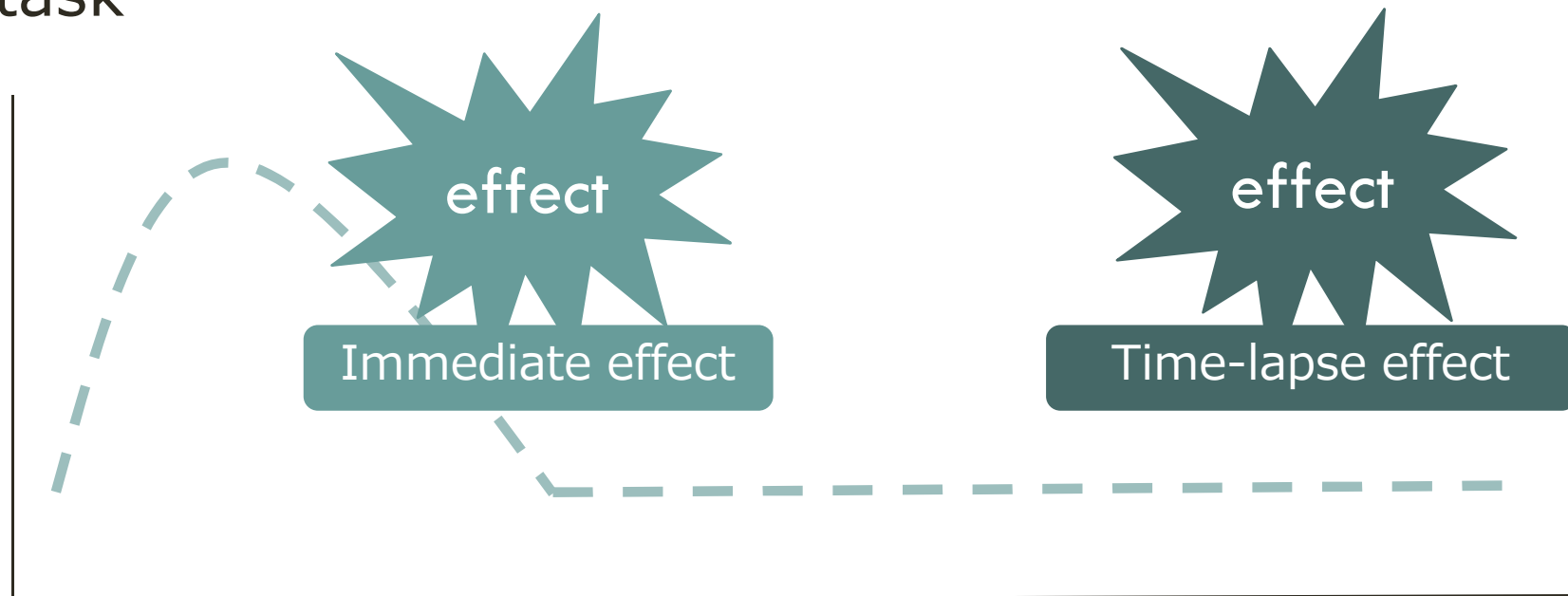
50 \$



Risk-taking

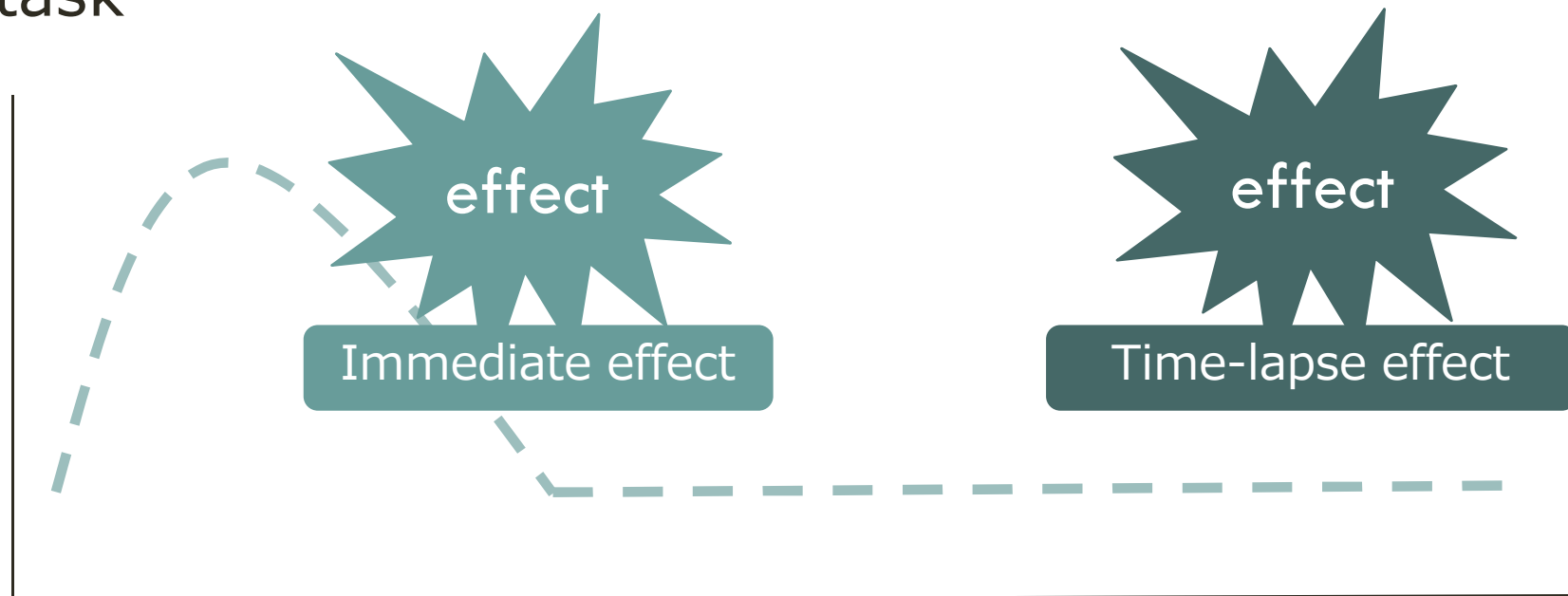
We investigate

- Time-dependent effect on decision-making under the risk depending to emotional frame.
- Especially, we focus on cognitive function and motivation to do task



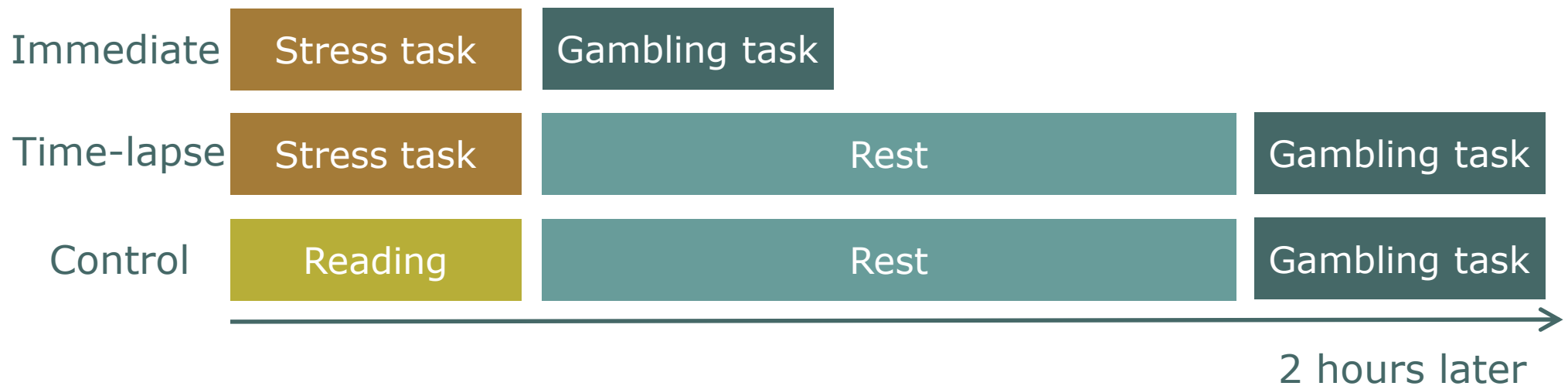
We investigate

- Time-dependent effect on decision-making under the risk depending to emotional frame.
- Especially, we focus on cognitive function and motivation to do task



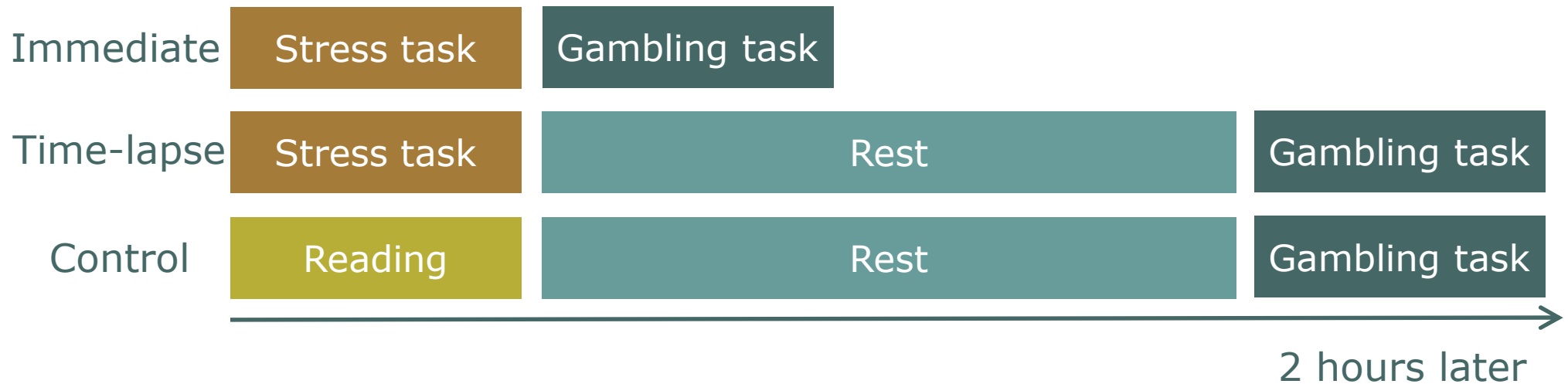
Method

- Participants performed gambling task after exposure to stress
 - Stress task composed interview and arithmetic task
 - Participants on Control group read book instead of stress task



Method

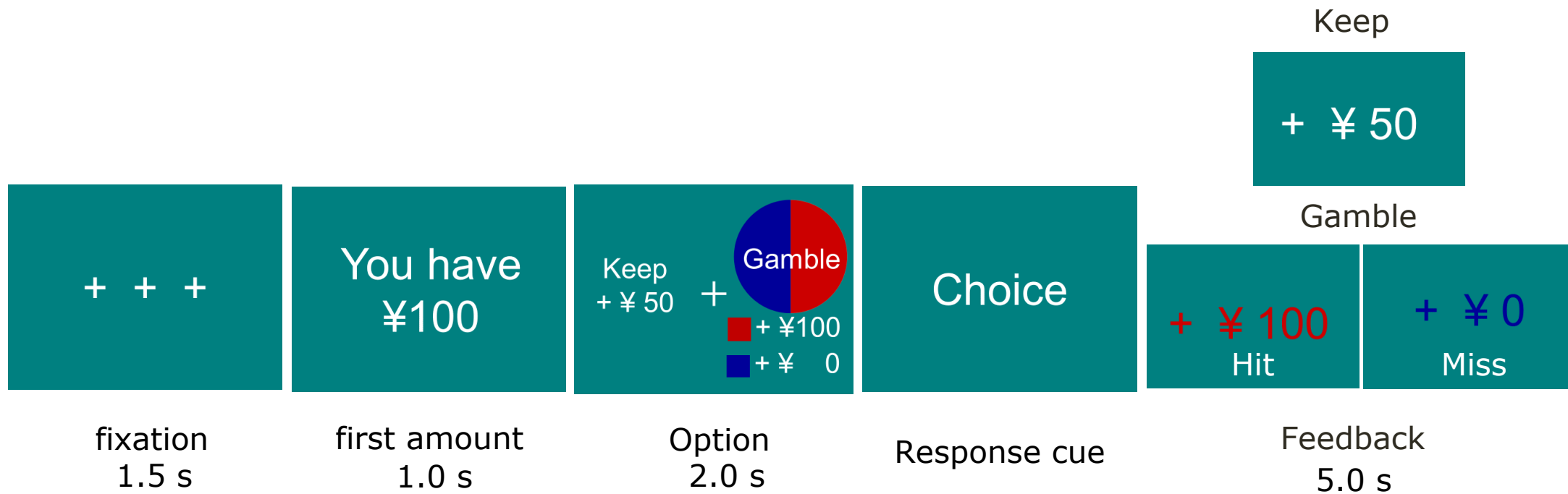
- Participants performed gambling task after exposure to stress
 - Stress task composed interview and arithmetic task
 - Participants on Control group read book instead of stress task



Gambling task

■ Timeline of gambling task

- Participant selected “keep” or “gamble”
- After choice, outcome depending on choice is presented.



Gambling task

■ Condition

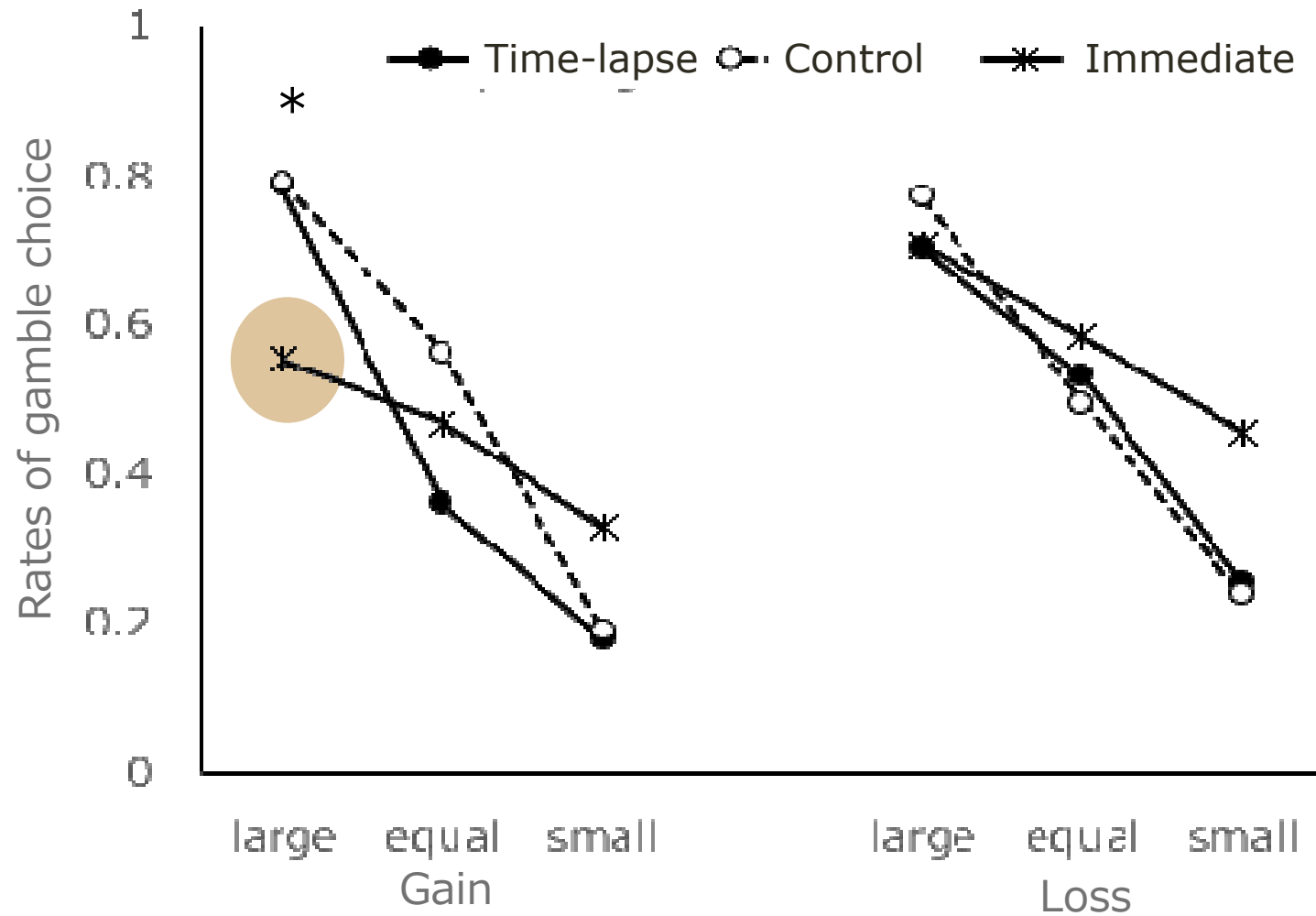
- Option domain for investigation of emotional framing effect
 - Gain frame: "Try to increase reward in this task"
 - Loss frame: "Try NOT to decrease reward in this task"
- Level of expected value (EV) for assessing the adaptability of decision-making
 - Large EV: gamble $>$ sure "Gambling is advantageous."
 - Equal EV: gamble = sure "They are the same EV."
 - Small EV: gamble $<$ sure "Gambling is disadvantageous."

Gambling task

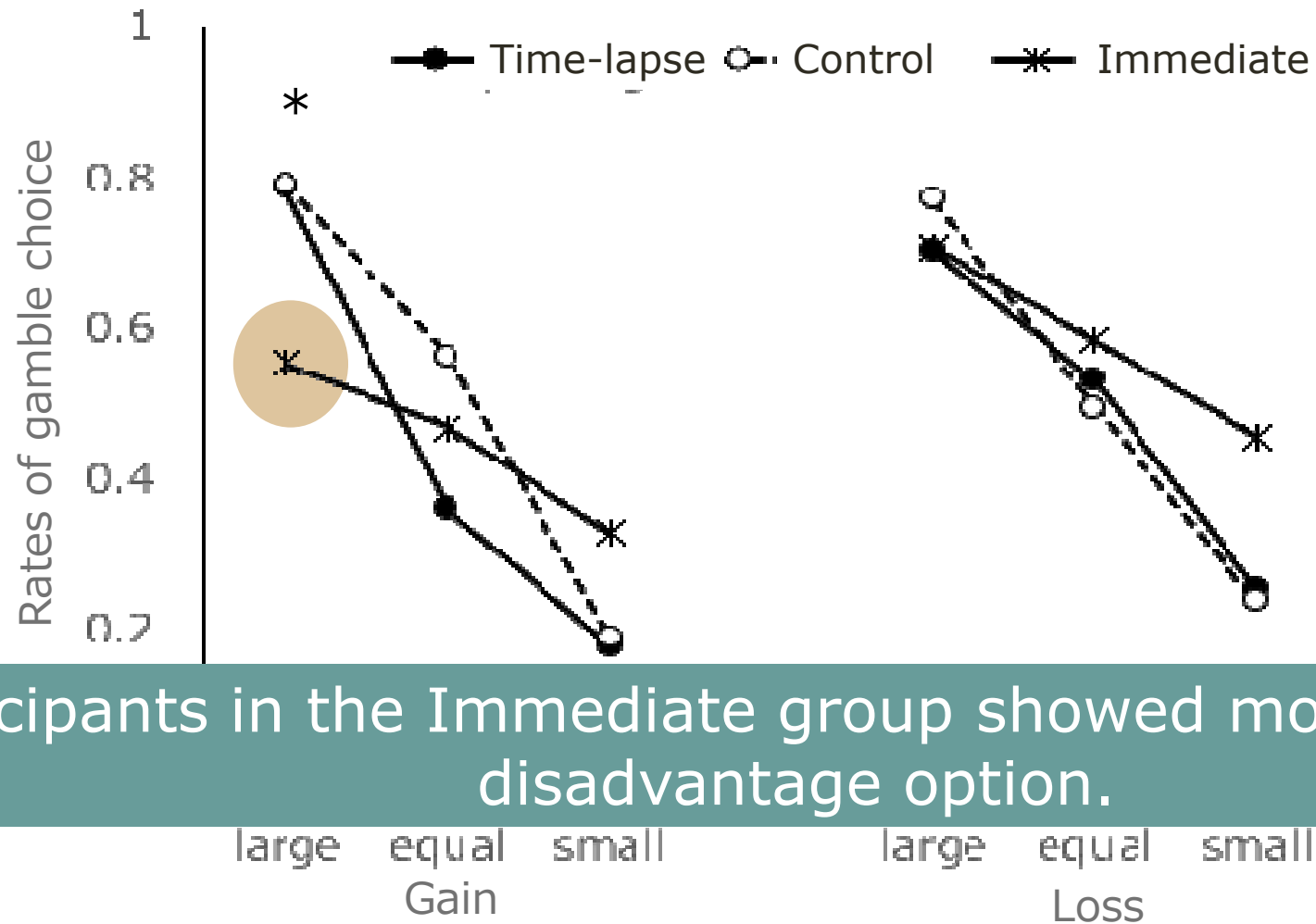
■ Condition

- Option domain for investigation of emotional framing effect
 - Gain frame: "Try to increase reward in this task"
 - Loss frame: "Try NOT to decrease reward in this task"
- Level of expected value (EV) for assessing the adaptability of decision-making
 - Large EV: gamble $>$ sure "Gambling is advantageous."
 - Equal EV: gamble = sure "They are the same EV."
 - Small EV: gamble $<$ sure "Gambling is disadvantageous."

Risk: Immediate vs. Control

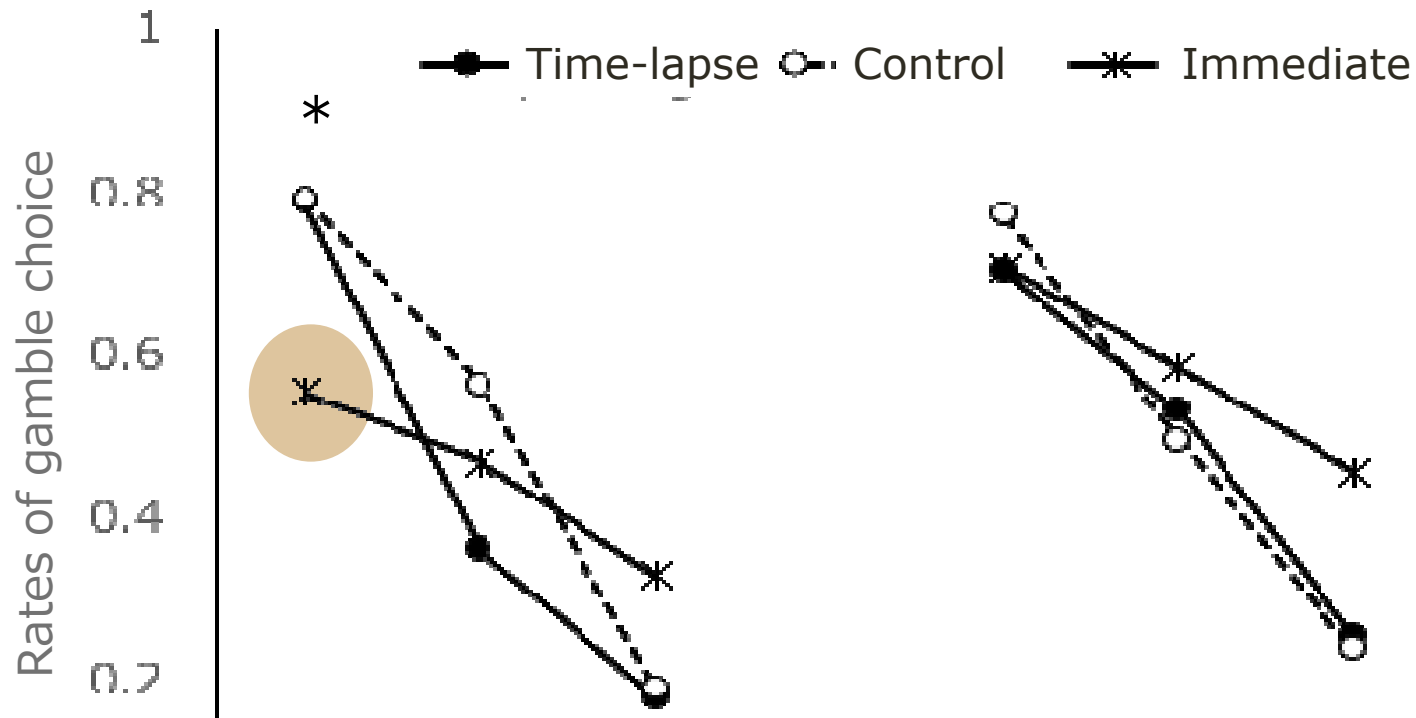


Risk: Immediate vs. Control



Participants in the Immediate group showed more increase of disadvantage option.

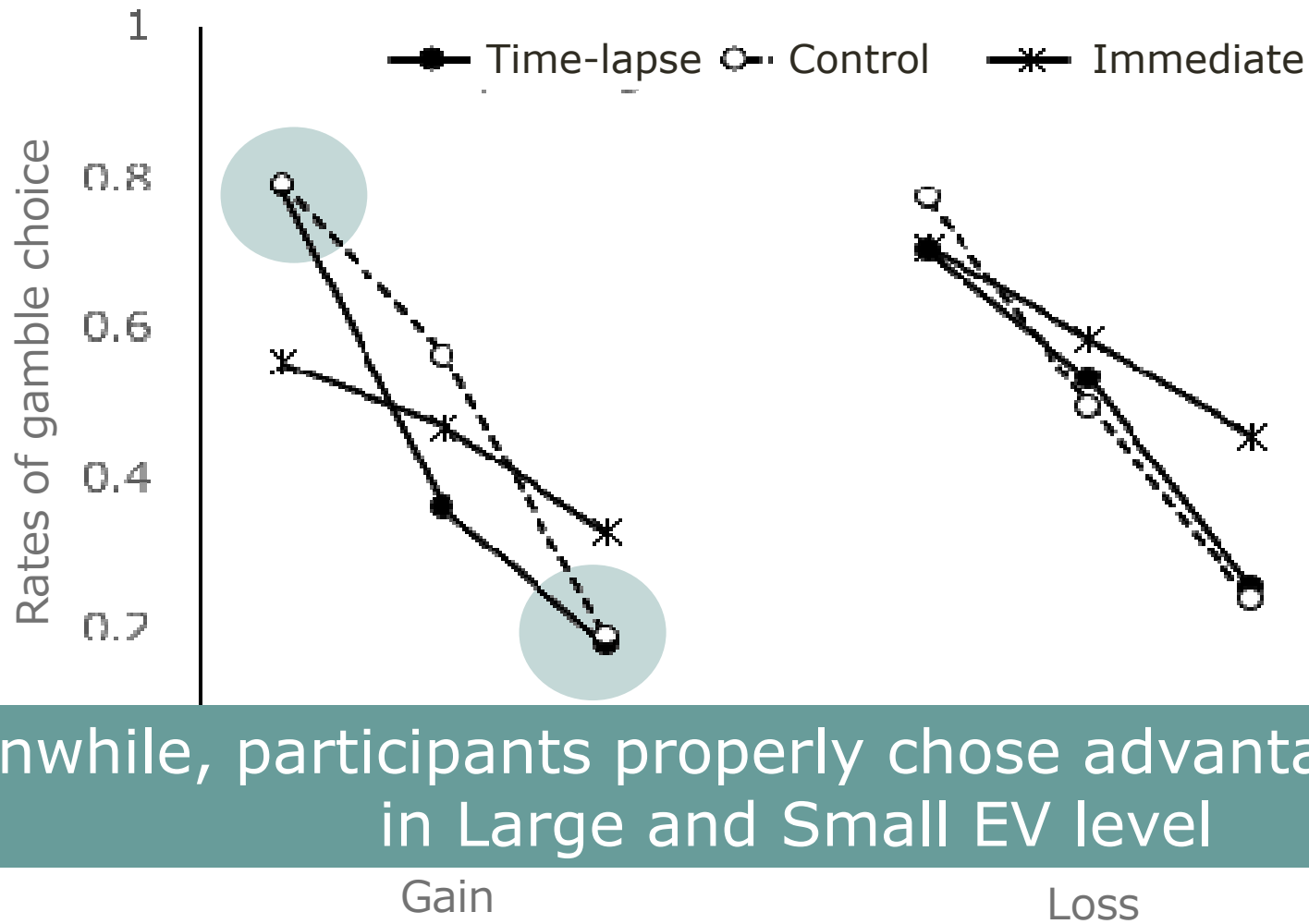
Risk: Immediate vs. Control



Participants in the Immediate group showed more increase of disadvantage option.

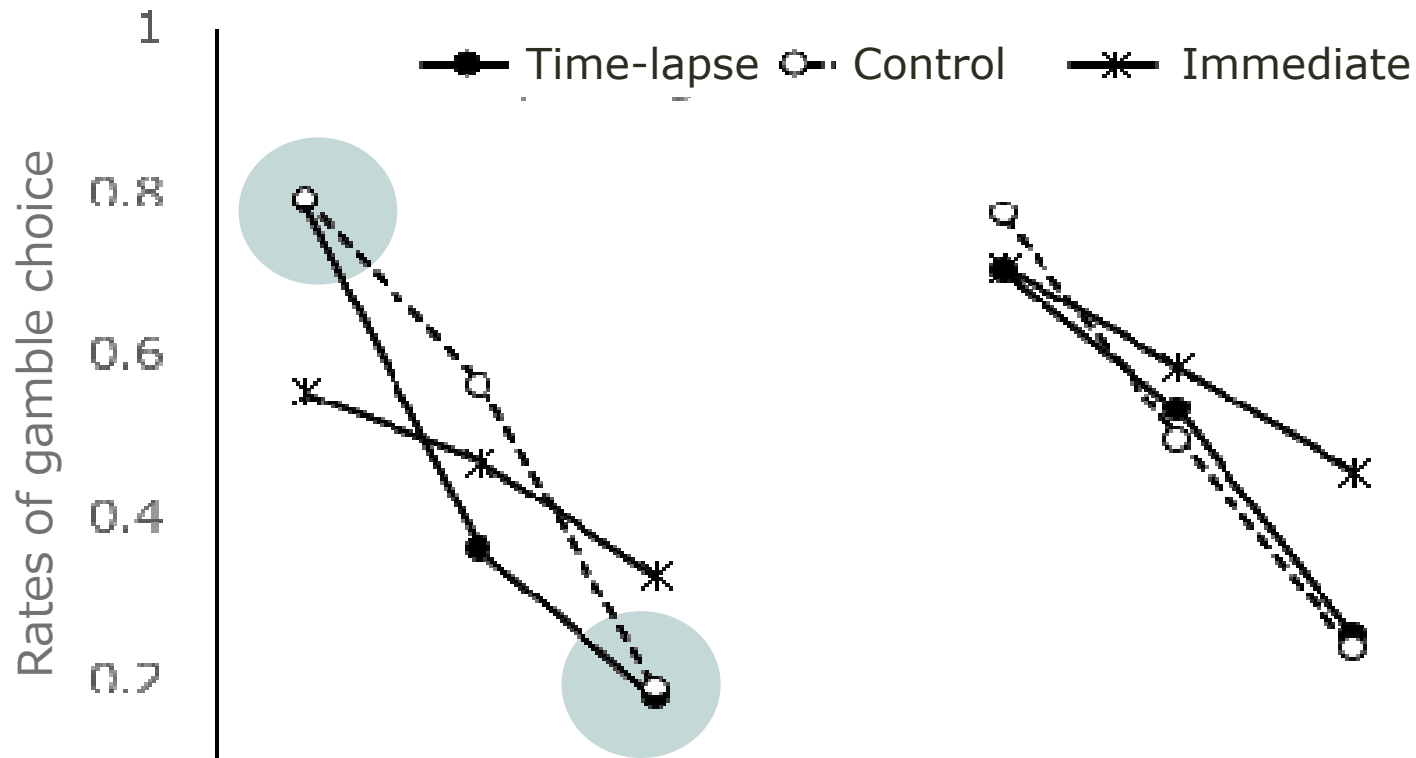
Immediate group = bad choice

Results: Time-lapse vs. Control



Meanwhile, participants properly chose advantageous option in Large and Small EV level

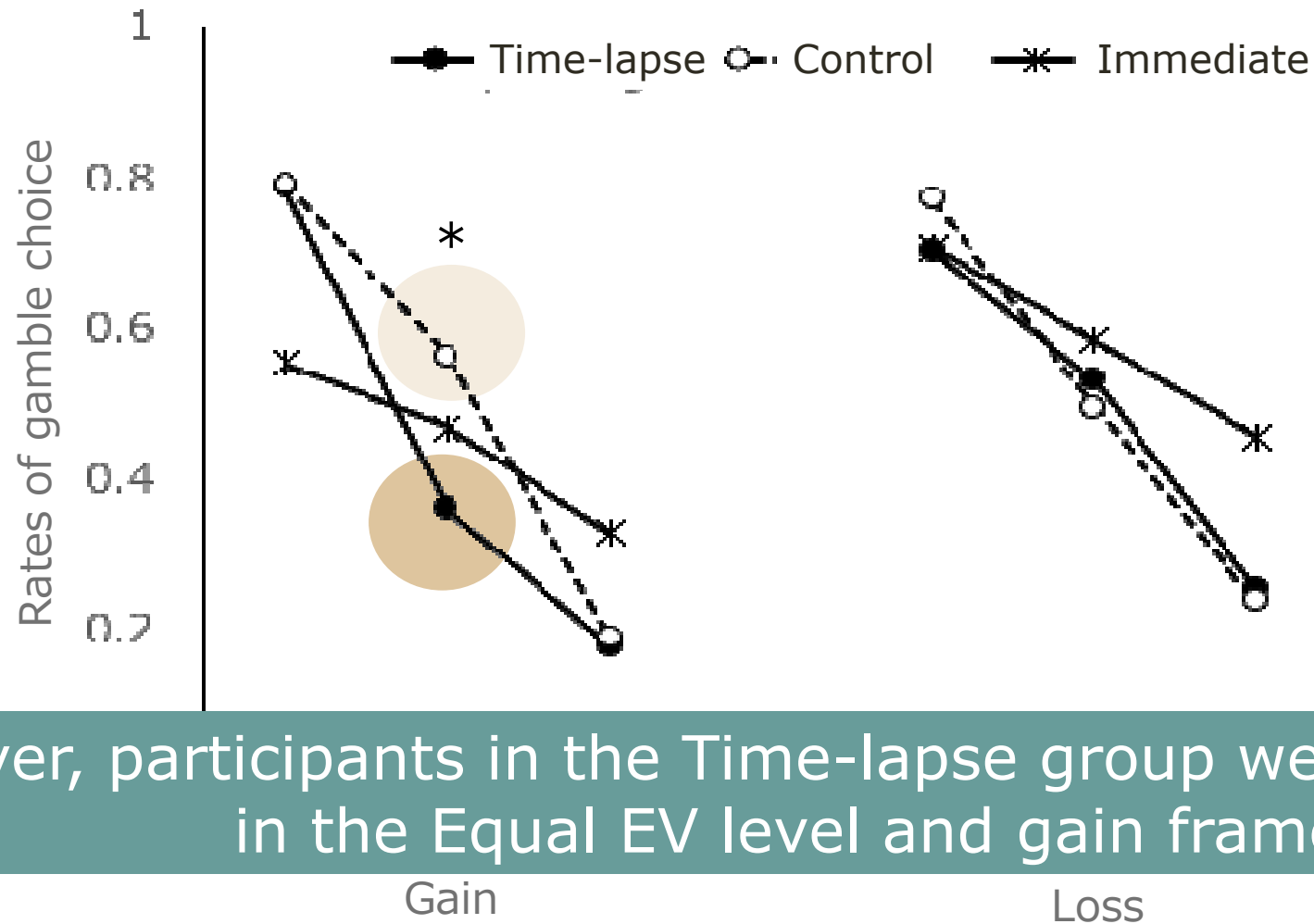
Results: Time-lapse vs. Control



Meanwhile, participants properly chose advantageous option in Large and Small EV level

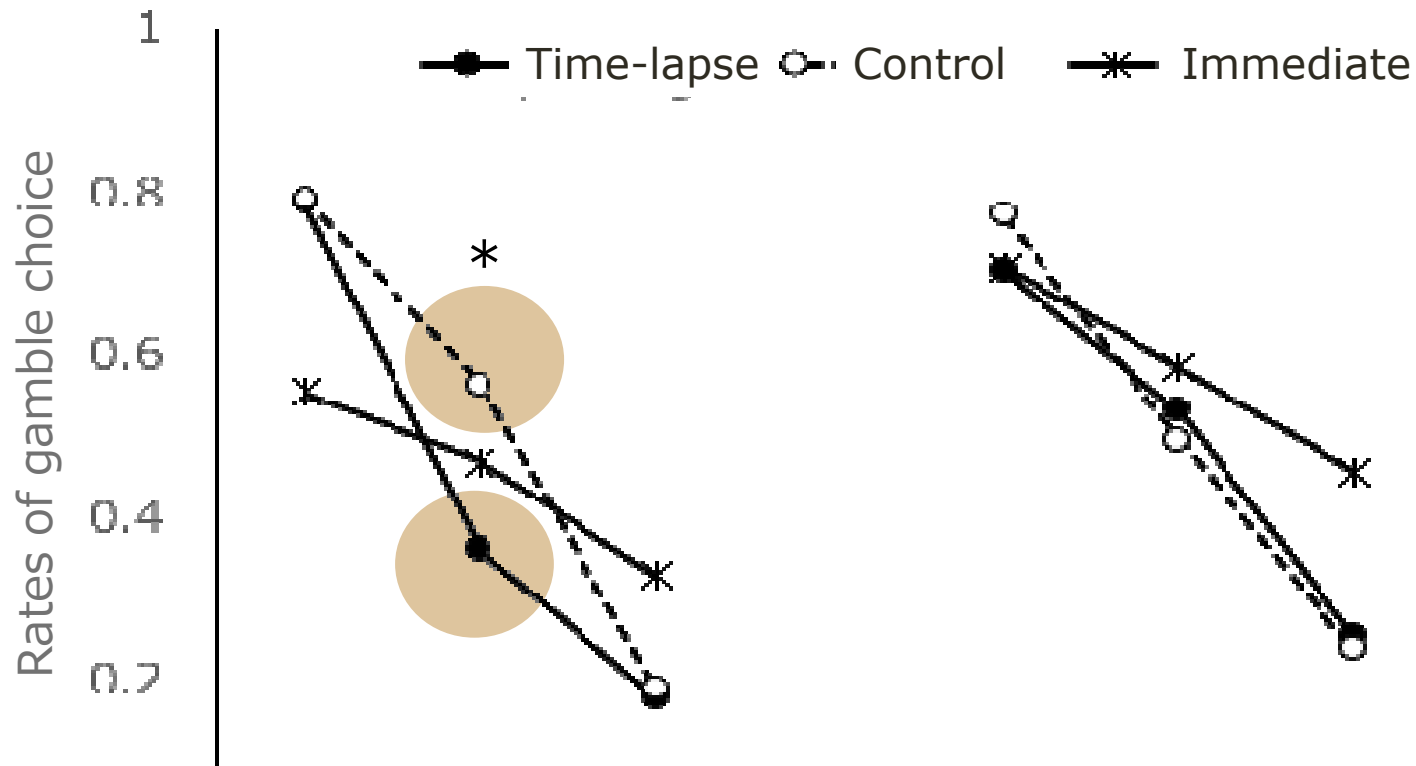
Time-lapse group = beneficial choice

Results: Time-lapse vs. Control



However, participants in the Time-lapse group were risk-averse in the Equal EV level and gain frame.

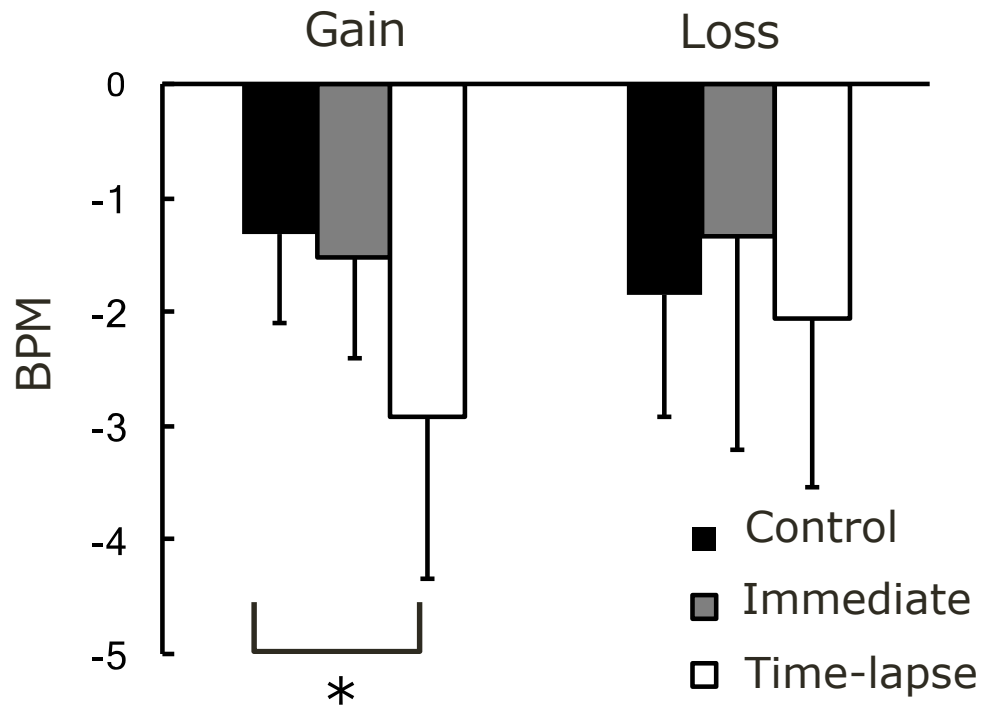
Results: Time-lapse vs. Control



However, participants in the Time-lapse group were risk-averse in the Equal EV level and gain frame.

Time-lapse group = risk-averse

Results: Oriental response by HR



- Oriental response by HR
- Oriental response is the index for the level of motivation to task
- Control \ll Time-lapse ($p < .05$)
- in only gain frame

Participants in the Time-lapse group were higher motivation to task

We found the time-lapse effect on the risk

- Why did the time-lapse effect elicit the risk-aversion in only the gain frame?
 - the Immediate effect
 - increase of the disadvantage choice = **decline in cognitive function**
 - the Time-lapse effect
 - increase of the choice of advantage option
 - higher motivation to gain frame task
 - = **recovery in cognitive function and focusing on positive issue**

Time-dependent effect of acute stress



decline of cognitive function
for making energy



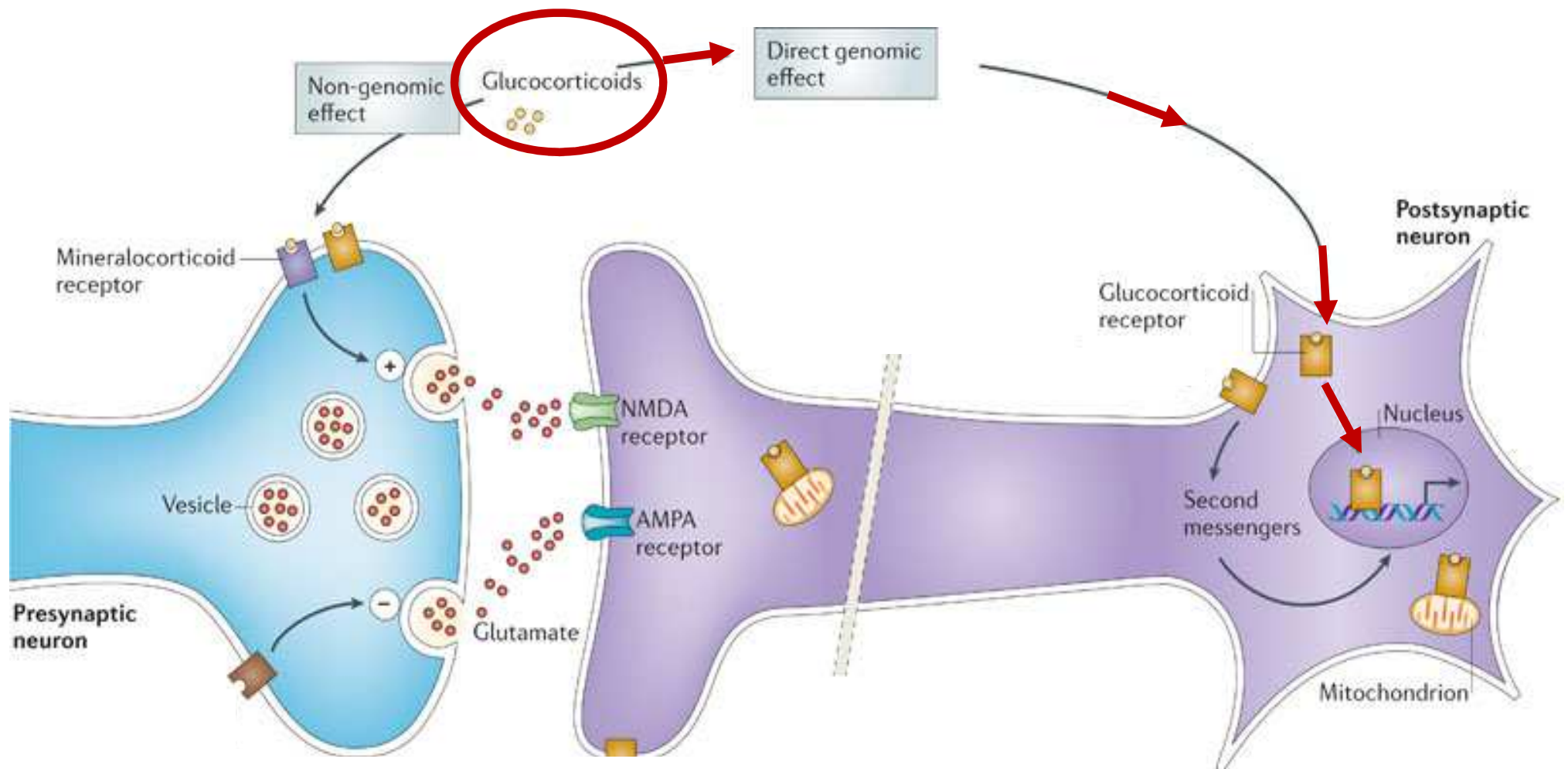
Clear thinking and focusing
to only positive issue



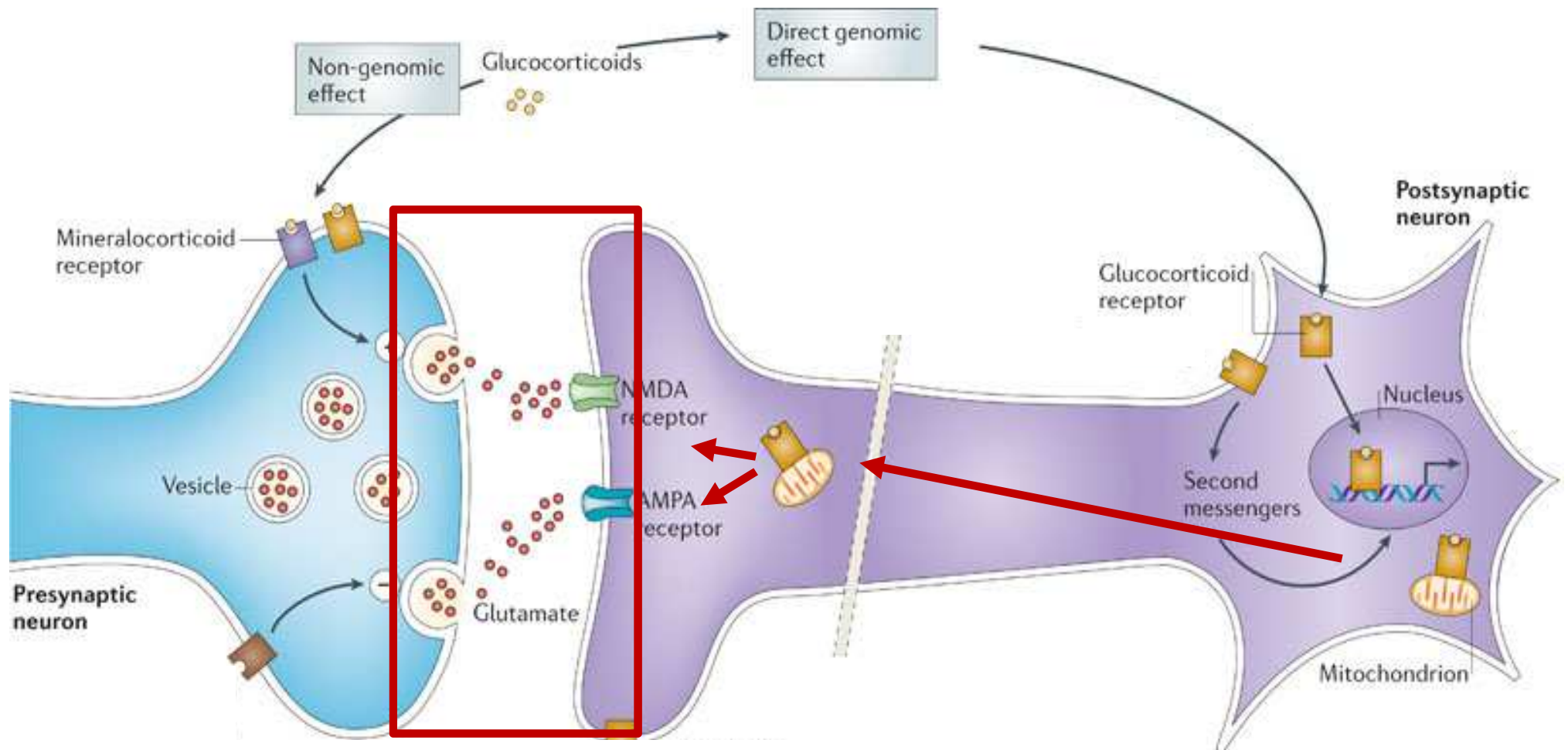
Thank you for your attention

Biological mechanisms of time-dependent effect

- time-dependent effect of glucocorticoid (Diamond et al., 2007)
- Immediate effect
 - via the blood brain barrier (de Kloet, 2005)
- Time-lapse effect
 - resulting in modulation of neurotransmission (Joels, 2007)
 - glucocorticoid can be mediated via receptors and continue to influence neural plasticity for several hours

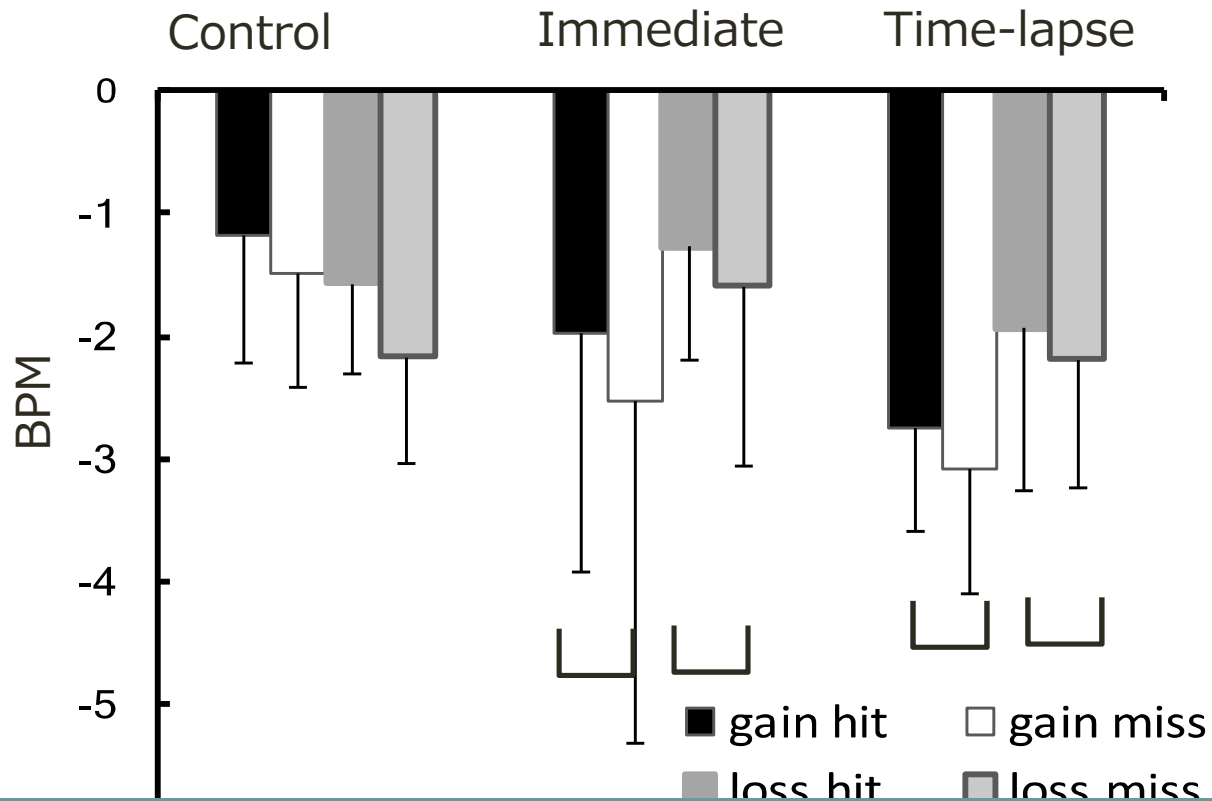


Popoli et al. (2012) Nat. Rev.



伝達効率が調整
 脳部位によって促進・もしくは抑制される

Results: Oriental response by HR



■ Oriental response by HR for investigation of motivation

■ Oriental response is the index for the level of motivation to task

□ Control << Time-lapse ($p < .05$)
□ in only gain domain

Participants in the time-lapse group were higher motivation to task