Life Improvement Science

Dr. Falk Lieder
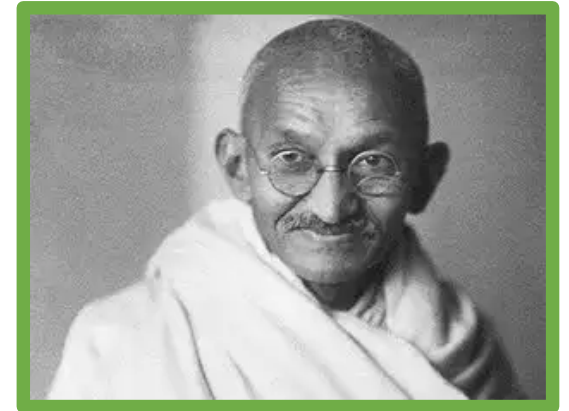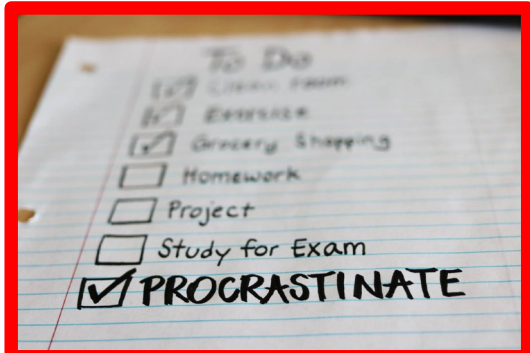
Max Planck Research Group Leader

Rationality Enhancement Group

Max Planck Institute for Intelligent Systems, Tübingen
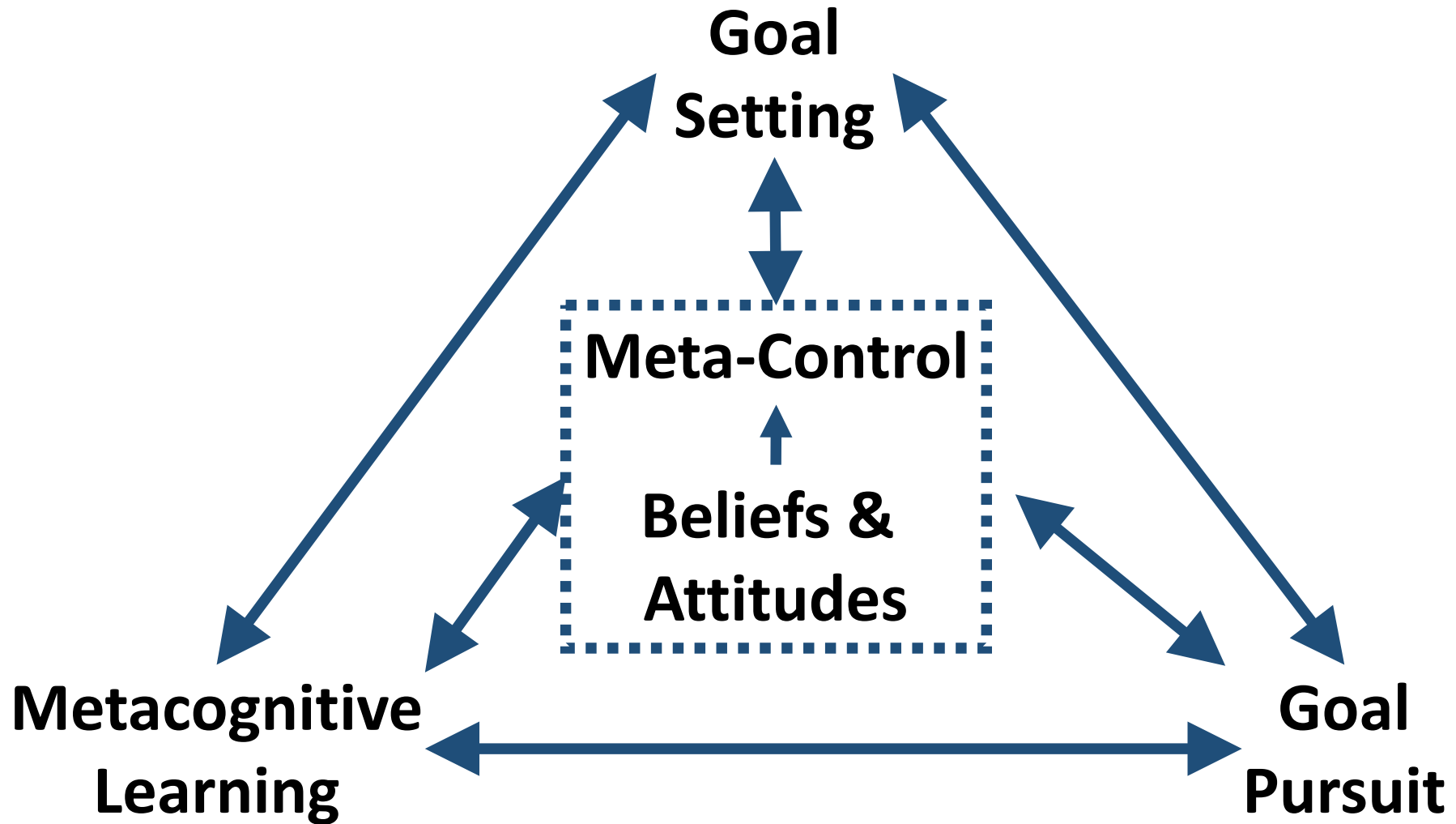
MAX-PLANCK-GESELLSCHAFT

Unrealized Human Potential

Life Improvement
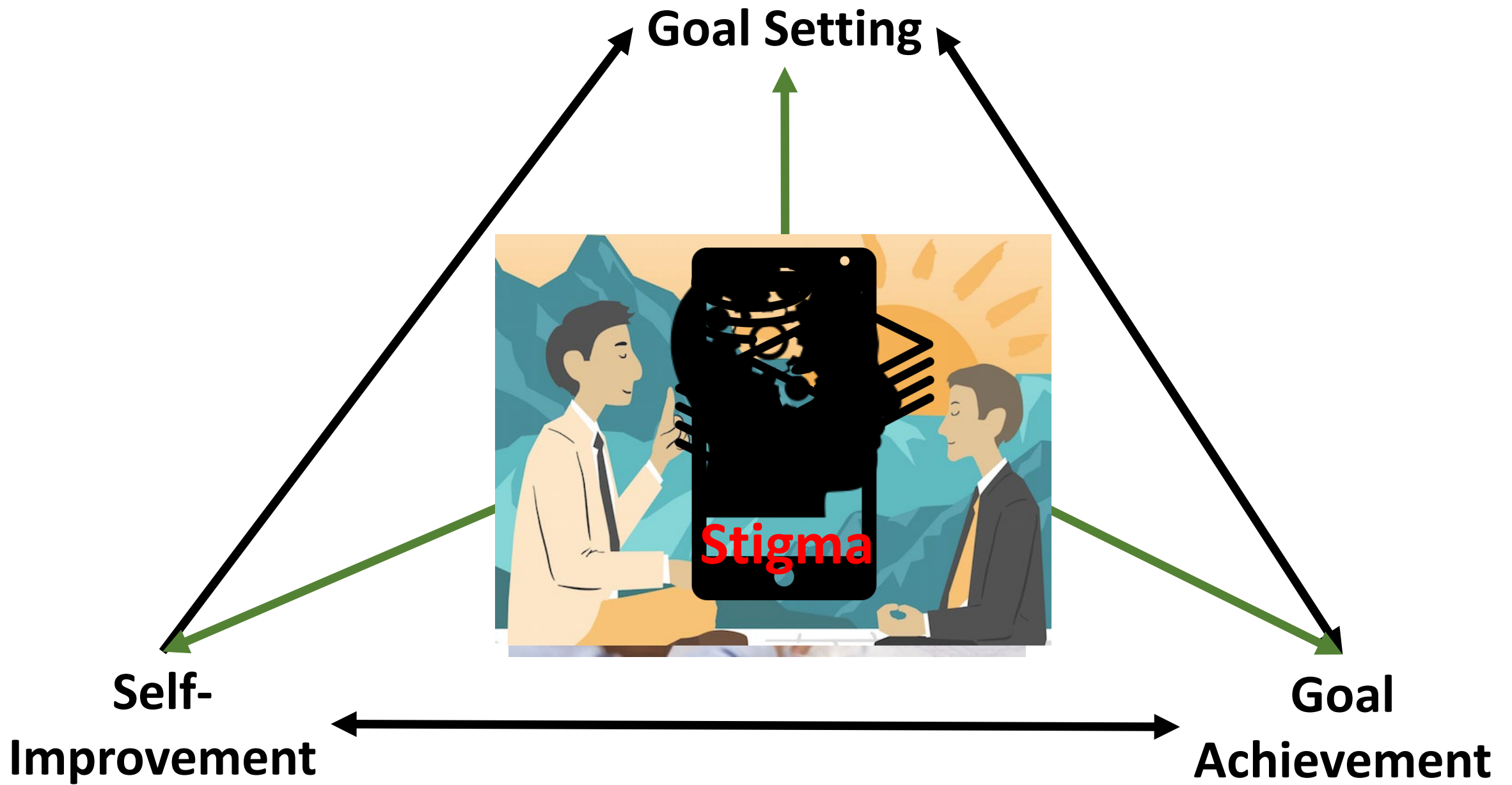
Cognitive Foundation

Technological Foundation

Socio-Cultural Foundation
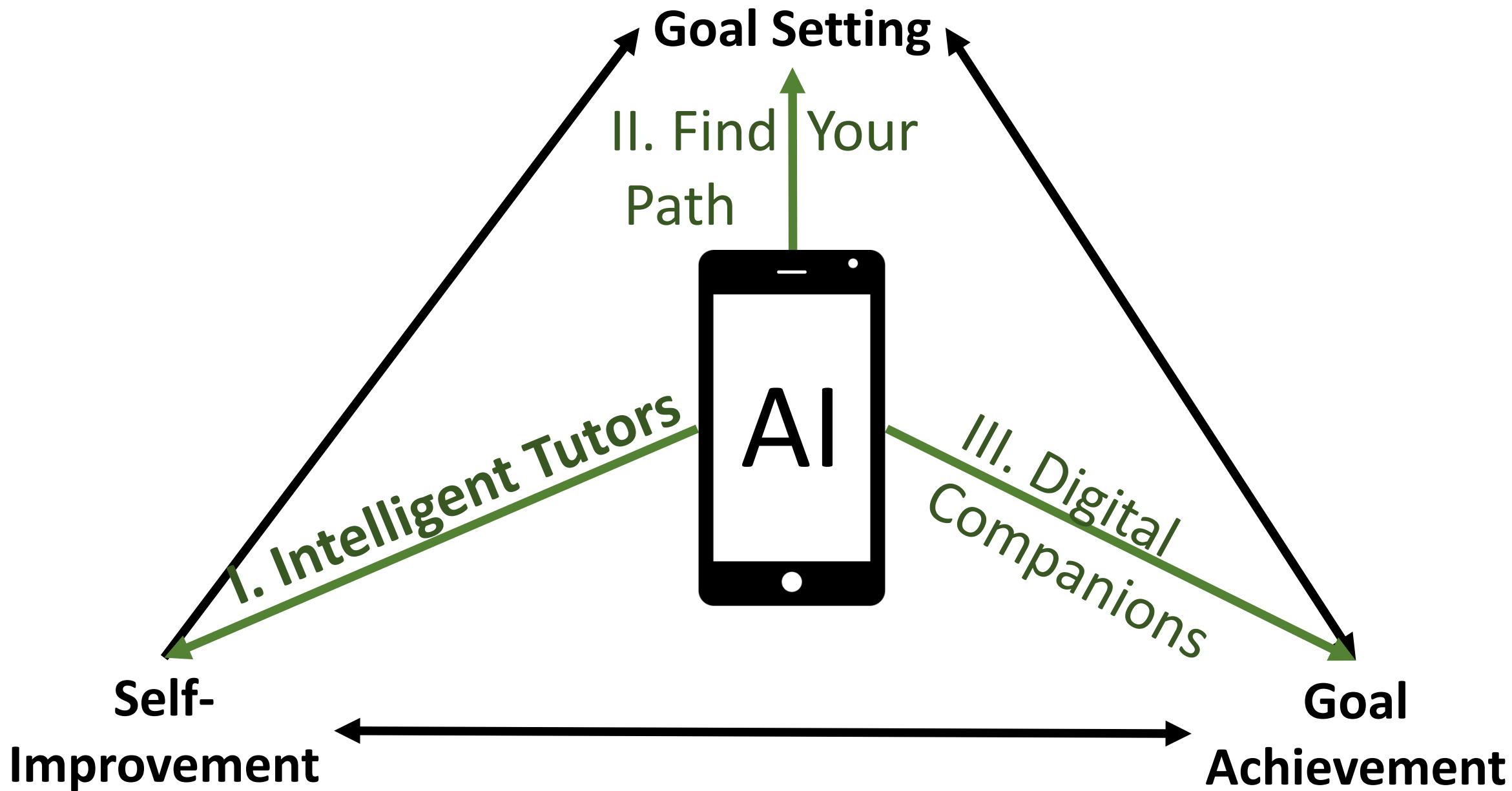
People learn how to think and how to decide

metacognitive learning
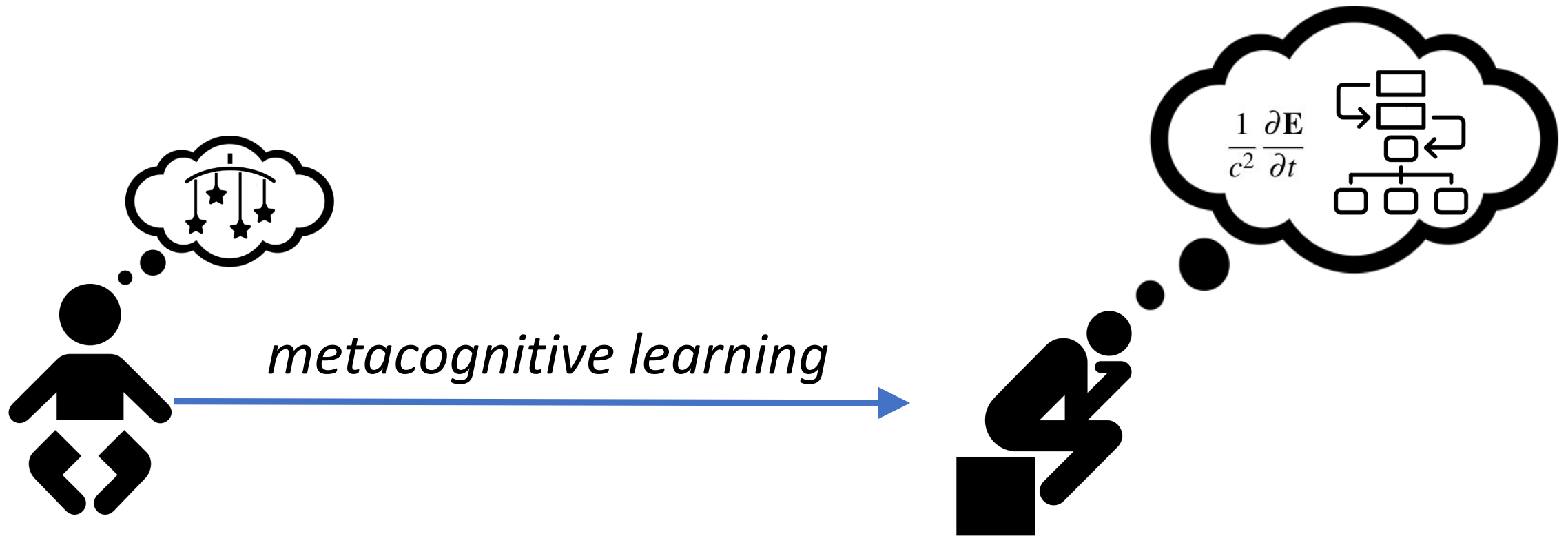
What are the brain's algorithms for metacognitive learning?
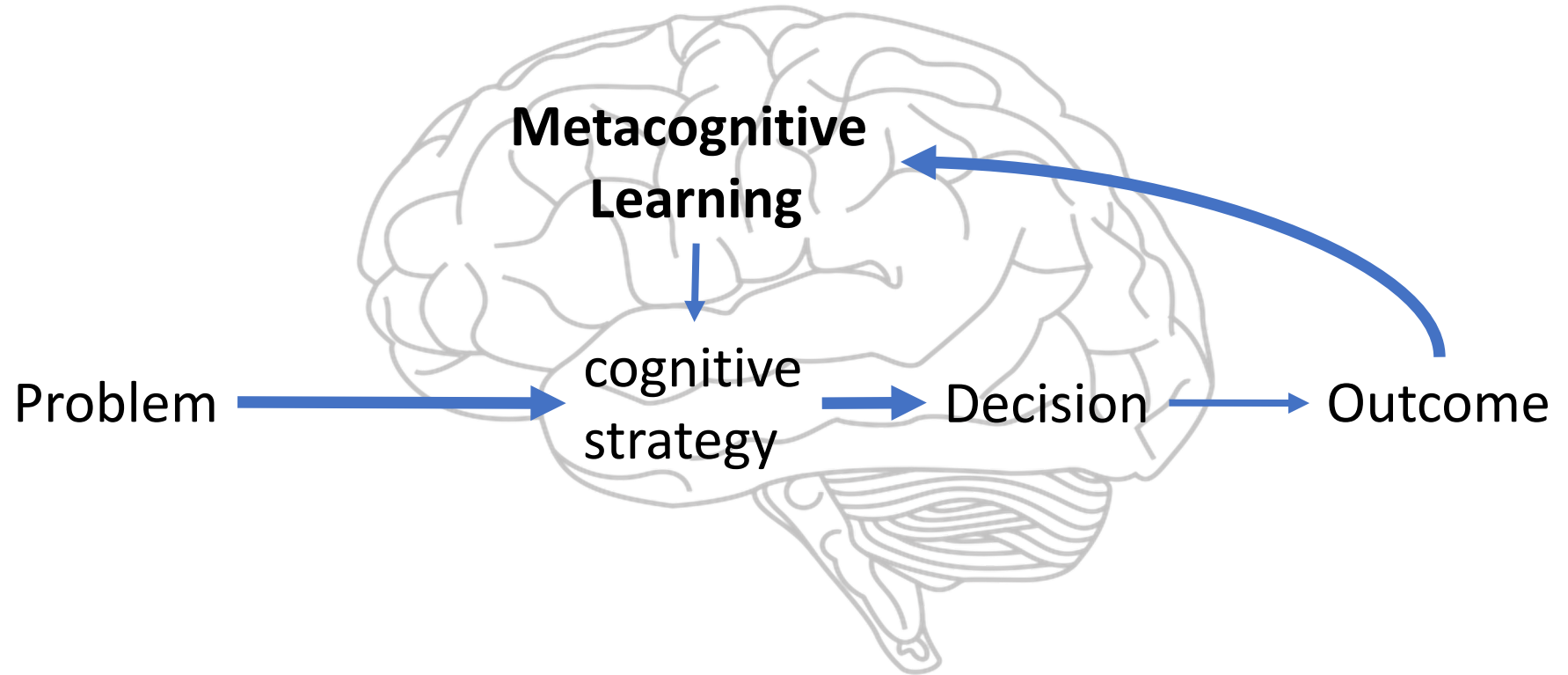
How do people learn how to plan?
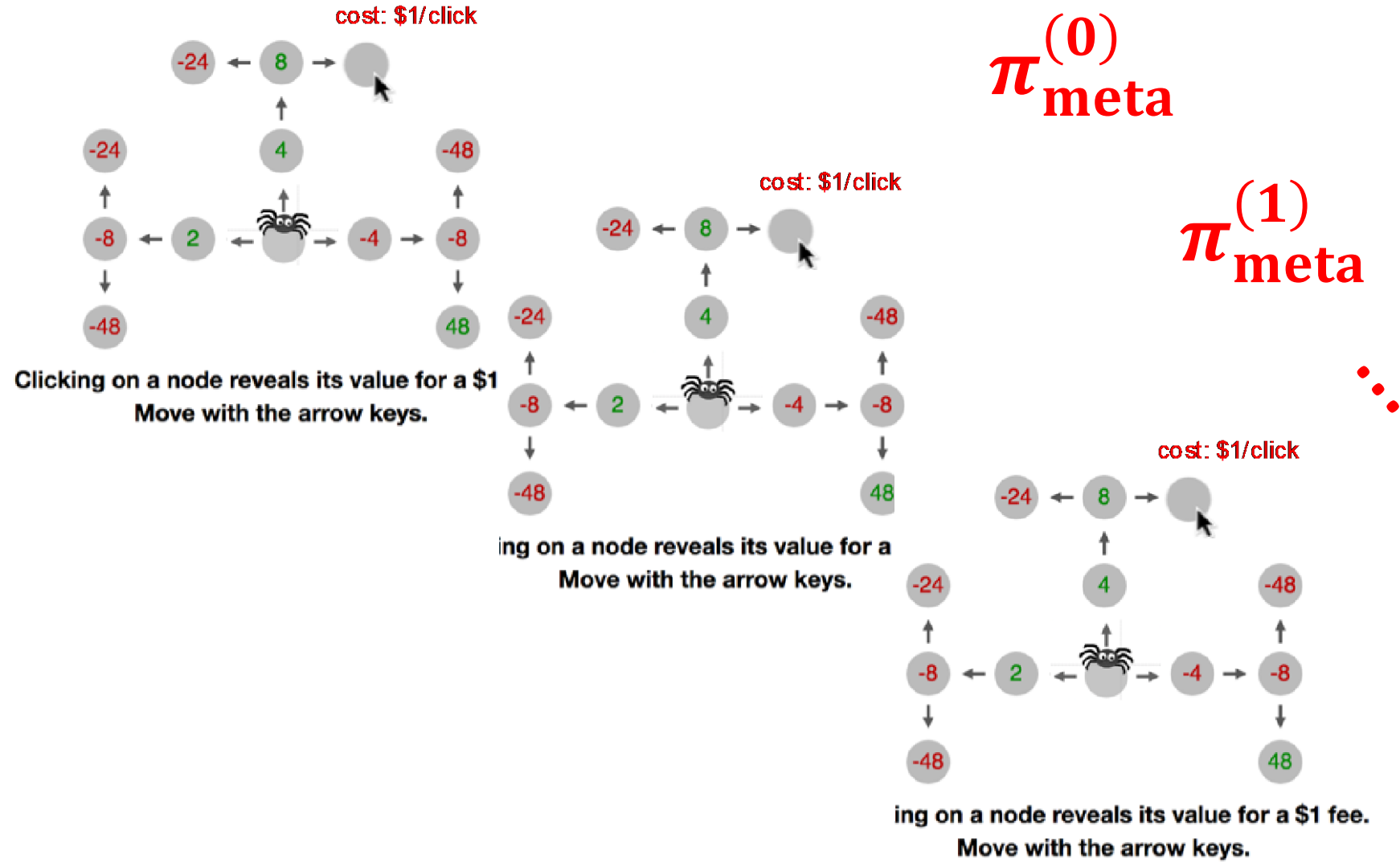
Process Tracing: Making Planning Observable
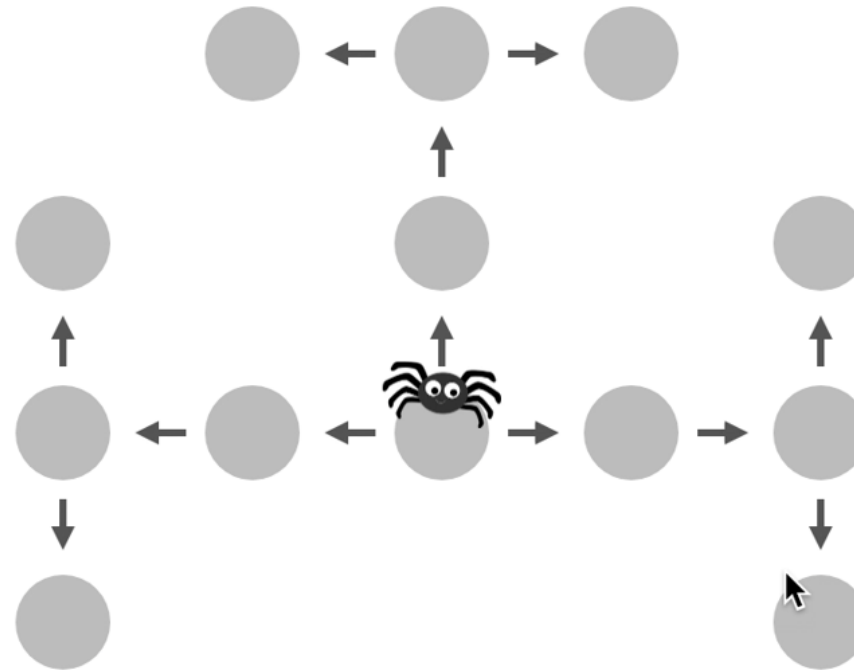
planning cost:
$1/click

Clicking on a node reveals its value for a $1 fee.
Move with the arrow keys.

(Callaway[1], Lieder[1], Krueger[1], & Griffiths, 2018)

An environment where long-term outcomes are most important
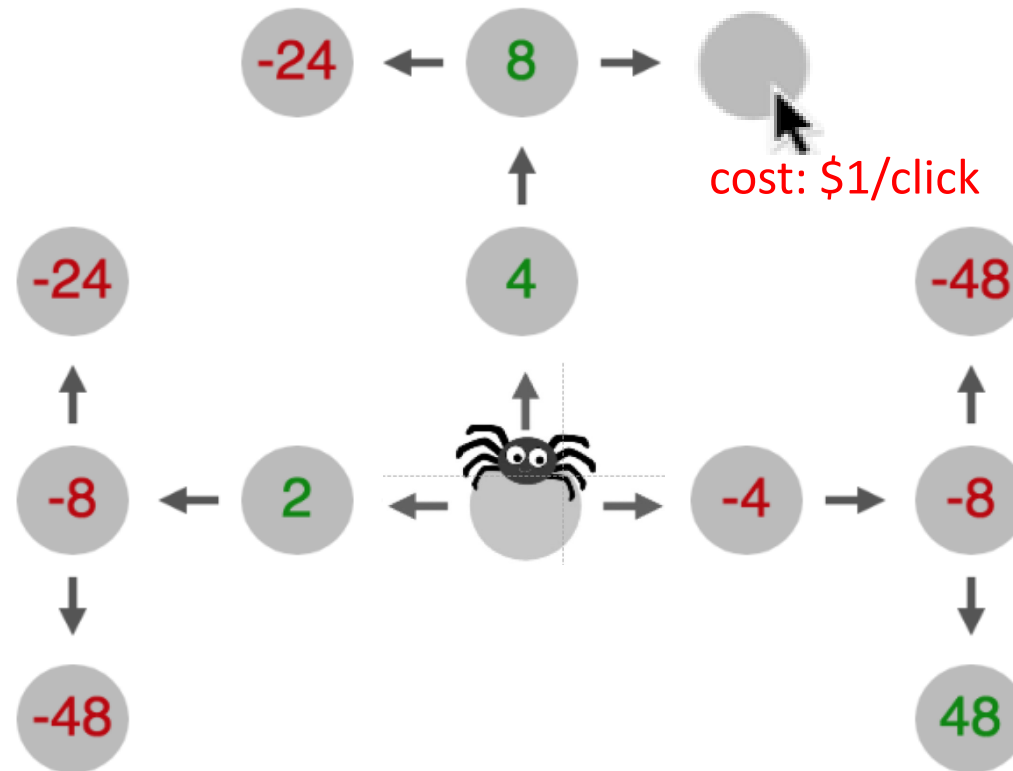
Clicking on a node reveals its value for a $1 fee.
Move with the arrow keys.
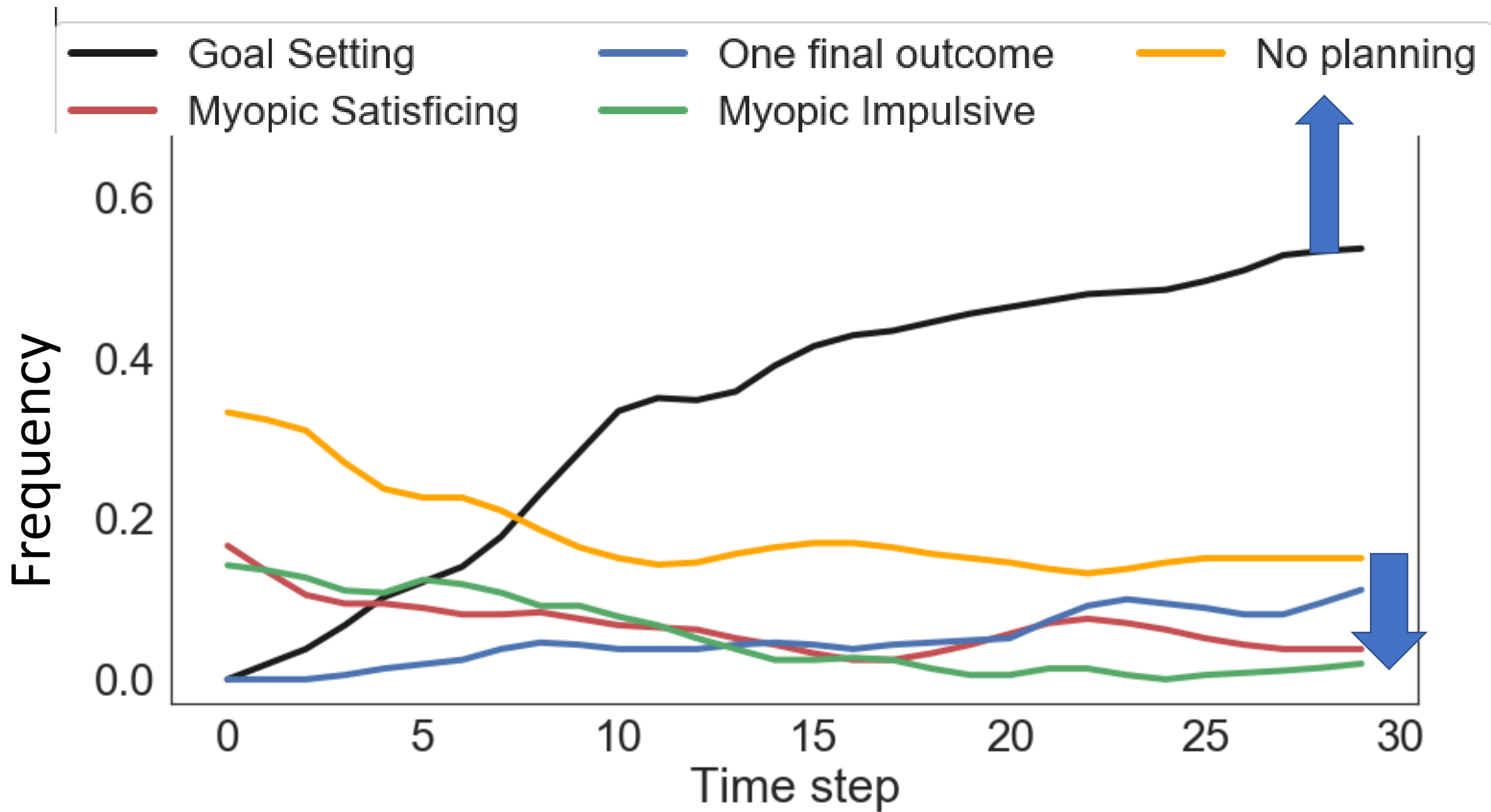
Cognitive Tutors

Metacognitive **Reinforcement** Learning

cognitive strategy

Problem

Optimal Feedback

Cognitive Tutor
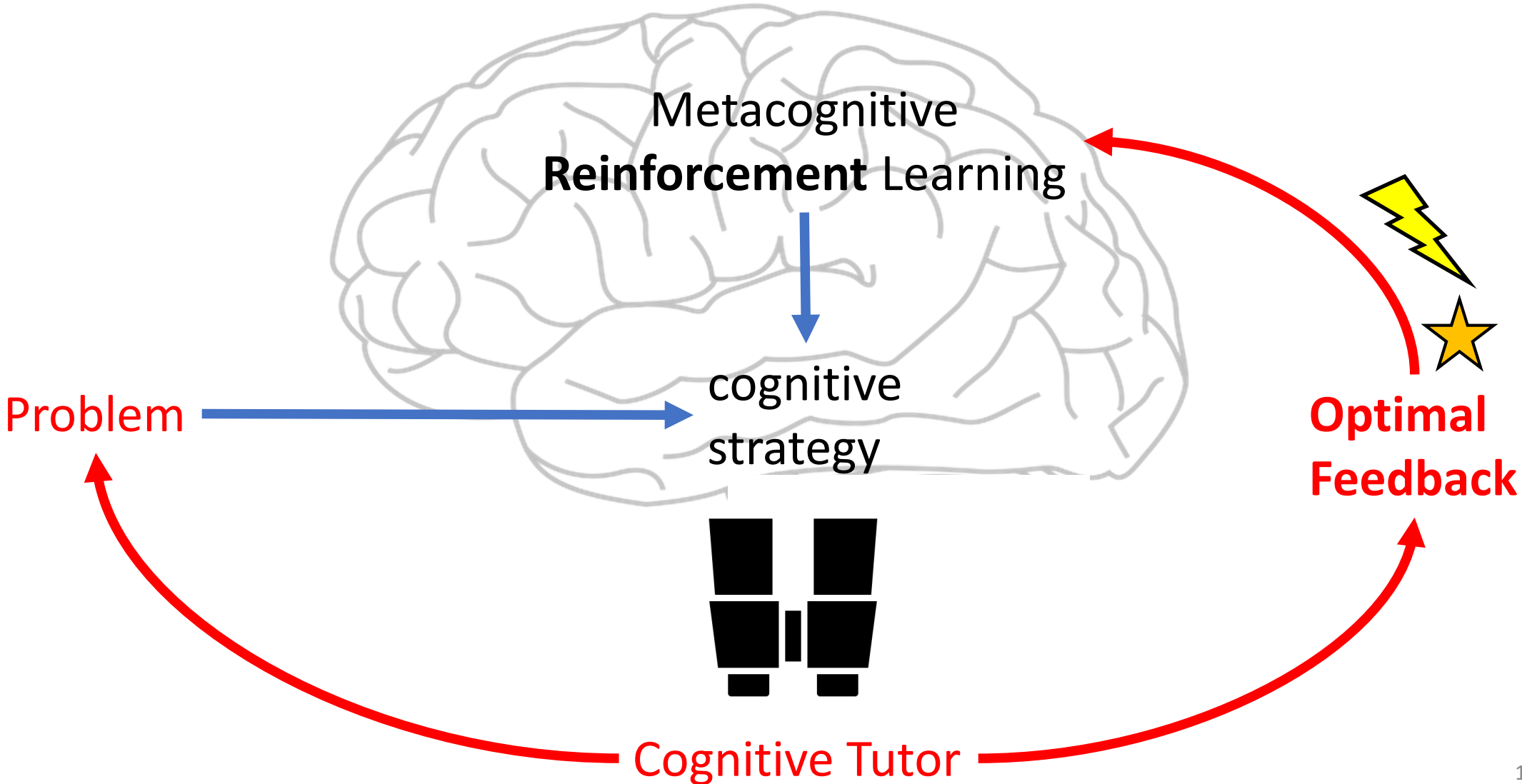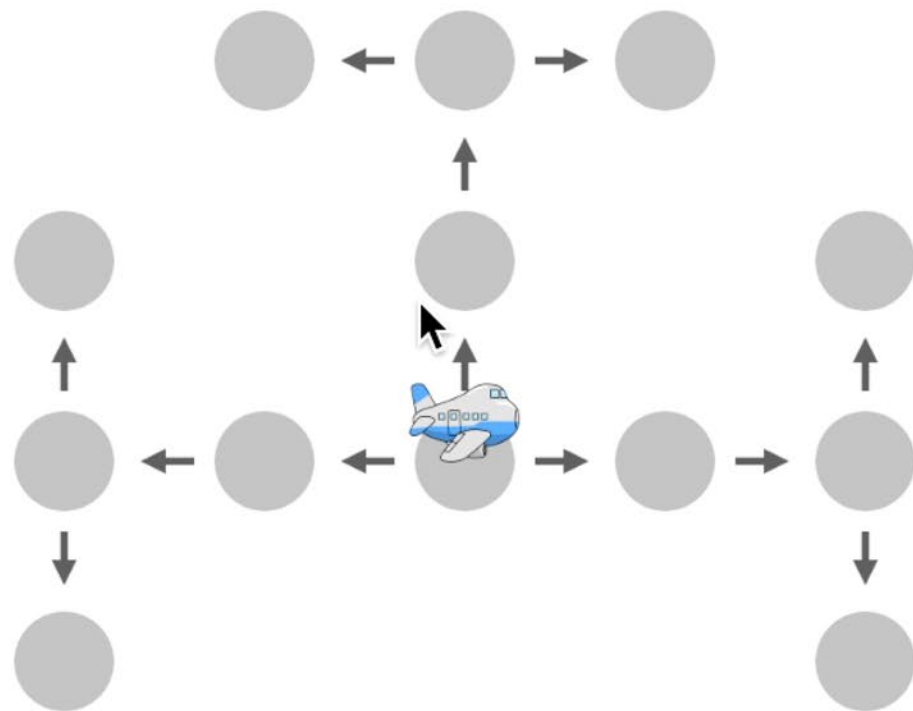
Clicking on a node reveals its value for a $1 fee.

Move with the arrow keys.

Faster Learning --> Better Planning
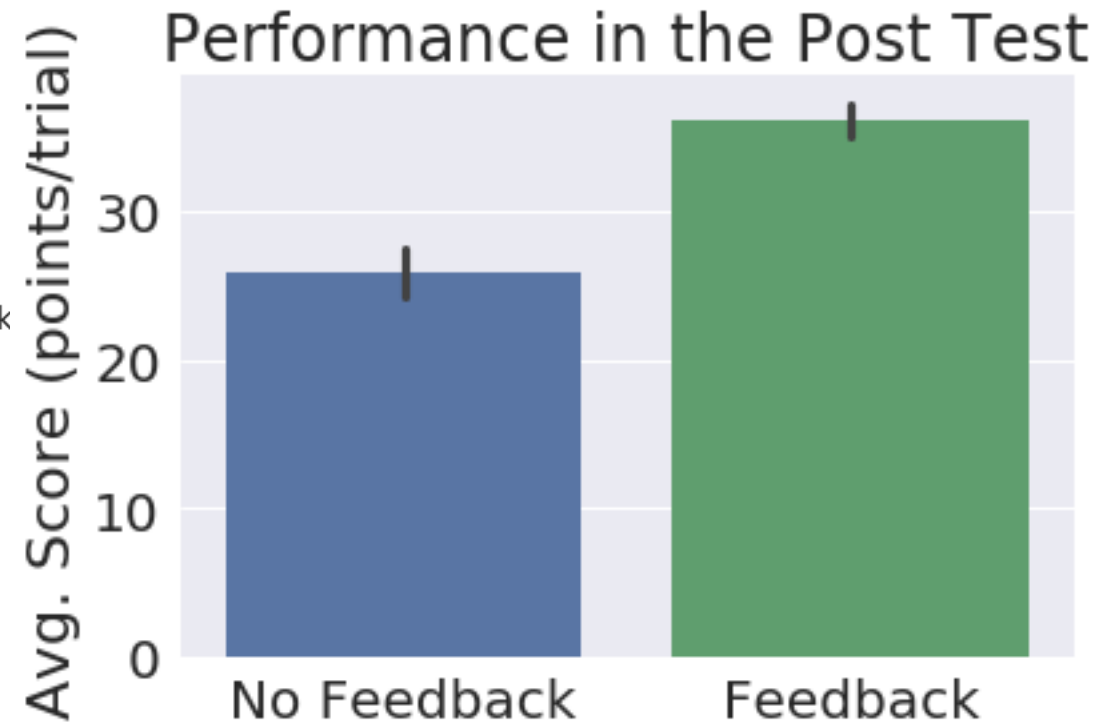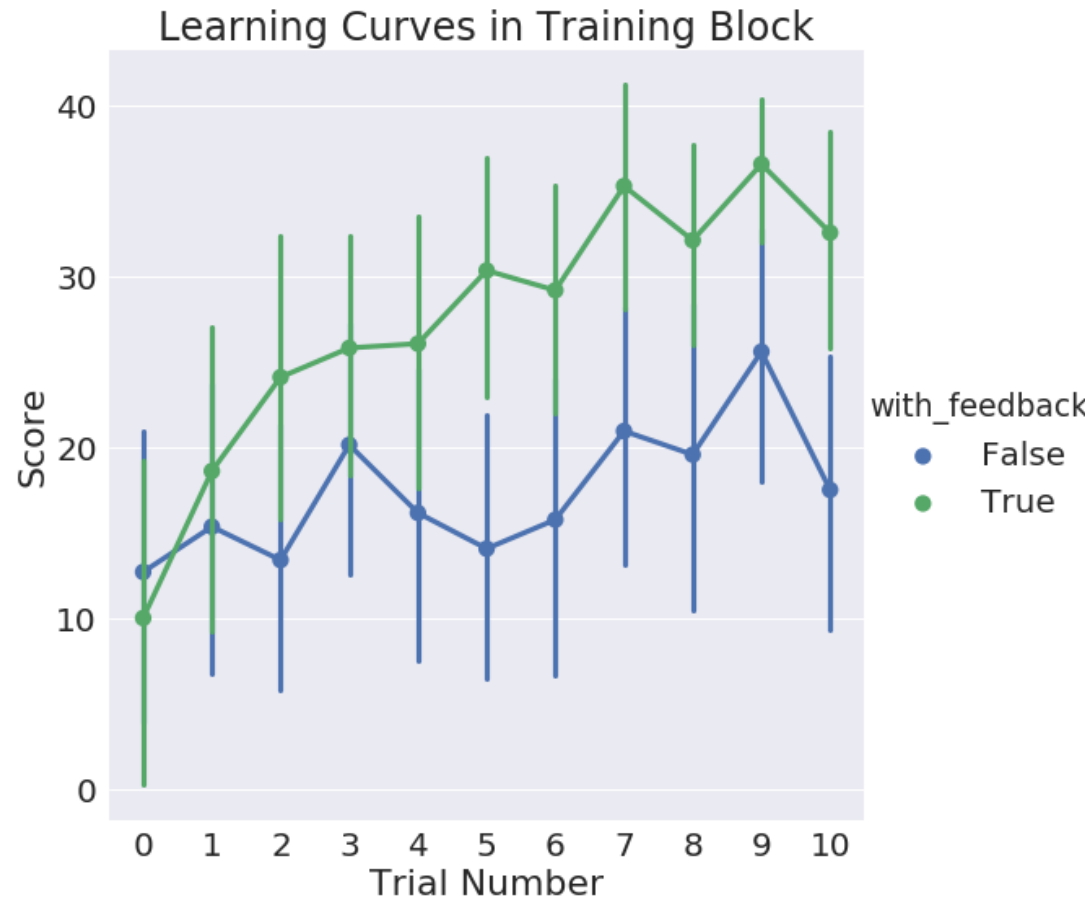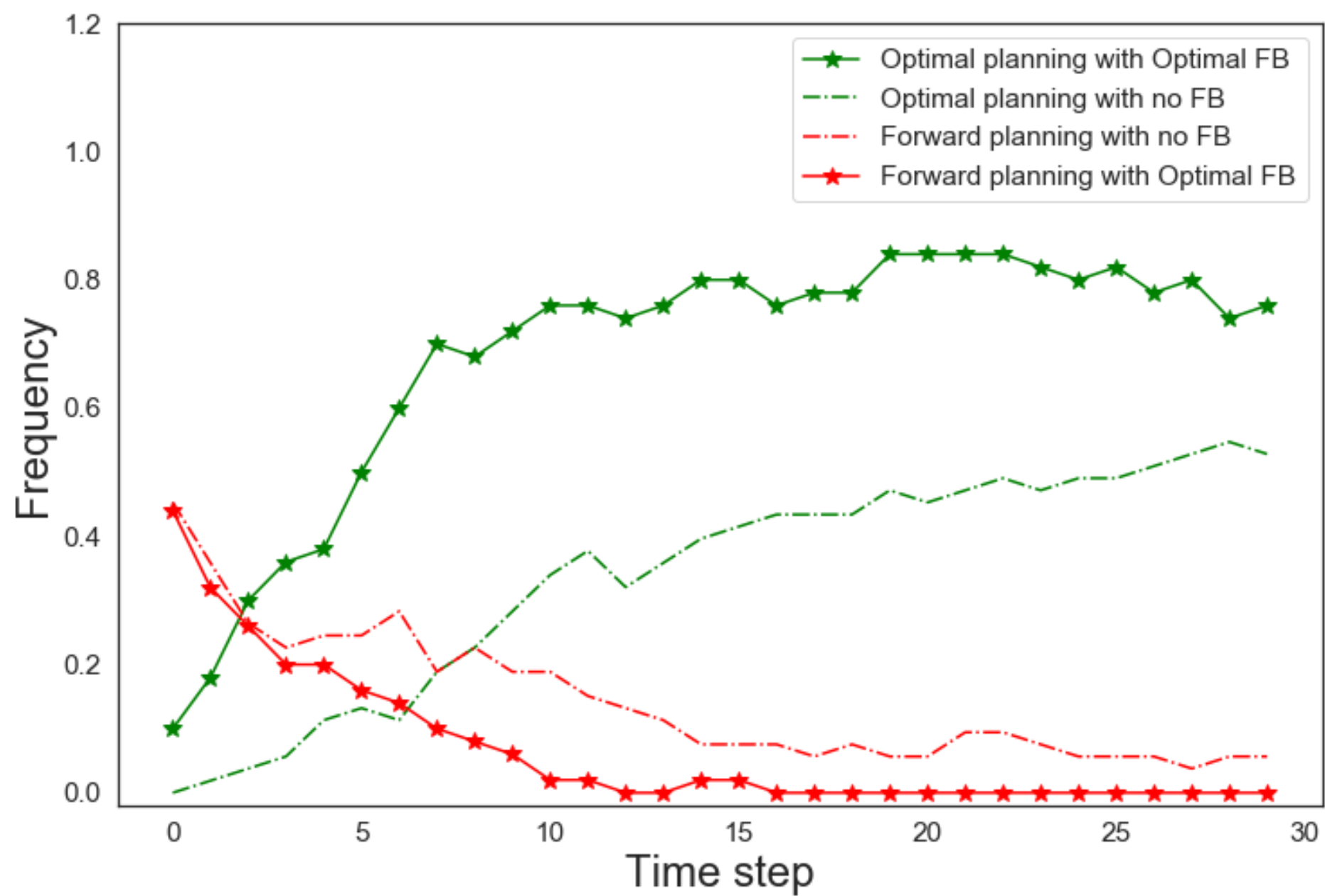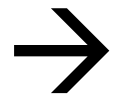
Training Task → Transfer Task
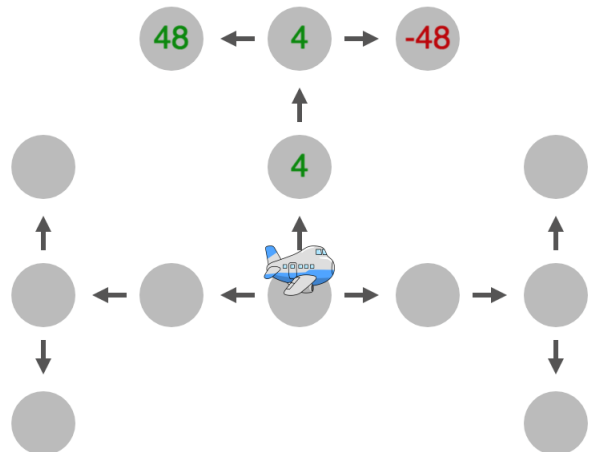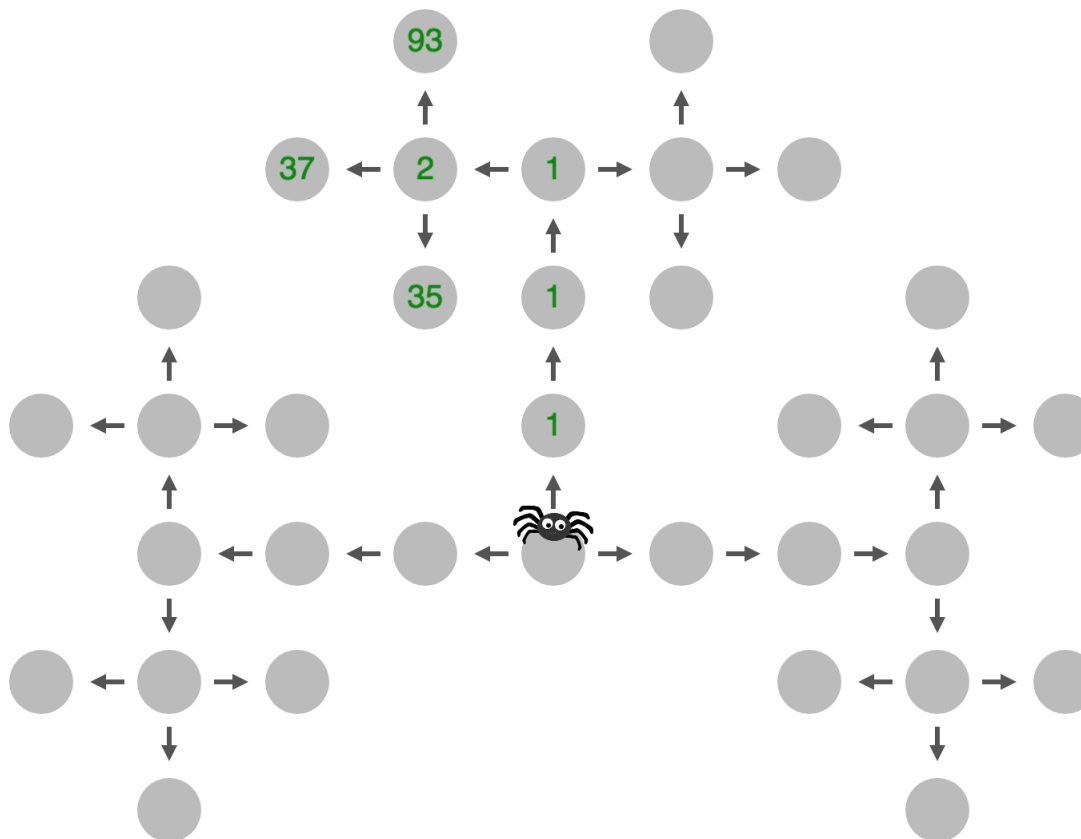
Clicking on a node reveals its value for a $1 fee.
Move with the arrow keys.

Transfer Effects

Performance on the Transfer Task
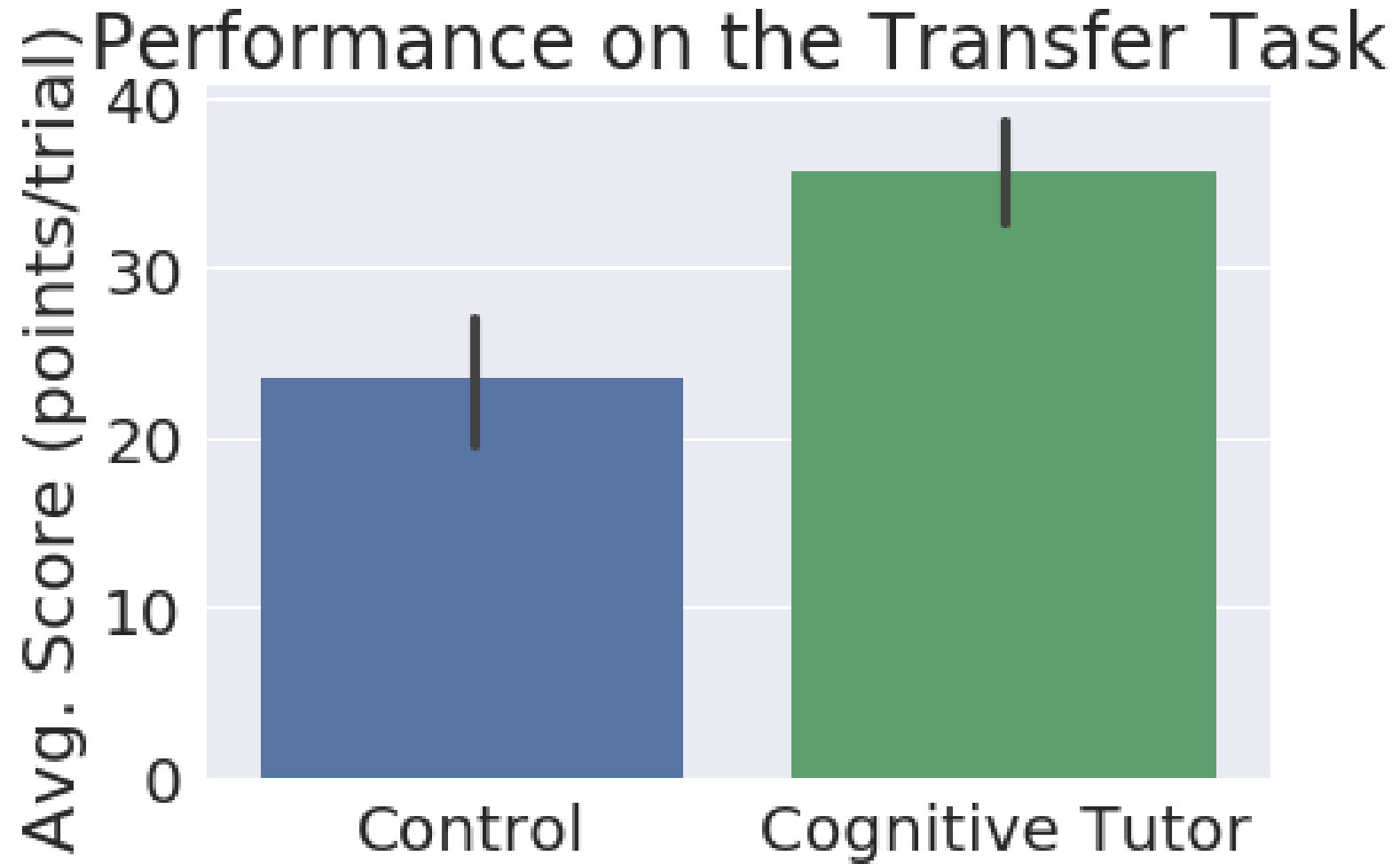
Adding instruction about effective strategies
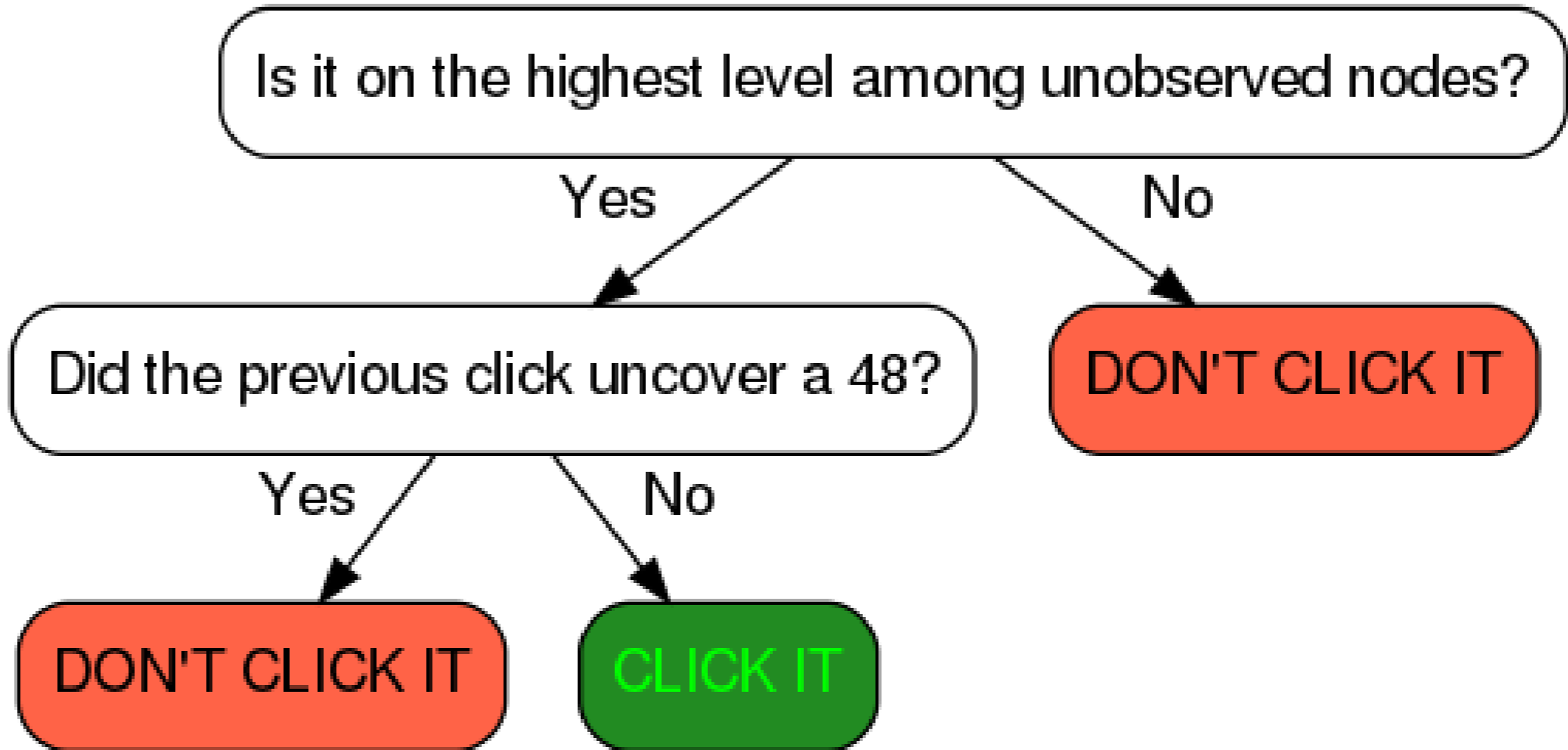
Leveraging AI to improve how people plan

metalevel
MDP

Metalevel RL

optimal
cognitive
strategies
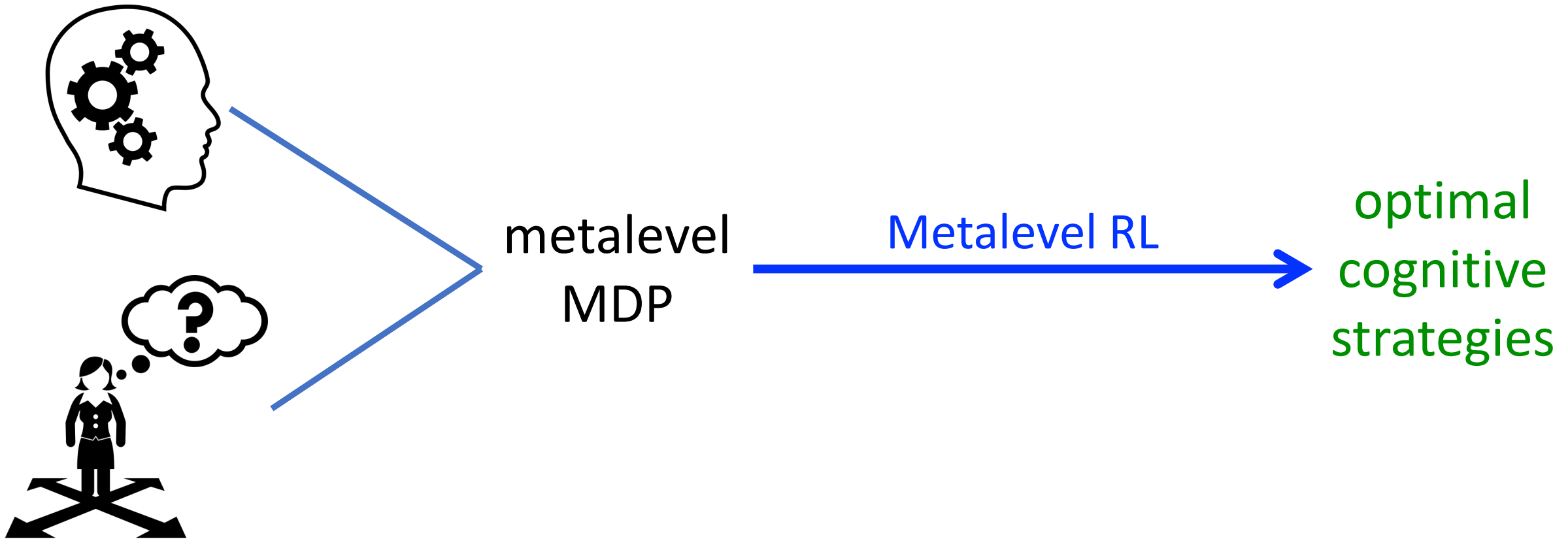
Deriving descriptions of optimal strategies automatically
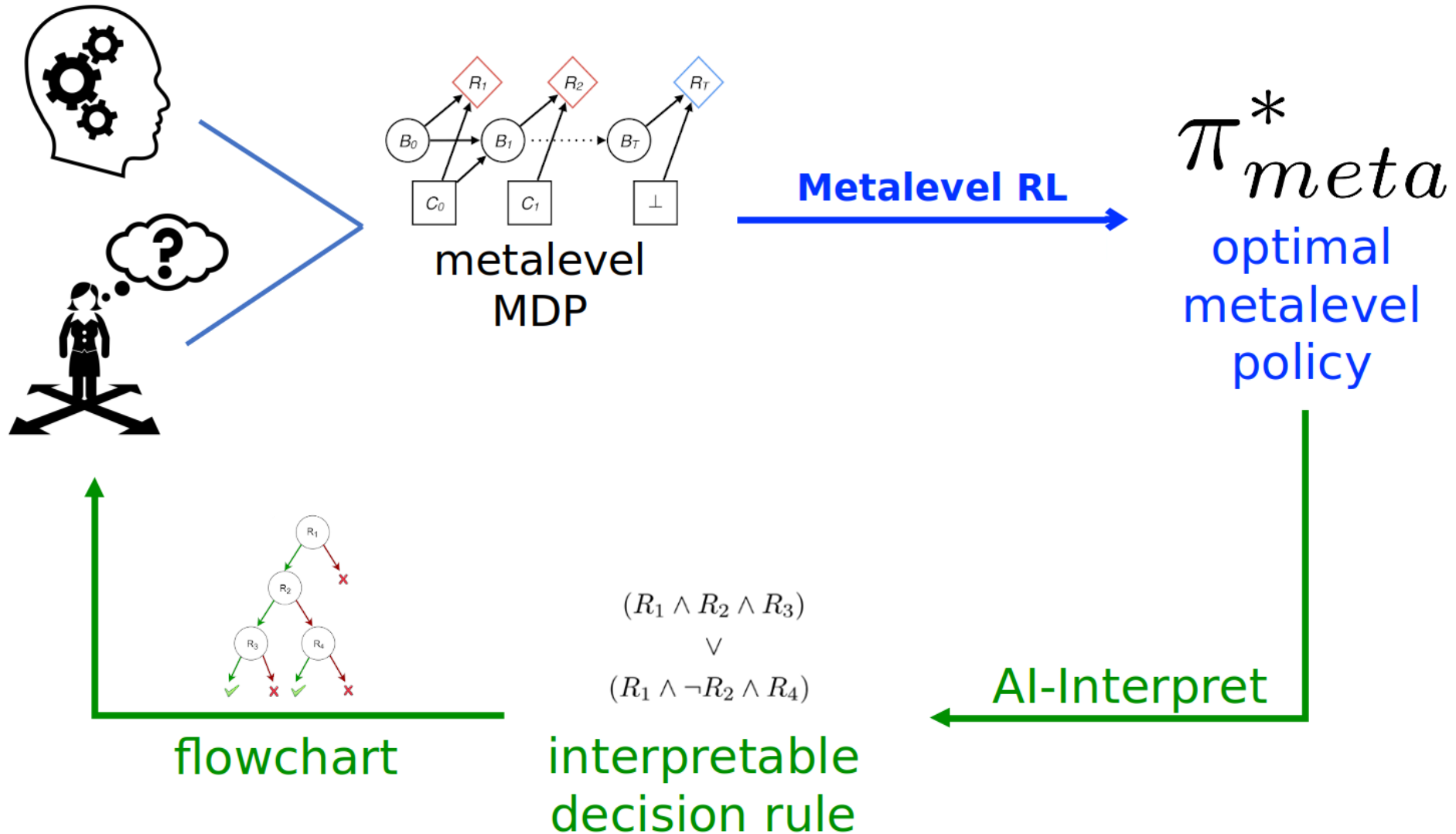
Mean expected score per tutor and environment
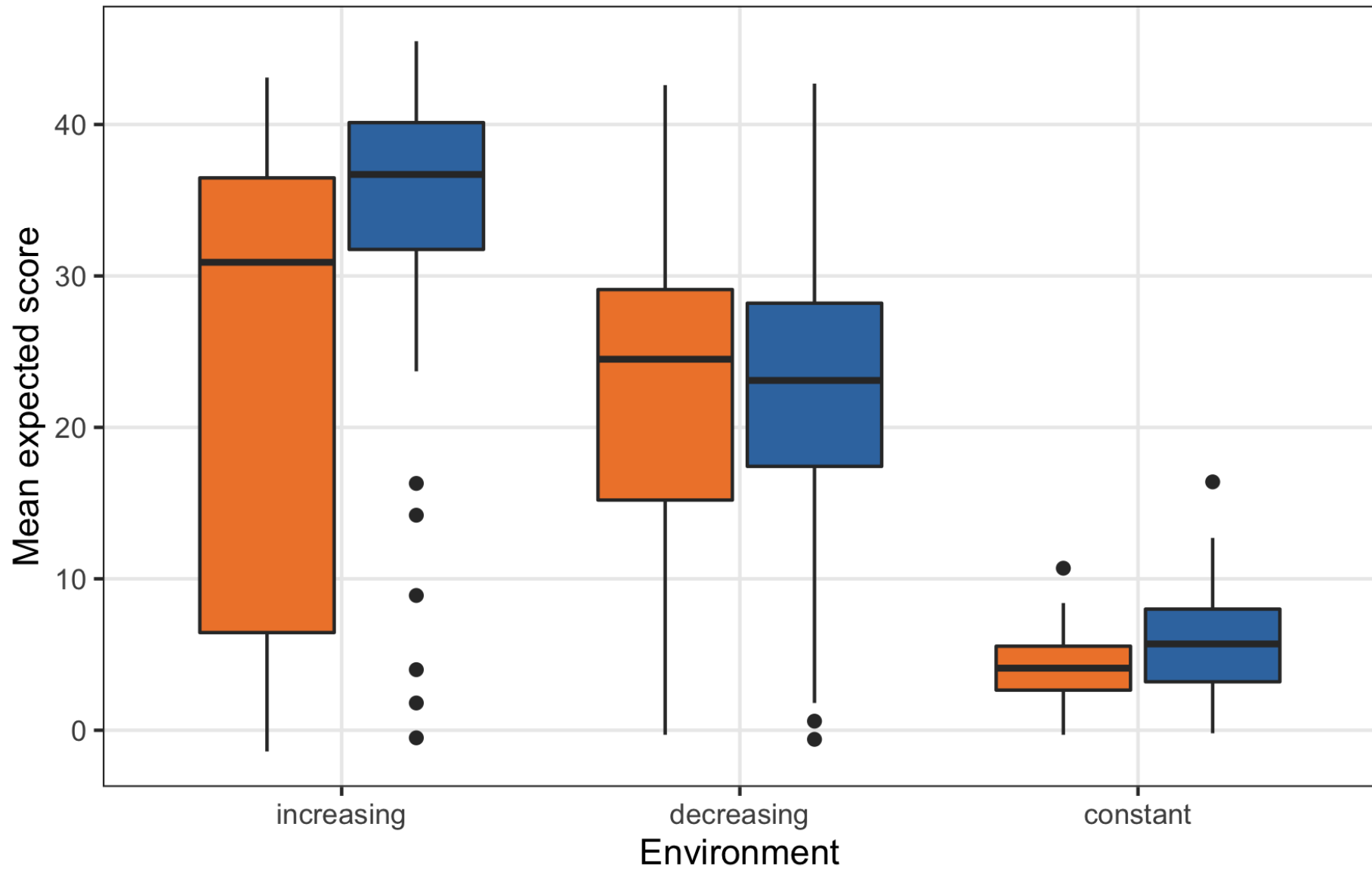
Promoting Metacognitive Learning with Reflection Prompts
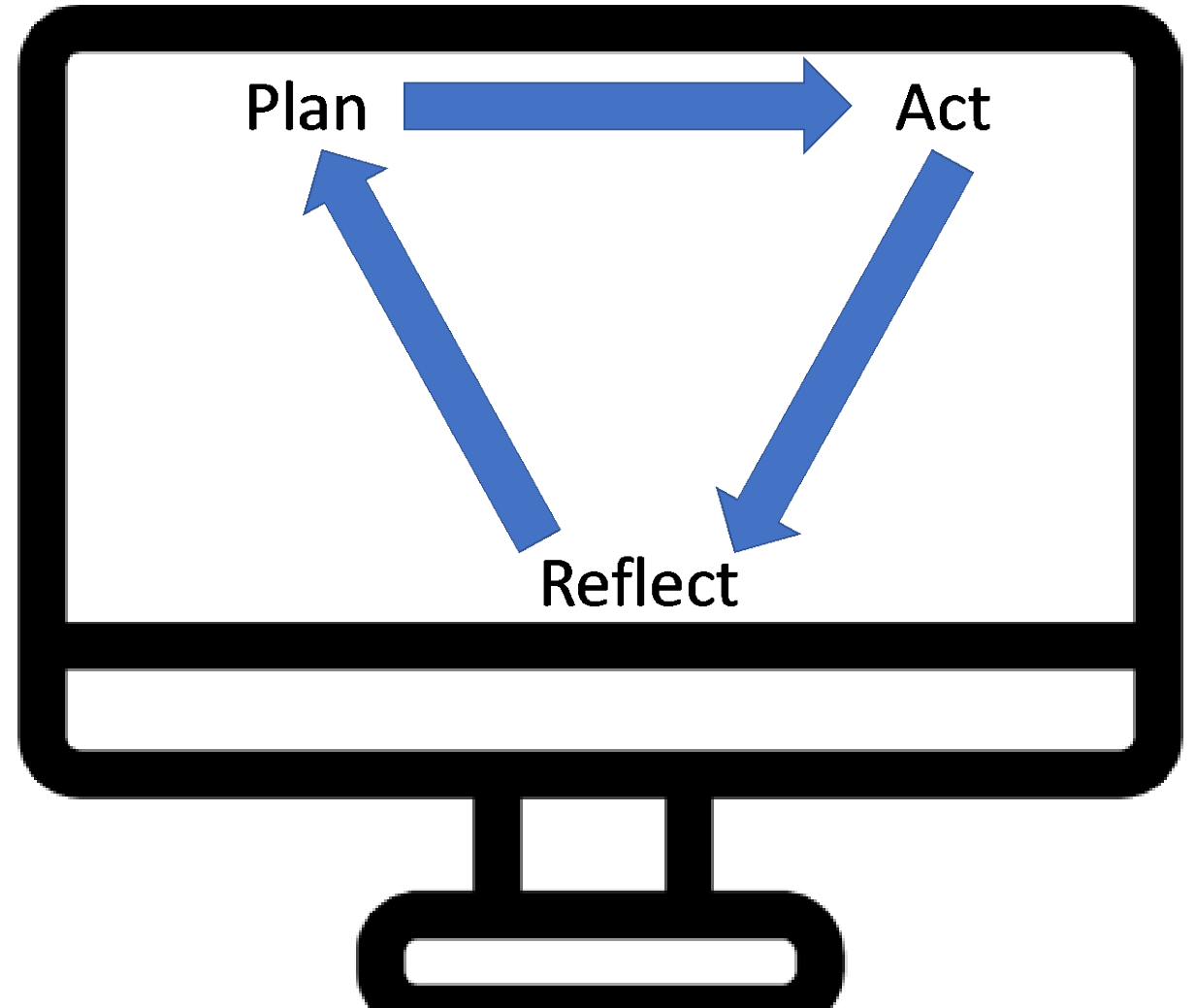
1. Plan

2. Act
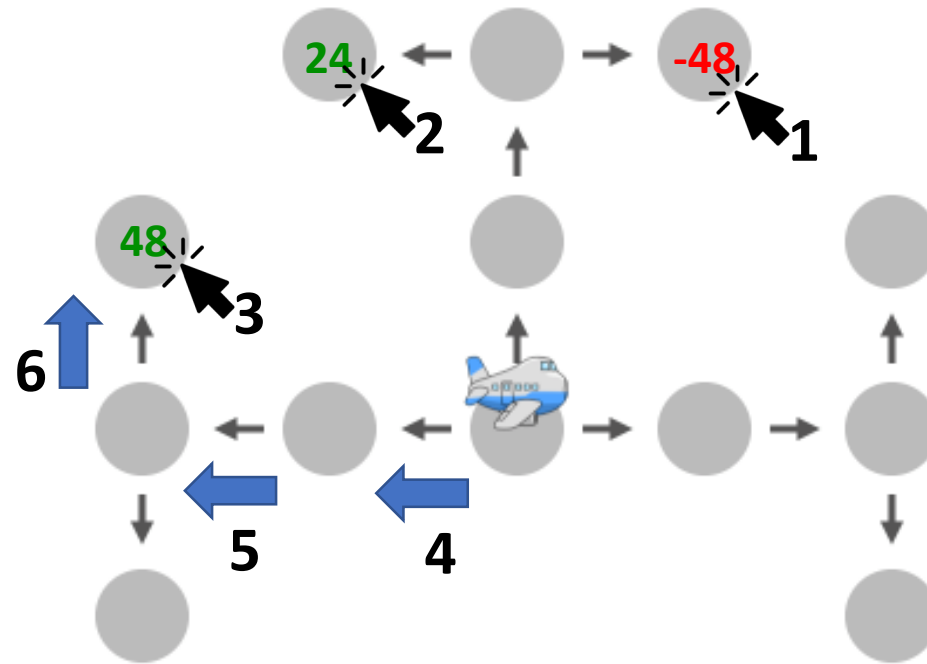
Clicking on a node reveals its value for a $1 fee.
Move with the arrow keys.

# Please complete the following statements:

How did you decide what to do in the most recent rounds? I did...

How did it work out? It worked out...

Why did it turn out that way? It turned out that way, because...

3. Reflect

Please consider the rewards of the last trial and complete the following statements:

What would have happened if you had chosen a strategy that evaluated the end states first in the latest round?
It would have...

How would it have worked out? It would have worked out...

Why would it have turned out this way? It would have turned out this way, because...
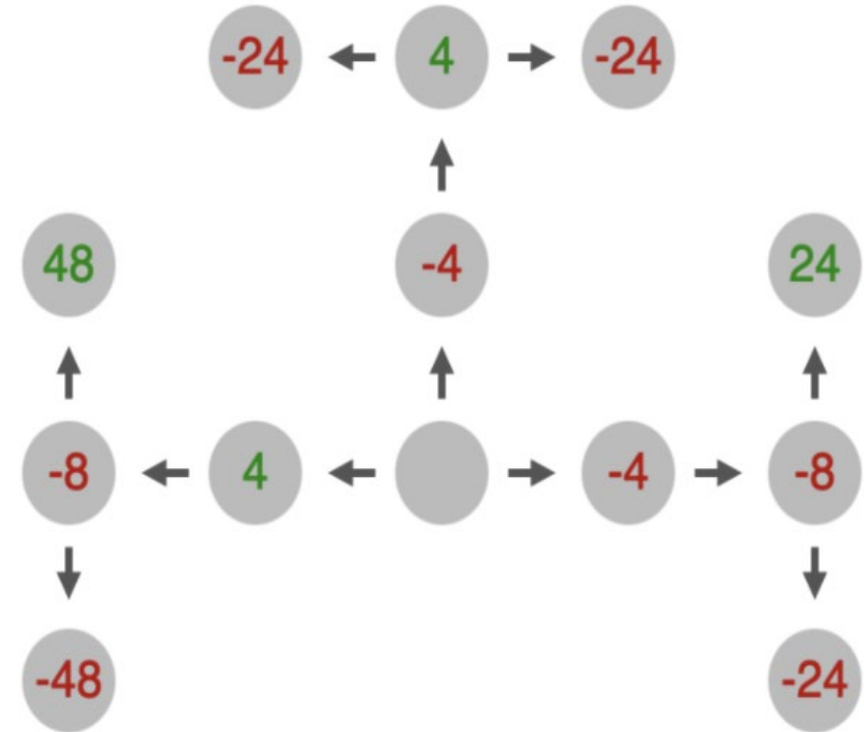
3. Reflect
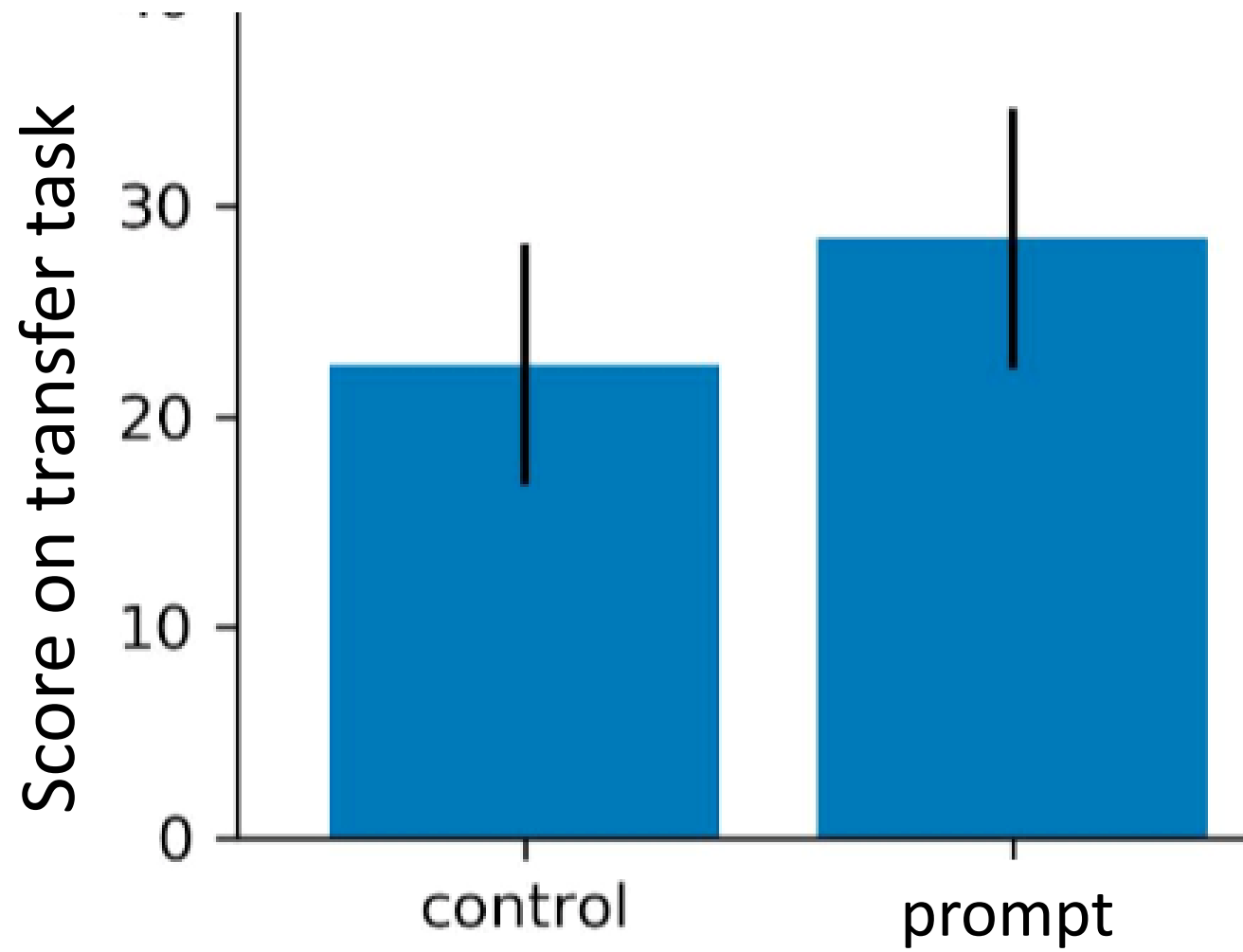
Take Home Message 1

Intelligent cognitive tutors can help people overcome their biases and learn how to make better-informed decisions.

Value-Based Goal-Setting

Values → Long-term goals → Mid-term goals → Short-term goals → Daily Goals

Self-Concordance

Hierarchical Goal-Setting

Goal Network Congruence
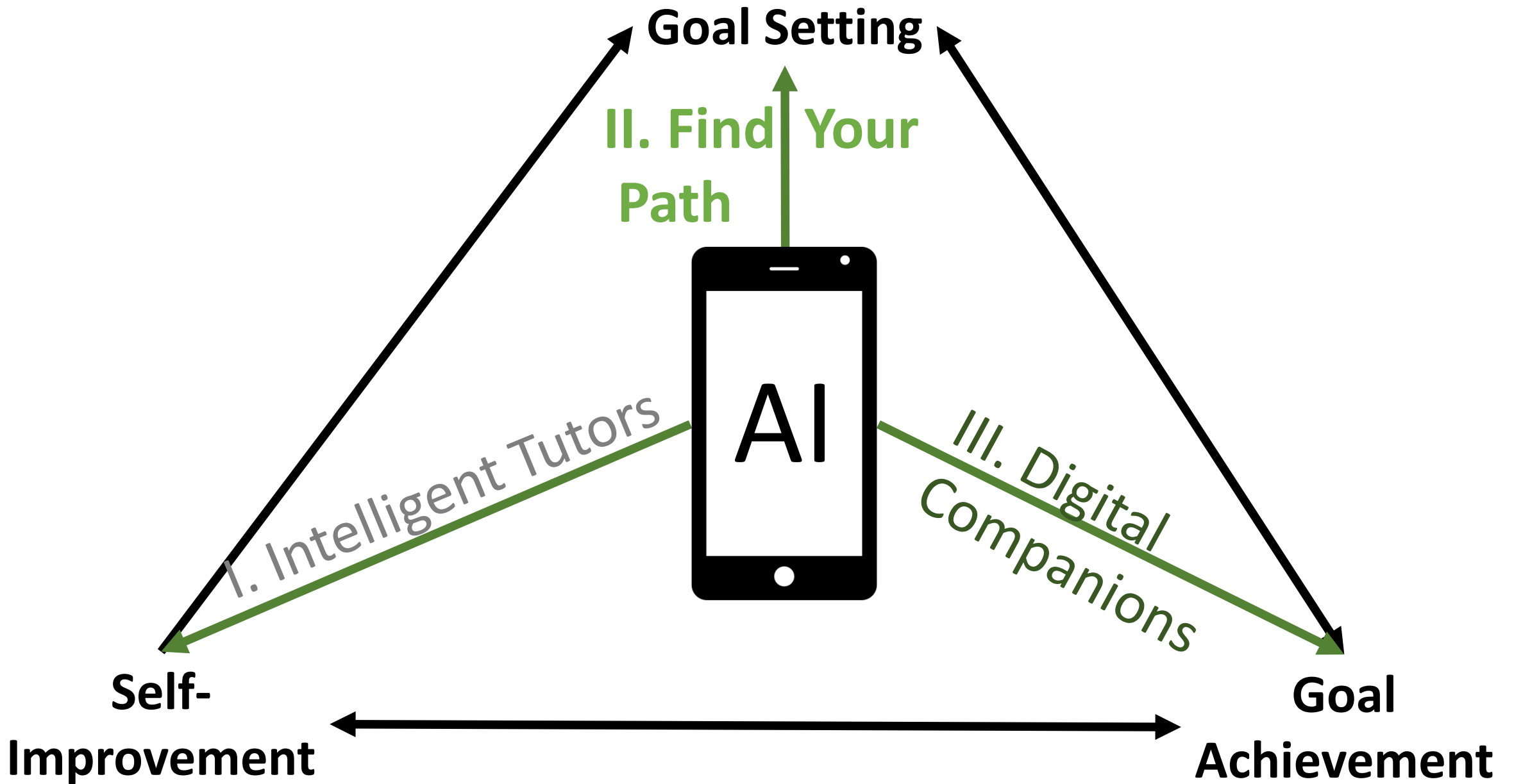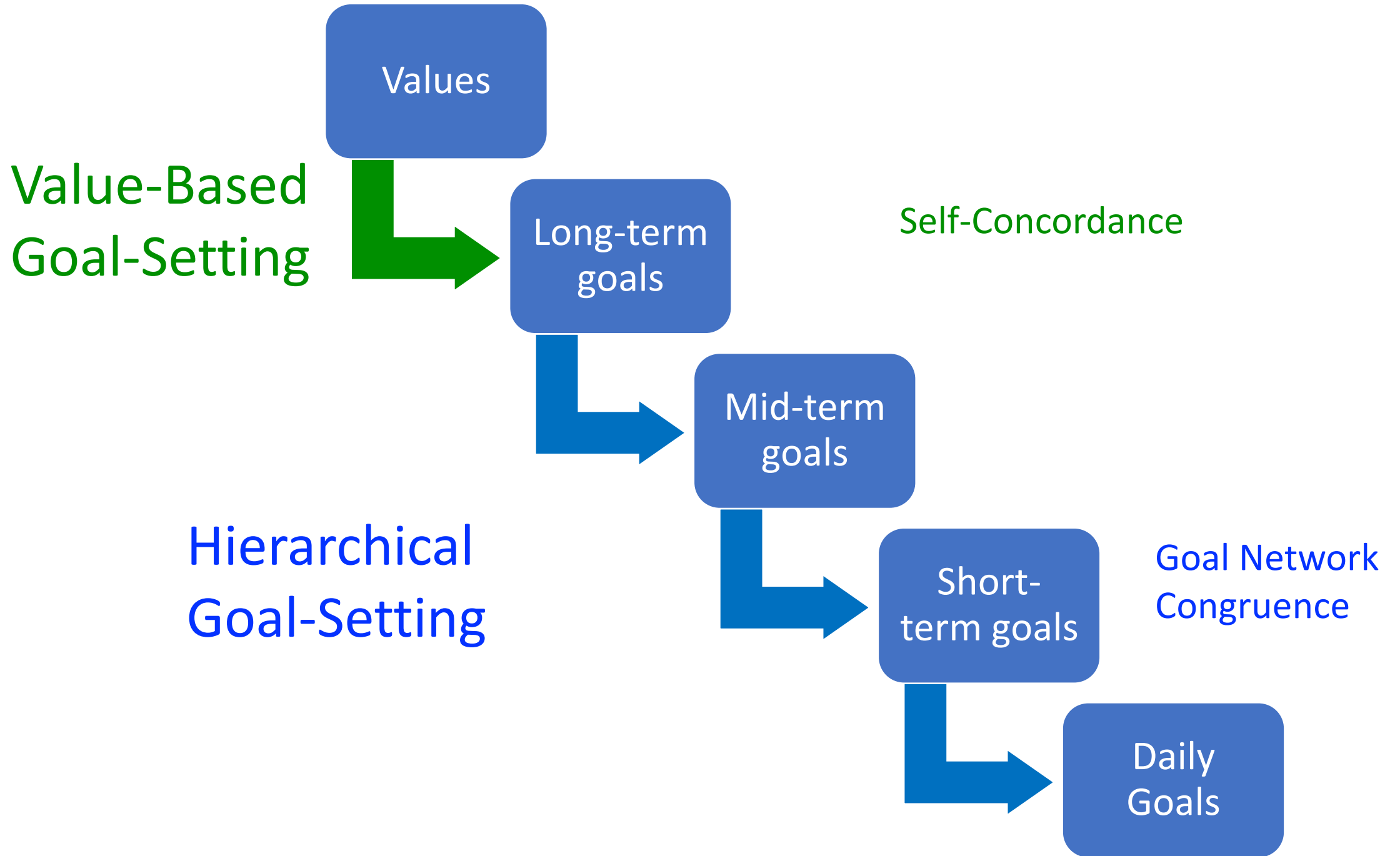
Value-Based Goal-Setting

Olive
I will now show you several questions to help you reflect about your most important life goals. Please choose the question you like best and then take a minute to reflect on it. Remember, taking the time to honestly think about these questions is for your benefit! Click on the question and continue to reflect on it.
16:00:49

1. What do you want to make sure you do, achieve, or experience before you're gone?

2. What is the most important thing that you know you really should do but that you have trouble getting yourself to do?

● ● ●
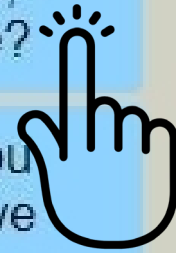
Value-Based Goal-Setting

> 1. What do you want to make sure you do, achieve, or experience before you're gone?
> 09:27:21

> **Olive**
> Now take a moment to honestly to reflect on what your most honest answer to this question would be. You will be able to proceed in one minute.
> 09:27:22

> **Olive**
> Are you ready to keep going?
> 09:28:23

> I'm ready
> 09:28:34

Value-Based Goal-Setting

Olive
Based on your reflection, which ultimate life aspiration would you like to define for yourself? Please enter it in the text box.
09:28:39

Cure cancer
09:29:02

Hierarchical Goal-Setting

Hierarchical Goal-Setting

Olive
Great! Now that you have imagined what you want to achieve in **six months**, take a moment to think about where you would like to be halfway to your goal. Write down the outcome you want to achieve by the time you get to **three months**
18:00:10

I want to have researched the Top 10 Med Schools and want to have sent at least 5 applications.
18:00:45

Olive
Awesome, this is your first milestone! Creating milestones is an effective way to break down your long-term goals into actionable next steps.
18:00:51

Hierarchical Goal-Setting

Olive
Alright, let's create another milestone! I'd like you to imagine what succesfully completing your milestone in **three months** would look like. Where would you be? How would it feel? Imagine it fully. You will be able to continue in about 30 seconds.
18:01:41

• • •

The resulting long-term goals reflect the person's values and identity

+2 on a scale from -3 to +3
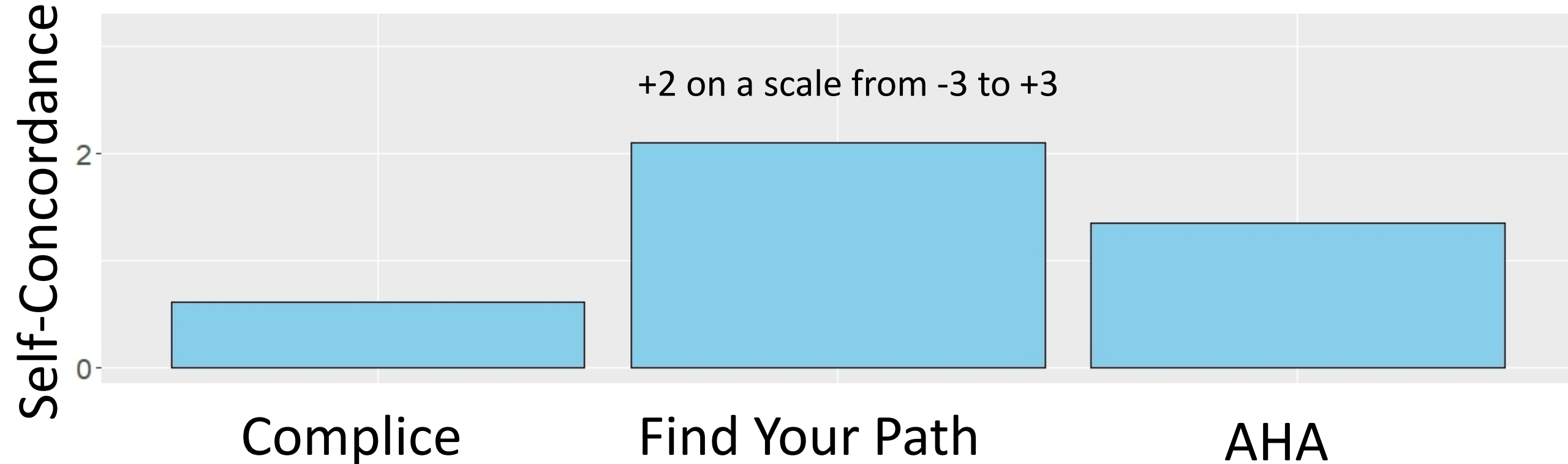
$F(2, 145) = 4.50, p = .01, \eta^2 = .06$

The resulting goals are more congruent with each other
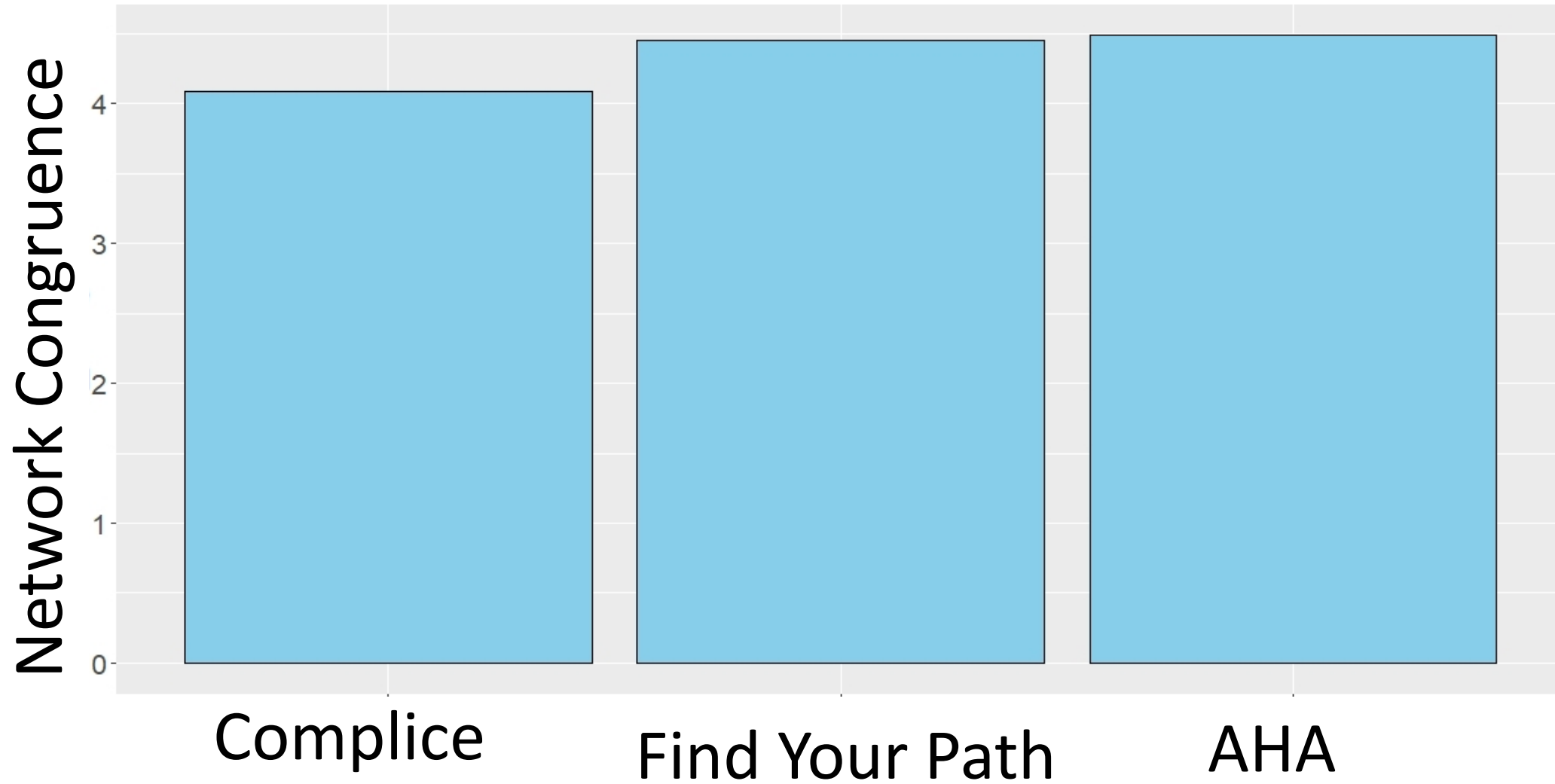
$F(2, 176) = 6.85$, $p < .01$, $\eta^2 = .07$

Take Home Message 2

Chatbots can be used to help people set meaningful long-term goals and break them down into actionable intentions.
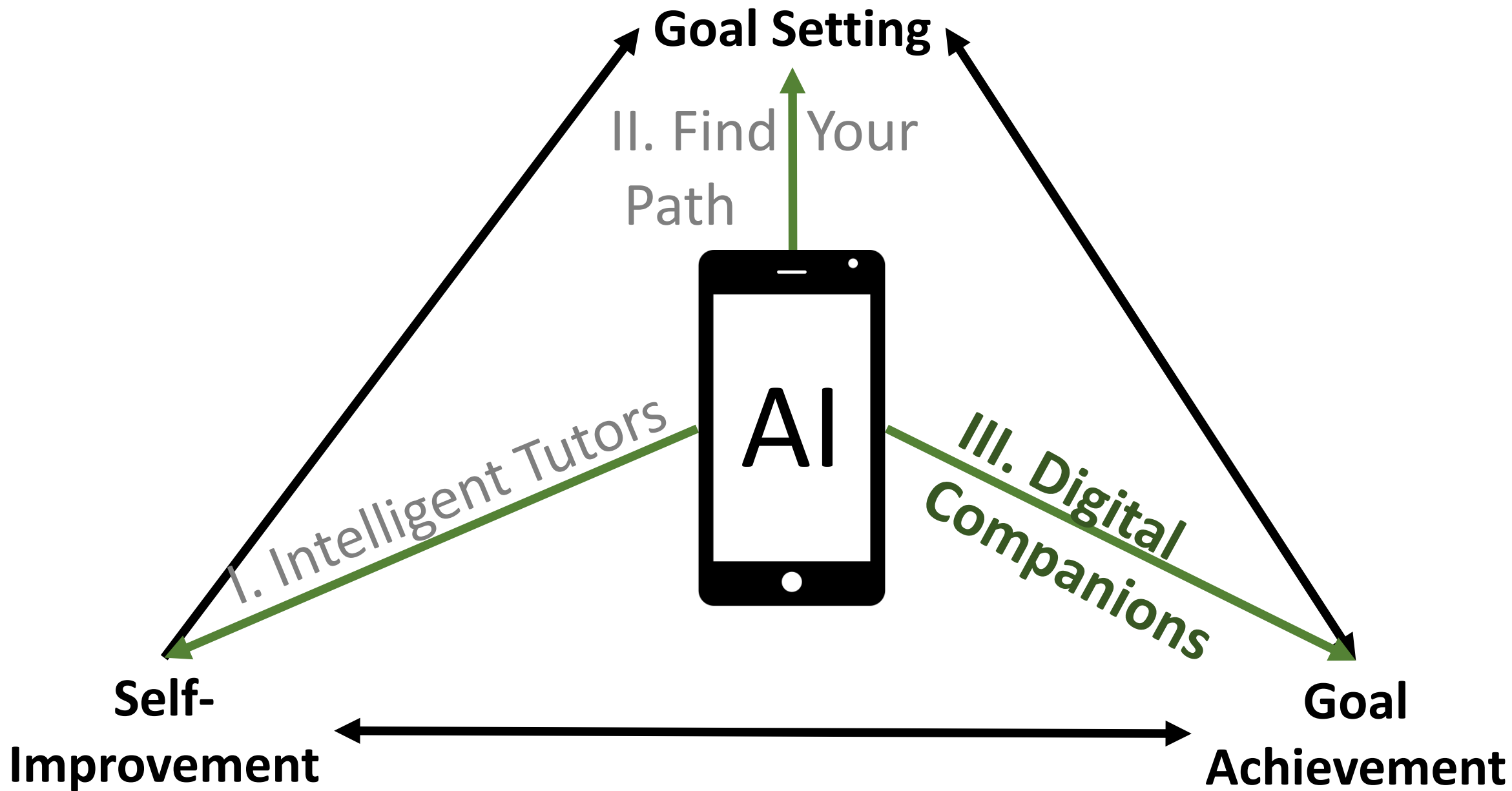
People often fail to do what is best in the long-term when it is unpleasant in the short-term
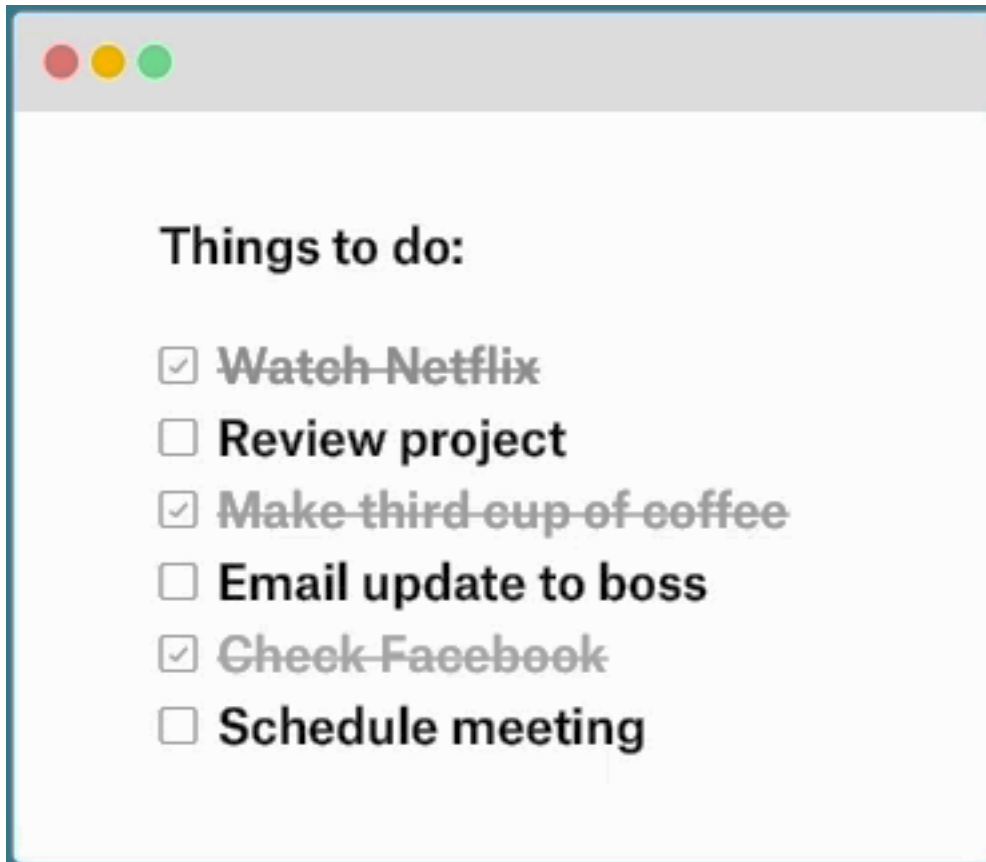
Making good decisions easier by **aligning** short-term reward with long-term value

Short-Term Reward   Long-Term Value
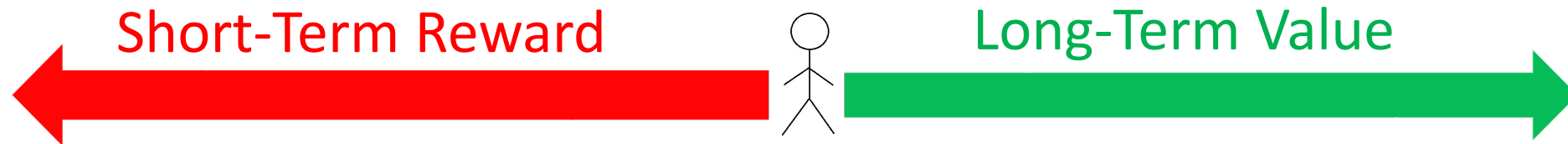
Goal: Add incentives *f* so that the short-sighted decision becomes optimal:

$$\arg\max_{a} \mathbb{E}[r(s, a, s') + f(s, a)] = \pi^{\star}(s)$$

Solution:

$$f(s, a) = \gamma \cdot \mathbb{E}[V^{\star}(S')|s, a] - V^{\star}(s)$$

To-Do List Gamification

$$f(s,a) = \gamma \cdot \mathbb{E}[V^\star(S')|s,a] - V^\star(s)$$

To-Do List Gamification

To-Do List Gamification Alleviates Procrastination
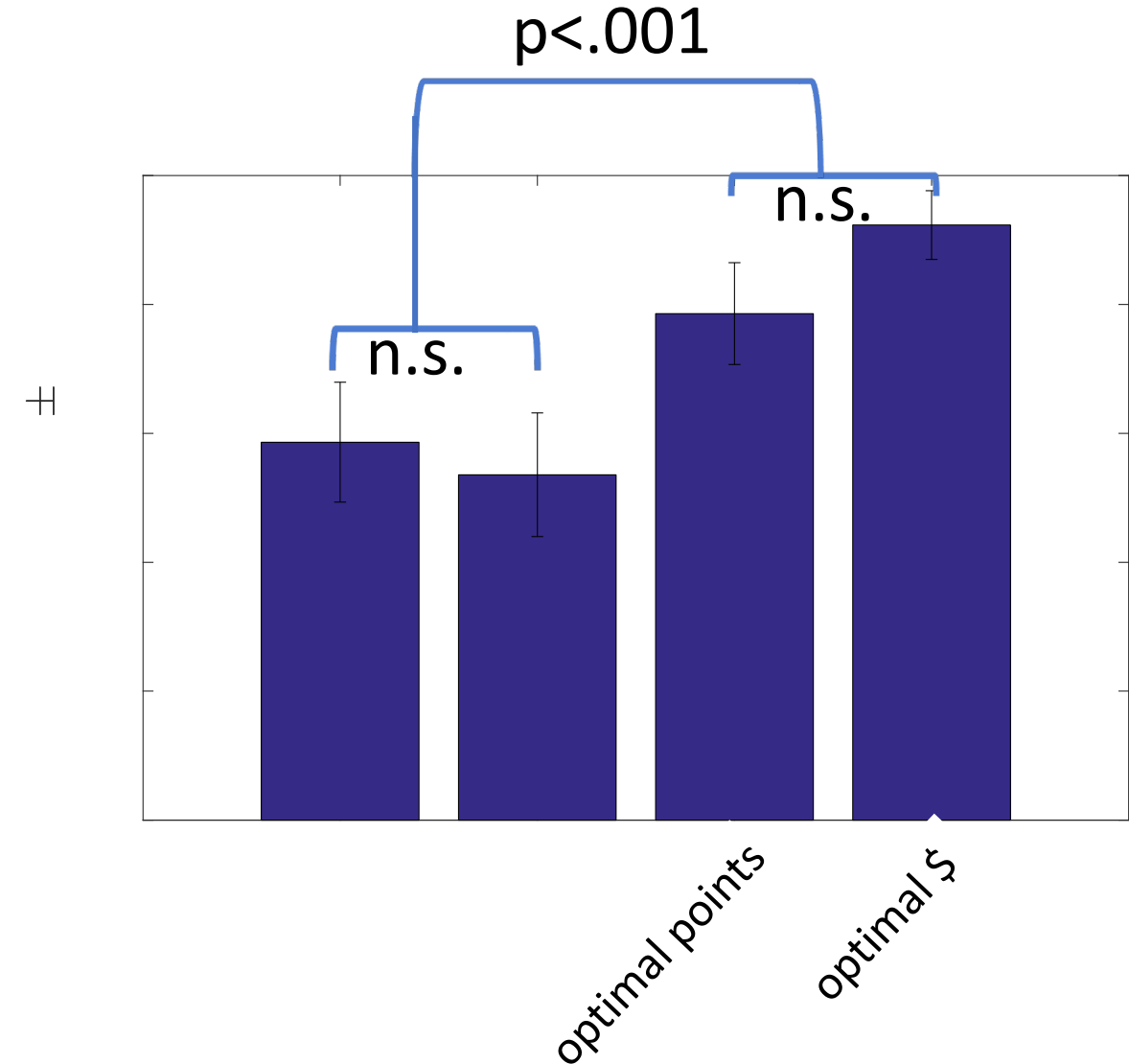
Lieder, F., Chen, O., Krueger, P.M., & Griffiths, T.L. 2019). Cognitive Prostheses for Goal Achievement. *Nature Human Behavior*.

Welcome, Elon!

There are 10 tasks in total and you may complete as many or as few as them as you like. Writing Assignments 2,3,6,8, and 10 belong to Project 1 and Writing Assignments 1,4,5,7, and 9 belong to Project 2. To complete a project y~~ou have to submit original high quality essays for all of its assignments. If you complete both projects~~ by the dead~~line~~ Proportion of People wasting time on the unimportant project

Project 2 but not Project 1 you earn a bonus of $1. The deadline is on **February 11 2019** at 12am Pacific Time (midnight).   **32.6%**   **41.9%**   **11.1%**

$$(\chi^2(2) = 10.85, p = .004).$$

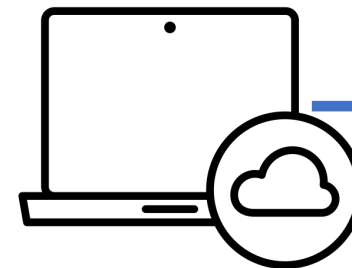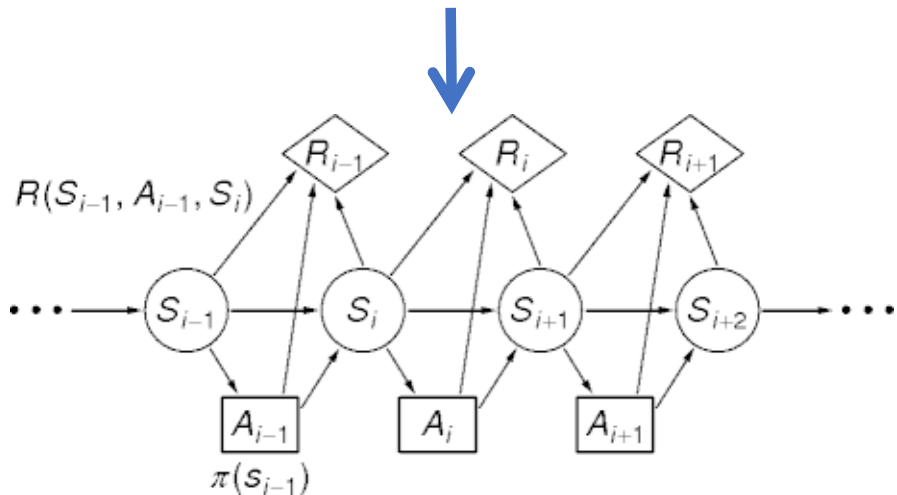| 2 Assignment 2 |
|---|
| 3 Assignment 3 |
| 4 Assignment 4 |
| 5 Assignment 5 |
| 6 Assignment 6 |
| 7 Assignment 7 |
| 8 Assignment 8 |

2 Assignment 2	$2.90
3 Assignment 3	$2.32
4 Assignment 4	$0.81
5 Assignment 5	$3.19
6 Assignment 6	$1.16
7 Assignment 7	$2.32
8 Assignment 8	$2.32

2 Assignment 2	$5.91
3 Assignment 3	$4.09
4 Assignment 4	$-0.91
5 Assignment 5	$-0.91
6 Assignment 6	$4.09
7 Assignment 7	$-0.91
8 Assignment 8	$4.09

Take Home Message 3

We can leverage AI and gamification to repair broken incentive structures to help people overcome procrastination and make better decisions.

Good job staying off Facebook.

Goal Setting

II. Find Your Path

AI

I. Intelligent Tutors

III. Digital Companions

Self-Improvement

Goal Achievement
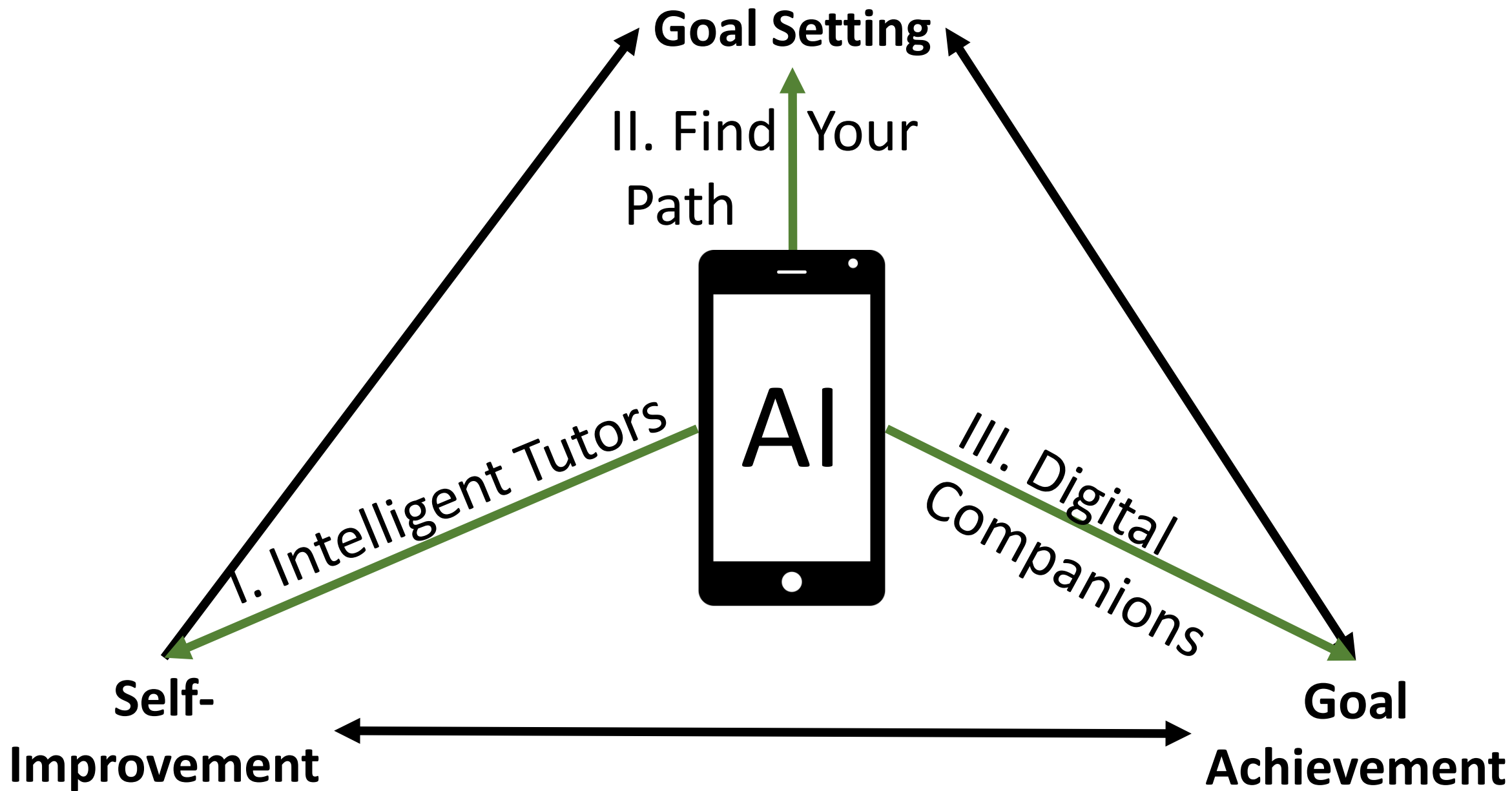
First steps towards putting it all together

Violet: What do you want to make sure you do, achieve, or experience before you're gone?

....

Violet: Great!
How long will it take you to achieve this goal?

6 month

Violet: On a scale from 1 to 10, how important is this goal to you?

8

Violet: Great! You've set your first life goal! It will be stored in a hierarchical list, allowing you to arrange your goals and subgoals better!

Violet: I will show you in a second!

Prioritize goals

sort by: ● goal ☐ points ☐ time to complete

Goal1 ➕   Due in 6 months

▽ **Subgoal 1** ➕

  ▽ Intention 1 ➕ Time to complete: 2H

  Intention 2 ➕ Time to complete: 1H

▽ **Subgoal 2** ➕

  ▽ Intention 1 ➕ Time to complete: 6H

  ▽ Intention 2 ➕ Time to complete: 1H

Goal 2 ➕   Due to 1 year

▽ **Subgoal 3.1** ➕

  ▽ Subsubgoal 3.1.1 ➕

    ▽ Intention 1 ➕ Time to complete: 2H

    ▽ Intention 2 ➕ Time to complete: 1H

    ▽ Intention 3 ➕ Time to complete: 1H

  ▽ Subsubgoal 3.1.2 ➕ due in 3 months

    ▽ Intention 1 ➕ Time to complete: 2H

    ▽ Intention 2 ➕ Time to complete: 45 min

▽ **Subgoal 3.2** ➕

  ▽ Subsubgoal 3.2.1 ➕

Goal 3 ▽

Chat with Violet ▽

Today
CompliceX - 11:22 AM

Violet: Well done! You have set many goals for you life, do you want to start working on it?

Yes

Type your message 🙂 ◁

⚙ ❓

Filter:

Working hours: 6

Points aim: optional

Choose goals/intentions you want to work on today:

AI suggestion

Goal 1 ➕ | Accept all the suggestions ▽

[X] Intention 1 | 70 points | Importance: 9 of 10, | 1H | Due Tomorrow 🛠

Goal 2 ➕ | Accept all the suggestions ▽

[ ] Subgoal 1 ➕ | 500 points | Importance: 8 of 10, | December, 2020 🛠
[X] Intention 1 | 100 points | Importance: 5 of 10, | 3H | October 10th 🛠
[ ] Intention 2 | 100 points | Importance: 5 of 10, | 2H | November 1st 🛠
[ ] Subgoal2 ➕ | 100 points | Importance: 5 of 10, | Jan, 2021 🛠

Other goals

Goal 1 ➕ | Select all intentions ▽

[ ] Intention 1 | 100 points | Importance: 3 of 10 | 1H | September 25th 🛠
[X] Intention 4 | 200 points | Importance: 3 of 10 | 30 min | September 28th 🛠

Goal 2 ➕ | Select all intentions ▽

[ ] Intention 2 | 100 points | Importance: 5 of 10, | 30 min | October 1st
[ ] Intention 1 | 35 points | Importance: 3 of 10, | Jan, 2021

Add new intention

Your new intentions:

Intention 1 | 70 points | | 1H | Tomorrow 🛠
Subgoal 1 | Intention 1 | 100 points | | 1H | September 25th 🛠
Intention 4 | 200 points | Importance, 3 of 10 | 30 min | September 28th 🛠
Onboarding tutorial | 500 points | | 10 Min | Tomorrow 🛠
Goal setting how to achieve Goal2 subgoa2? | 300 points | | 20 Min | Tomorrow 🛠

Edit ✏️
Delete 🗑
Snooze 🔔

Confirm and update my todo list

Chat with Violet ▼

Violet: Here is where you arrange your intentions to your todo list.

Type your message 🙂
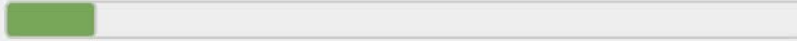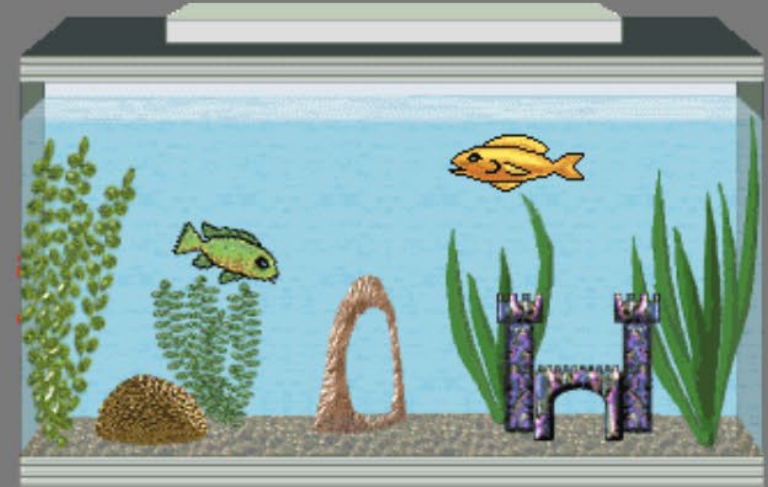
Progress bar

Points: **170/1170, 15% achieved**

To-Do List

✓ Intention 1 [Goal 1] | **70 points**	1H|	Tomorrow	✕
✓ Subgoal 1 | Intention 1 [Goal 2] | **100 points**	1h |	Sep. 25th	✕
✓ Intention 4 [Goal 1] | **200 points**	30 Min|	Sep. 28th	✕
✓ Onboarding tutorial | **500 points** |	10 Min|	Tomorrow	✕
✓ Goal setting how to achieve Goal2 subgoa2? | **300 points** |	20 Min|	Tomorrow	✕

Add new intention
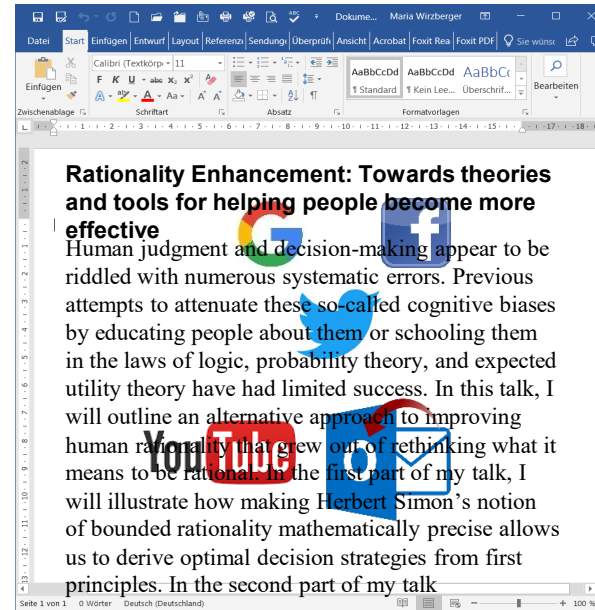
Select intentions from the goal list

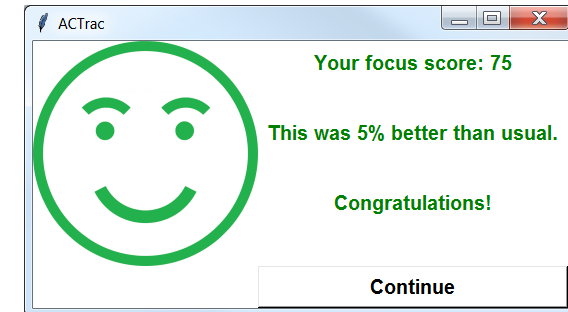Next fish tank addition:
Baby Nemo
(4370 of 5000 points)

◎ **Chat with Violet** ▲

Restructuring the work environment to help people learn to focus their attention

Wednesday 7

1) work on the LIS manifesto

1★)) process Mike's feedback on my sections of the LIS manifesto #week-41-2020 #priority

-1 ★)) think about updating the questiosn of the LIS manifesto #week-41-2020 #priority

-1 ★) make a plan for how to revise the LIS manifesto until the end of October #week-41-2020 #priority

-1 ★) read the current draft o the LIS manifesto #week-41-2020 #priority

-1) update Section 4 in the light of the changes in Sections 1-3 #week-41-2020

-1) plan updating Section 6 #week-41-2020

1 ← enough

Reflect on Study optimal living

What were your goals for this week and how did it go?

Have you made enough progress towards this goal this week?

What are your monthly priorities for this goal?

What are your goals for next week?

✌️ 🟢

Rationality Enhancement Group

MAX PLANCK GESELLSCHAFT

Falk Lieder –
Group Leader

Sierra Kaiser –
Lab Manager

Mike Prentice –
Postdoc

Victoria Amo –
PhD Student

Valkyrie Felso –
PhD Student

Lovis Heindrich –
PhD Student

Julian Skirzynski –
Researcher

Yash Raj Jain –
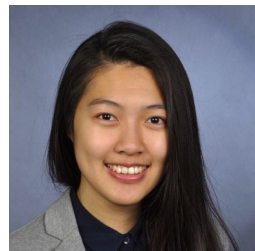Researcher

Hernán González –
Researcher

Saksham Consul –
Programmer

Frederic Becker –
Student Assistent

Benjamin Prystawski –
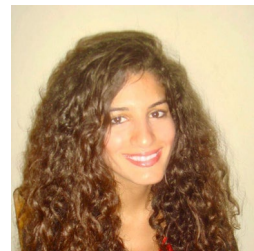Intern

Gabriela Iwama –
Student Assistent

Pin-Zehn Chen –
Intern

Maryam Elenguebawy –
Student Assistent

Adrian Stock –
Student Assistent

Mateo Tosic –
Web Developer

Anastasia Lado –
Student Assistent

Collaborators and Former REG Members

- Laura Bustamante

- Fred Callaway

- Jon Cohen

- Peter Dayan

- Lisa Eckerstorfer

- Ella Eisemann

- Spencer Greenberg

- Tom Griffiths

- Sanit Gupta

- Anirudha Kemptur

- Paul Krueger

- Aashay Mehta

- Florian Mohnert

- Sebastian Musslick

- Bastian Nowozimski

- Malcolm Ocean

- Viktoria Pammer-Schindler

- Vasundhara Rakesh

- Lennart Scatturin

- Amitai Shenhav

- Jugoslav Stojcheski

- Joseph Williams

- Maria Wirzberger

- Lin Xu

https://re.is.mpg.de

Conclusions

- Cognitive tutors and intelligent productivity apps can help people *overcome* procrastination and improve themselves.

- Advances in artificial Intelligence present unprecedented opportunities to empower people.

- To fully realize these opportunities, we need **Life Improvement Science**.