

Subliminal problem solving: Dual process of cognition and their interaction

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Dual Process Theories

| References | System 1 | System 2 |
|---|----------------------|---------------------|
| Schneider & Schiffrin (1977) | Automatic | Controlled |
| Chaiken (1980), Chen & Chaiken (1999) | Heuristic | Systematic |
| Fodor (1983, 2001) | Input modules | Higher cognition |
| Evans (1989, 2006) | Heuristic | Analytic |
| Reber (1993), Evans & Over (1996) | Implicit/tacit | Explicit |
| Epstein (1994), Epstein & Pacini (1999) | Experiential | Rational |
| Sloman (1996), Smith & DeCoster (2000) | Associative | Rule based |
| Hammond (1996) | Intuitive | Analytic |
| Stanovich (1999, 2004) | System 1 (TASS) | System 2 (Analytic) |
| Nisbett et al. (2001) | Holistic | Analytic |
| Wilson (2002) | Adaptive unconscious | Conscious |
| Lieberman (2003) | Reflexive | Reflective |
| Strack & Deustch (2004) | Impulsive | Reflective |
| Toates (2006) | Stimulus bound | Higher order |

System 1 vs. System 2

| System 1 | System 2 |
|----------------------------|-----------------------|
| Unconscious (preconscious) | Conscious |
| Automatic | Controlled |
| Low effort | High effort |
| Rapid | Slow |
| High capacity | Low capacity |
| Evolutionarily old | Evolutionarily recent |
| Shared with animals | Uniquely human |
| Nonverbal | Linked to language |
| Associative | Rule based |
| Domain specific | Domain general |
| Pragmatic | Logical |
| Parallel | Sequential |
| ... | ... |

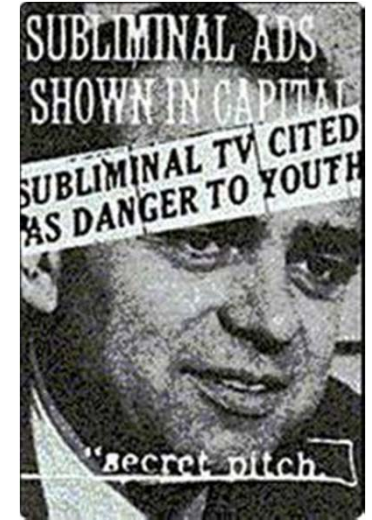
How to Control Unconsciousness

- Considering an approach to investigate the interaction between conscious and unconscious processes, It is comparatively easy to experimentally control conscious system, because experimenter can have participants do something by asking them to do by instruction.
- But it is not easy to experimentally control unconscious system, because if participants are explicitly asked to do or they intend to do something, it can hardly be unconscious process anymore.
- Some experimental techniques that stimulate participants' unconscious processes are indispensable.

Subliminal Effect

James Vicary's "experiment" (1957)

- An "experiment" of **subliminal ad**
 - Theater in Fort Lee, NJ, USA
 - *Picnic* ©1955
 - Flashing messages every 5 seconds
 - "Drink Coca Cola"
 - "Eat Popcorn"
 - Sales increases
 - Coke: 18.1%
 - Popcorn: 57.8%
- A publicity *hoax*, in fact



“Beyond Vicary’s fantasies”

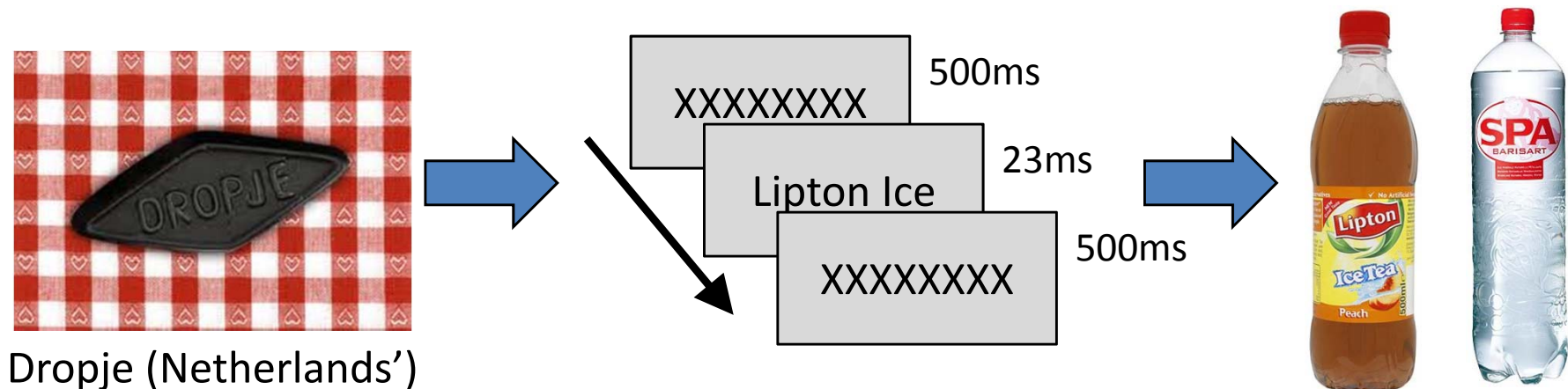
(Karremans, Stroebe, & Claus, 2006, Study 2)

- Motivation

- Subliminal priming is effective for people’s bland choice (only when accompanied with motivation)?

- Method

- “Tongue detection” task (Thirsty condition)
 - Visual detection task → Choice
- 2 (Prime: Lipton Ice/neutral) × 2 (Thirsty: yes/no)



Brand Choice Change by Subliminal Information

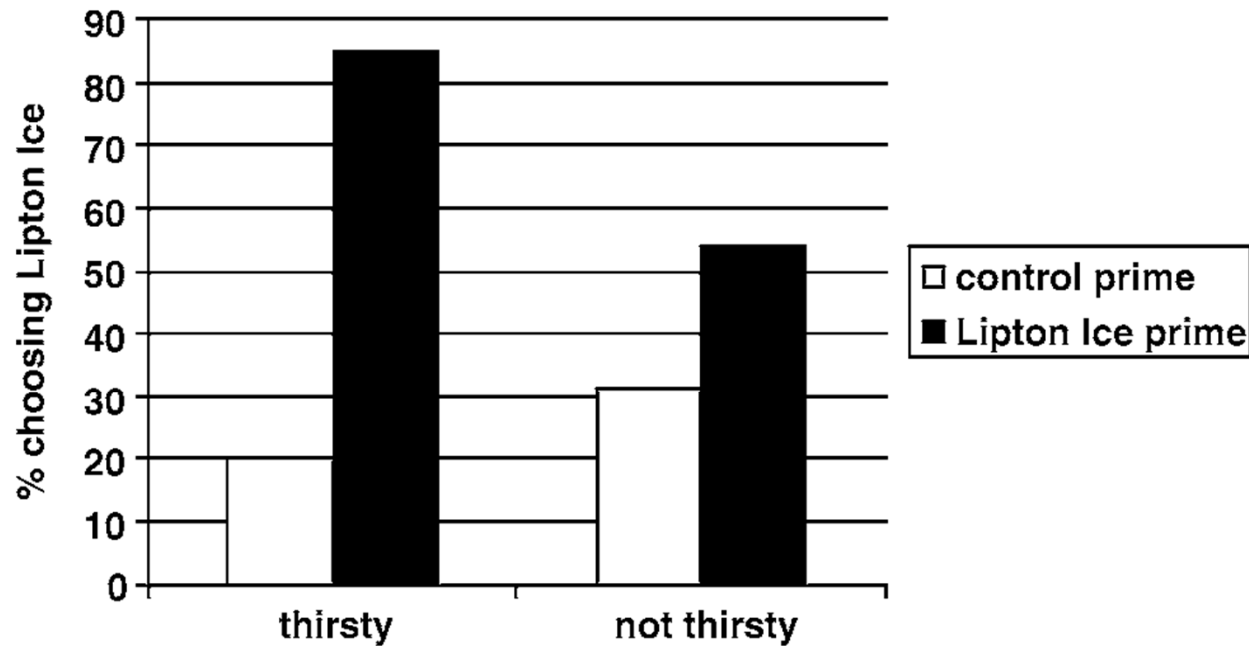


Fig. 2. Percentage of participants choosing Lipton Ice as a function of thirst and prime, Study 2.

- But only for people who are thirsty

Subliminal Mere Exposure Effect

(Kunst-Wilson & Zajonc, 1980, *Science*)

- Motivation

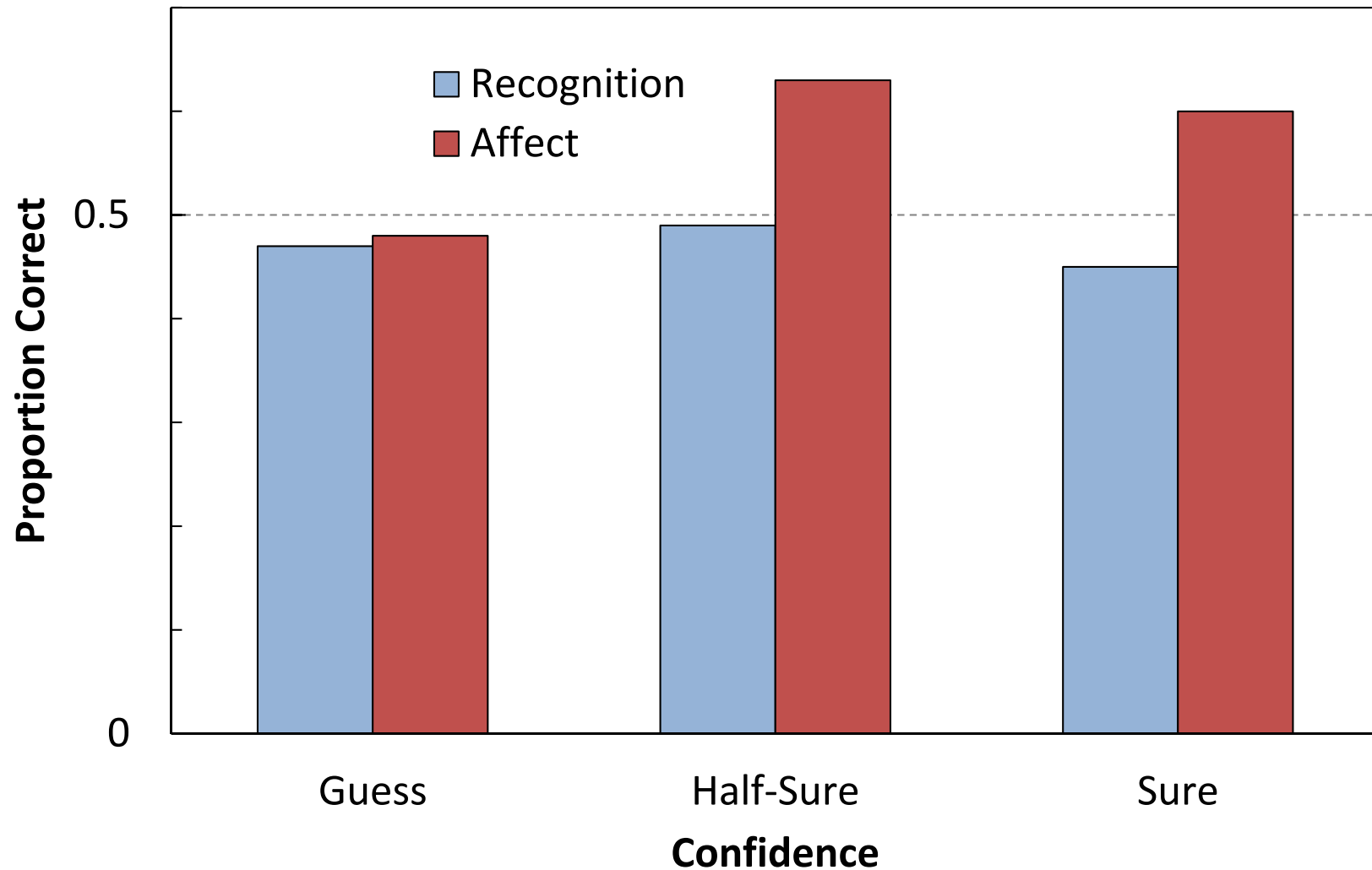
- Preference can develop even by subliminal exposures?



- Method

- Flashing 10 octagon pairs (1/1000 sec × 5)
- **Preference:** “Which do you **like** better?”
- **Recognition:** “Which do you think you have been **shown**?”
 - **Confidence:** Guess / Half-Sure / Sure

Affective Discrimination of Unrecognized Stimuli

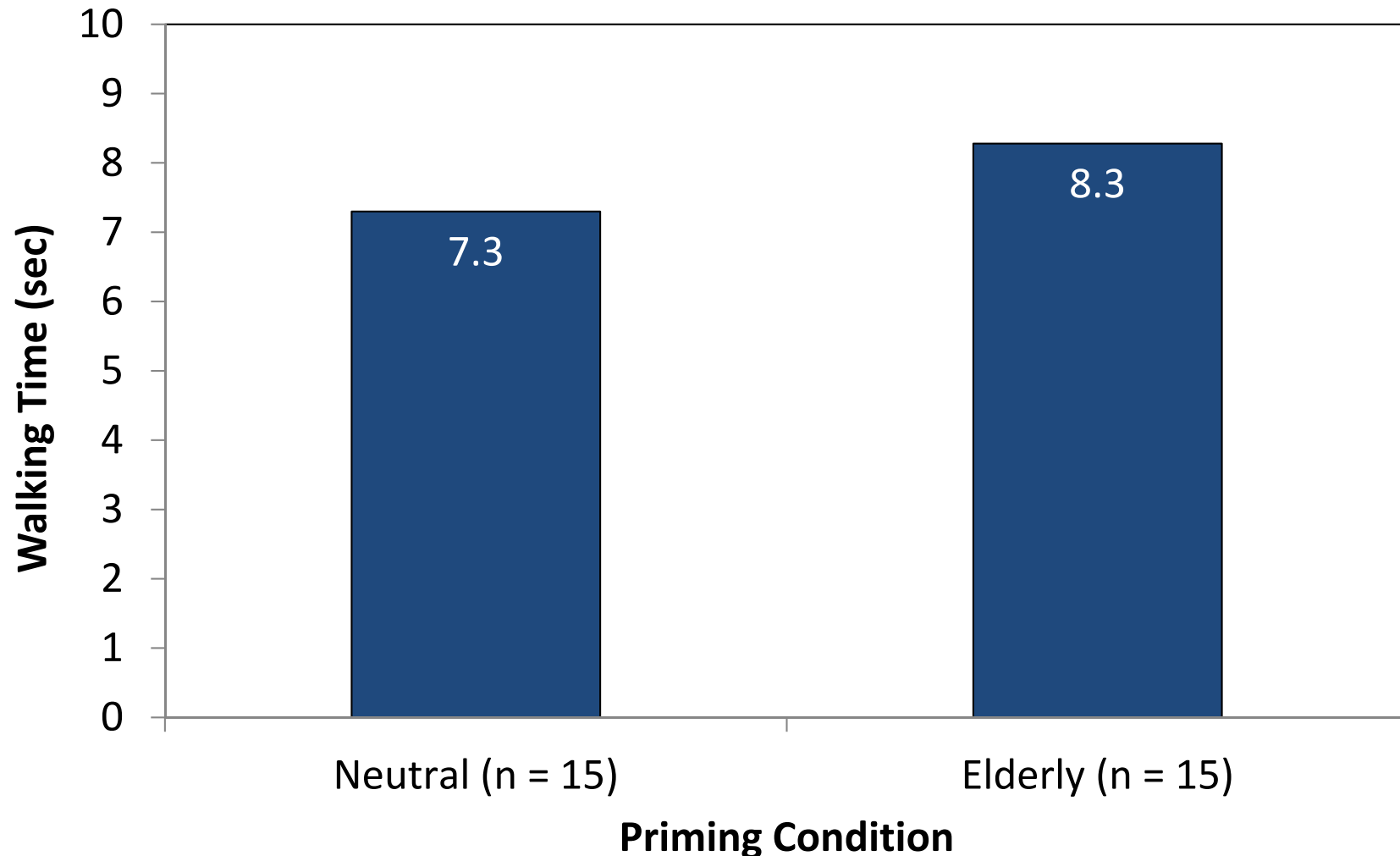


Automaticity of Social Behavior

(Bargh, Chen, & Burrows, 1996, Expts. 2a,b)

- Motivation
 - Primed stereotype automatically changes **behavior**?
- Method
 - Scrambled-sentence task (prime)
 - [him was **worried** she always]
→ She always worried him
 - [from are **Florida** oranges temperature]
→ Oranges are from Florida
 - [shoes give replace **old** the]
→ Replace the old shoes
 - Index of behavioral change:
 - **Walking time** of the corridor (9.75m) after the “Experiment”

Behavioral Effects of Activating the Elderly Stereotype

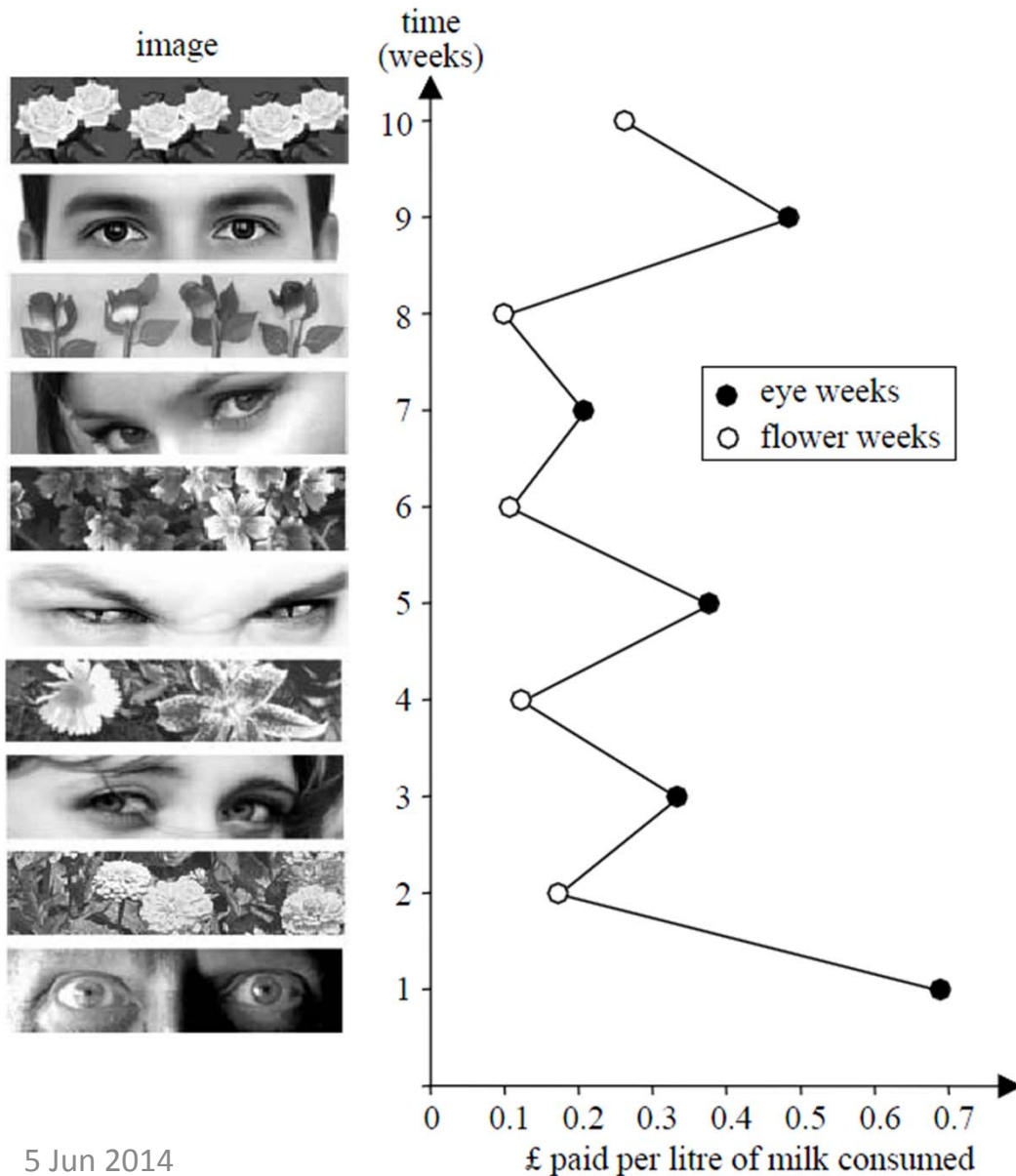


Effect of Eyes

(Bateson, Nettle, & Roberts, 2006)

- Motivation
 - **Being watched** affects (unconsciously) because reputation matters in reciprocal societies?
- Method
 - 48 members of Univ. of Newcastle, UK
 - “Honesty box” (appeal to conscience)
 - Tea (30 p), Coffee (50 p), and Milk (10 p)
 - Payment notice at eye height
 - Prices and an image (a pair of **eyes** / flowers)
 - A different image for each week

Unaware Information Affects Behavior



- Results

- Behavior changed: People paid **3-times** by an image of eyes
- **No one** reported being **aware** of the manipulation.

- Conclusion

- Unaware information can alter people's behavior

Issues of the Subliminal Effect

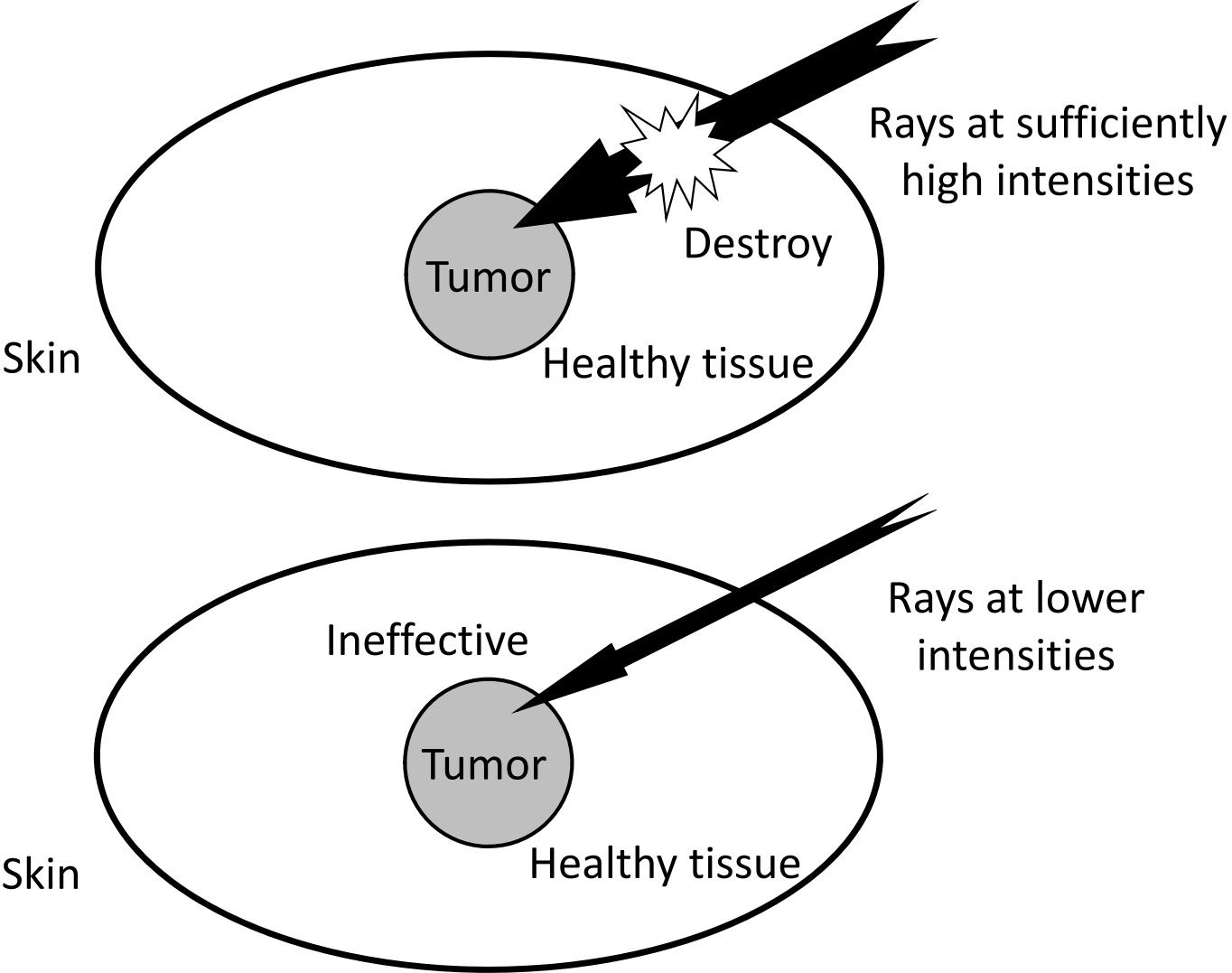
- Scope of the effect
 - Perceptual
 - Semantic
 - Affectional
 - Behavioral
 - Purchase behavior
- Inattentional vs. unrecognized stimulus
- Relevance
 - Priming effect
 - Mere exposure effect
 - False fame effect
 - Truth effect
 - Sleeper effect
 - ...

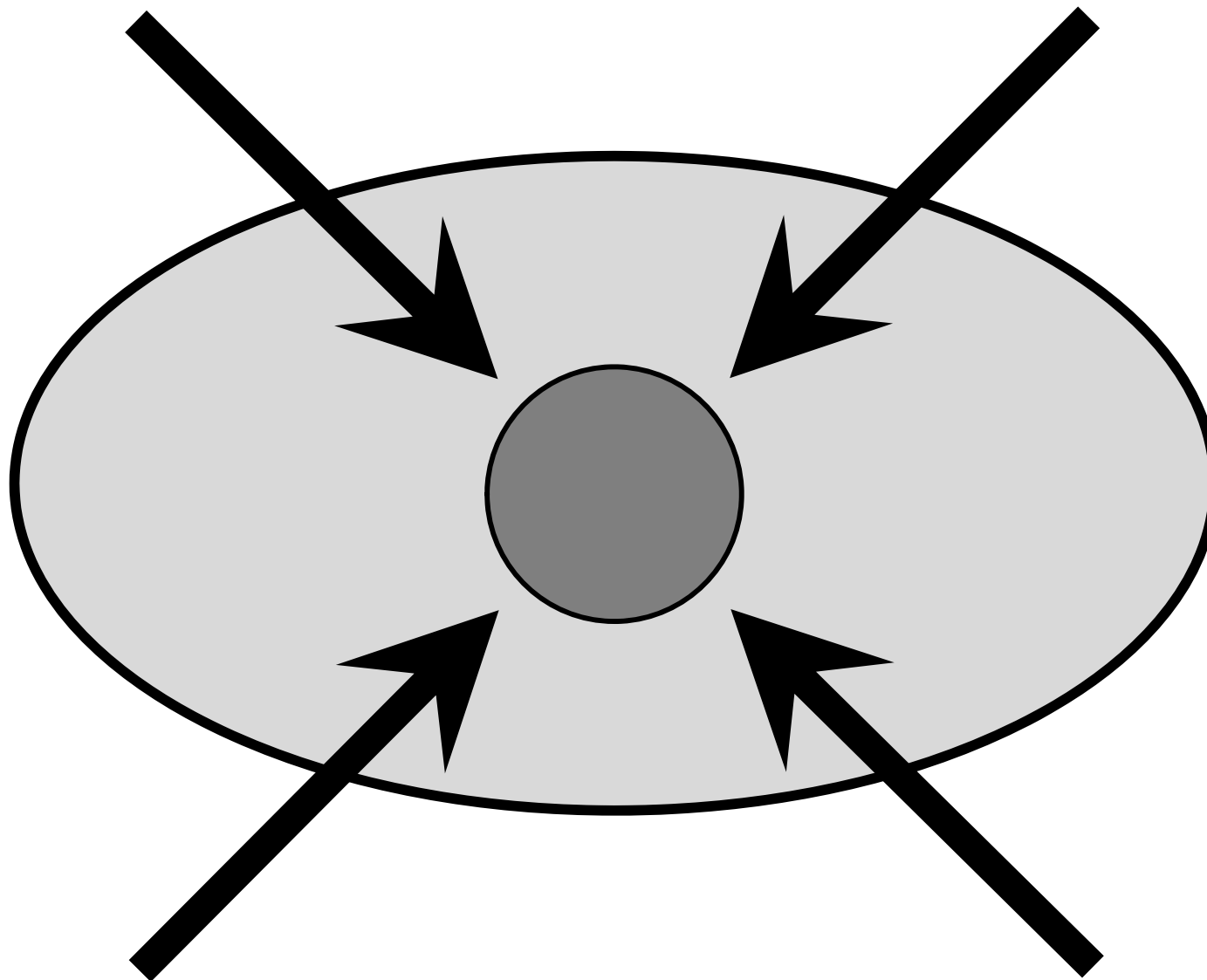
Insight Problem Solving

Radiation Problem (Duncker, 1945)

- Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient, but unless the tumor is destroyed the patient will die.
- There is a kind of ray that can be used to destroy the tumor. If the rays reach the tumor all at once at a sufficiently high intensity, the tumor will be destroyed.
- Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to healthy tissue, but they will not affect the tumor either.
- What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?

Illustration of the Radiation Problem



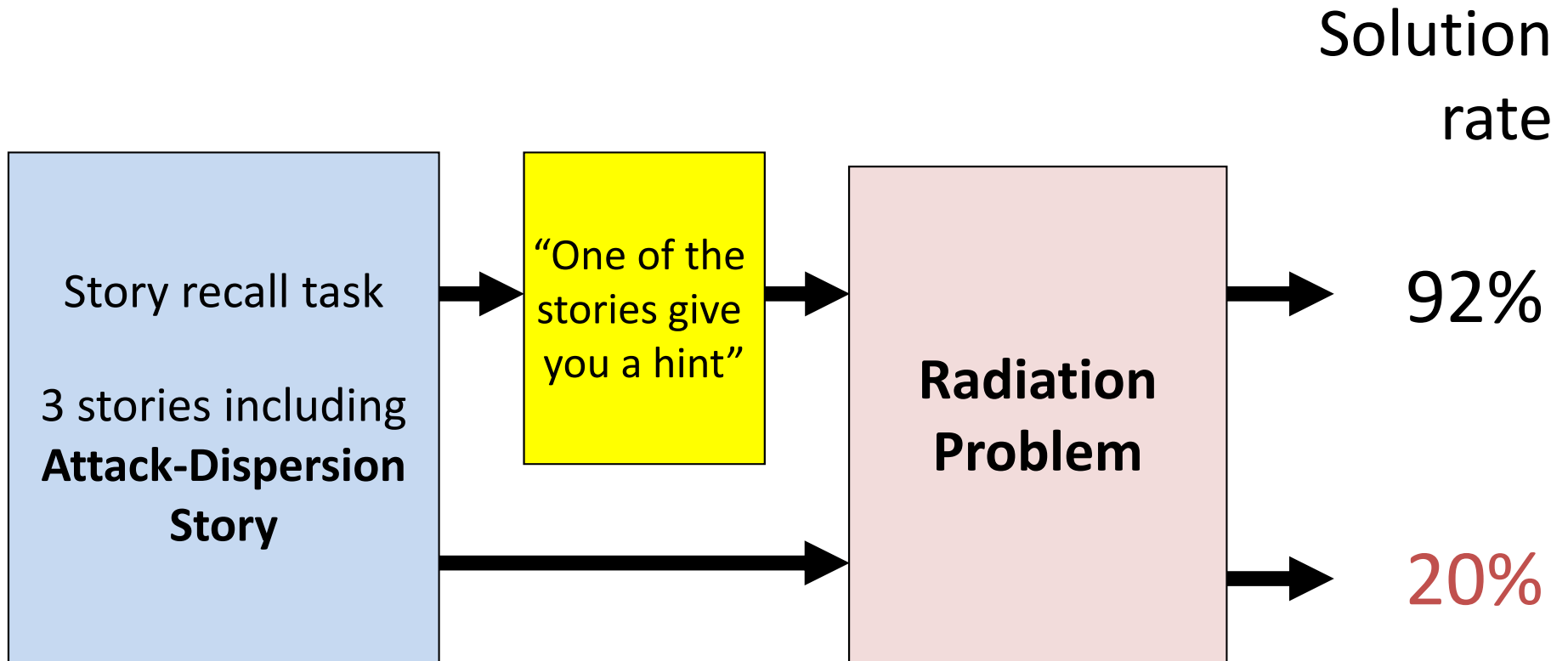


Attack-Dispersion Story

(Gick & Holyoak, 1980)

- A small country fell under the iron rule of a dictator. The dictator's fortress was situated in the middle of the country, surrounded by farms and villages. Many roads radiated outward from the fortress like spokes on a wheel. A great general arose who raised a large army at the border. The general knew that if his entire army could attack the fortress at once it could be captured. However, the ruthless dictator had planted mines on each of the roads. The mines were set so that small bodies of men could pass over them safely, but any large force would detonate the mines.
- The general, however, was undaunted. He divided his army up into small groups and dispatched each group to the head of a different road. All of the small groups passed safely over the mines, and the army then attacked the fortress in full strength. In this way, the general was able to capture the fortress and overthrow the dictator.

Gick & Holyoak (1980), Expt. 4



Awareness required for a hint to work

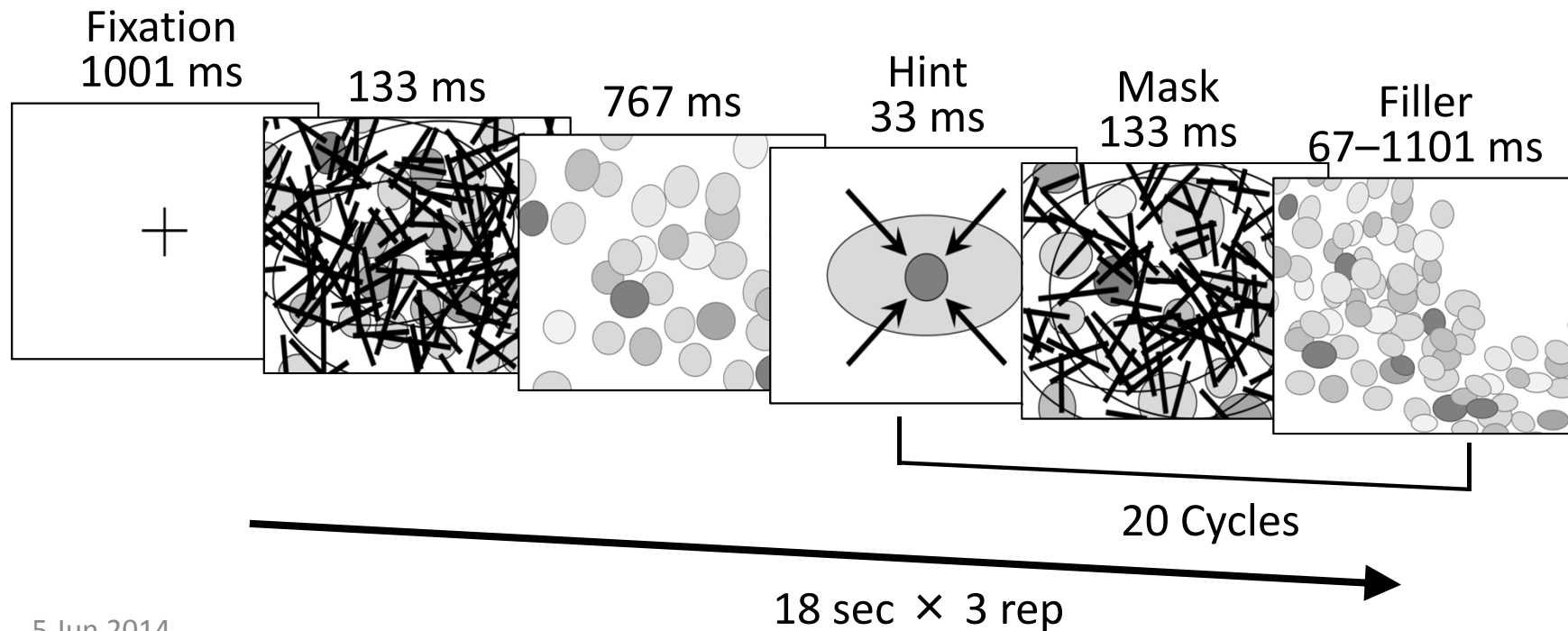
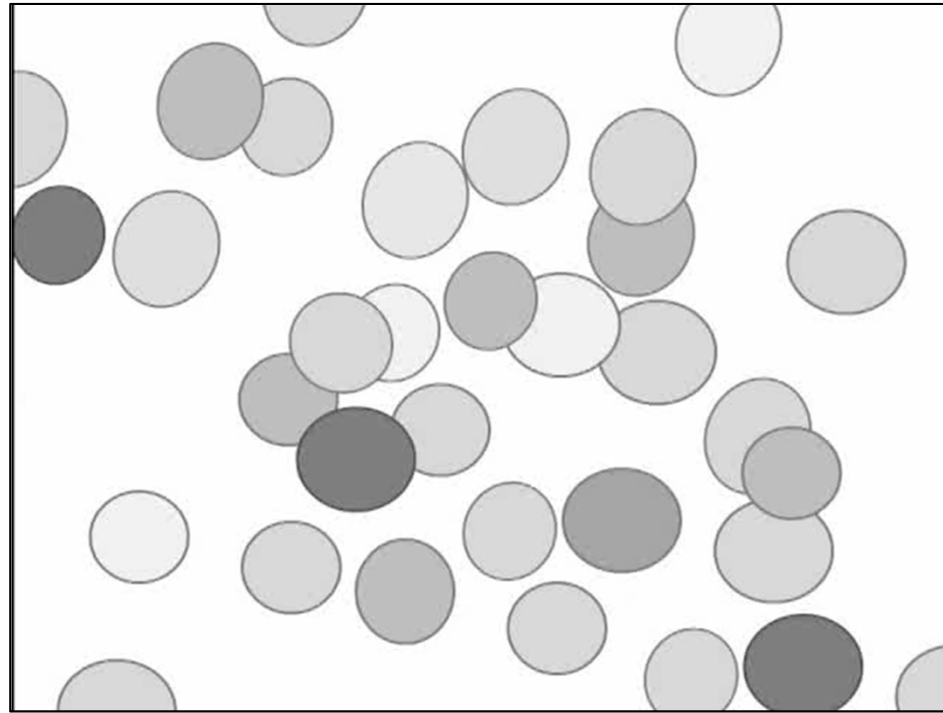
Awareness of “It’s a Hint!”

- Necessary
 - Analogy in **Radiation Problem** (Gick & Holyoak, 1980)
 - Conceptual transfer (Lockhart, Lamon, & Gick 1988; Gibson, 2004)
 - Noticing invariant features (Kaplan & Simon, 1990)
- Unnecessary
 - **The two string problem** (Maier, 1931)
 - Anagram (Rees & Israel, 1935; Safren, 1962)
 - Complex problems (Schunn & Dunber, 1996)

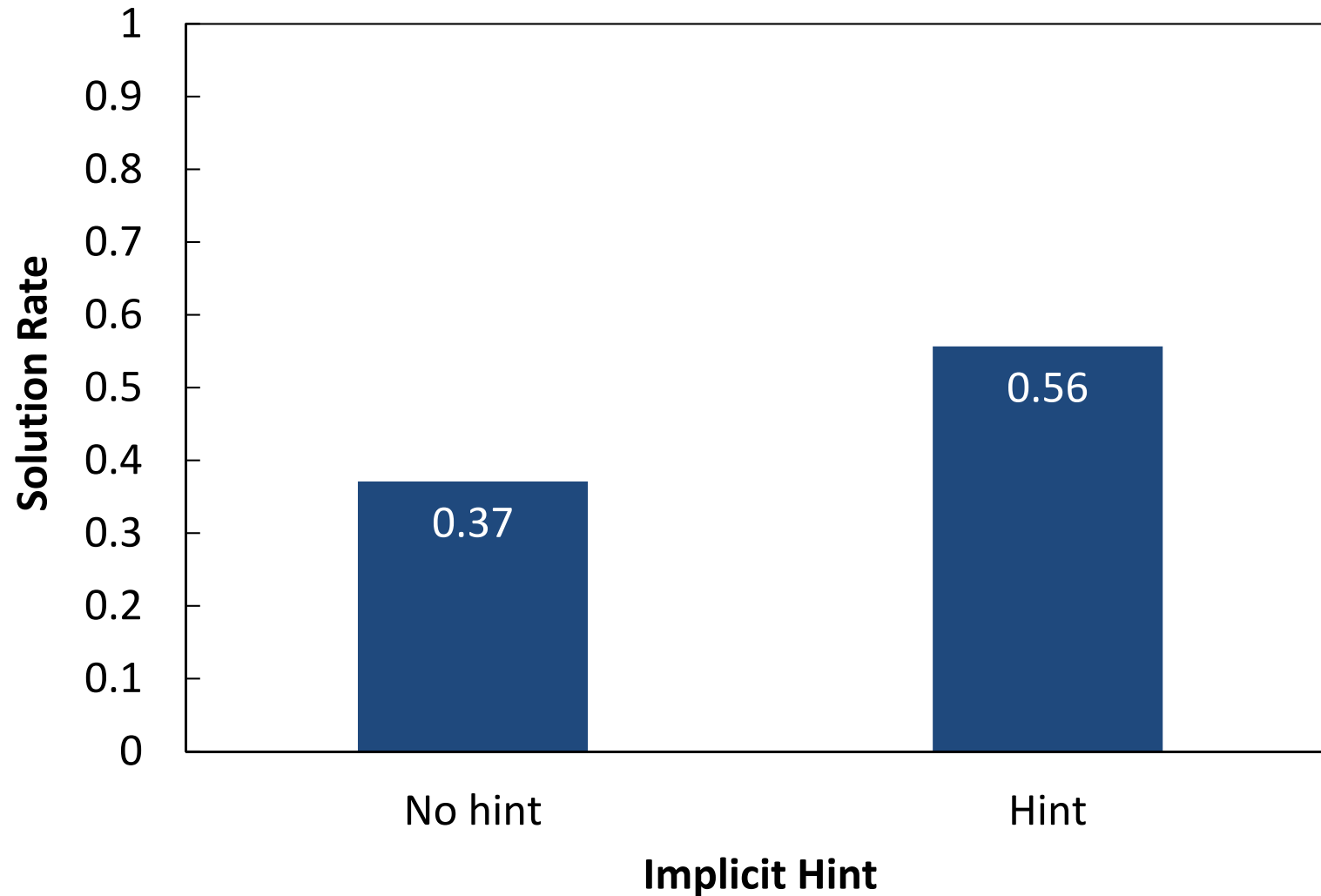
Experiment 1

(Hattori, Sloman, & Orita, 2013, *PB&R*, Expt. 1)

- Motivation
 - Subliminal priming is effective as a hint?
- Method
 - 206 undergraduates (in two classrooms)
 - The Radiation Problem (9 min time limit)
 - **Conditions:** Hint vs. No-hint
 - **Hint Condition**
 - Start → 2 min → **Subliminal movie (56 sec)** → 6 min → End
 - **No-hint Condition**
 - Start → 2 min → A dummy task (56 sec) → 6 min → End
 - A dummy calculation task: e.g., $23 + 18 = \underline{\quad}$



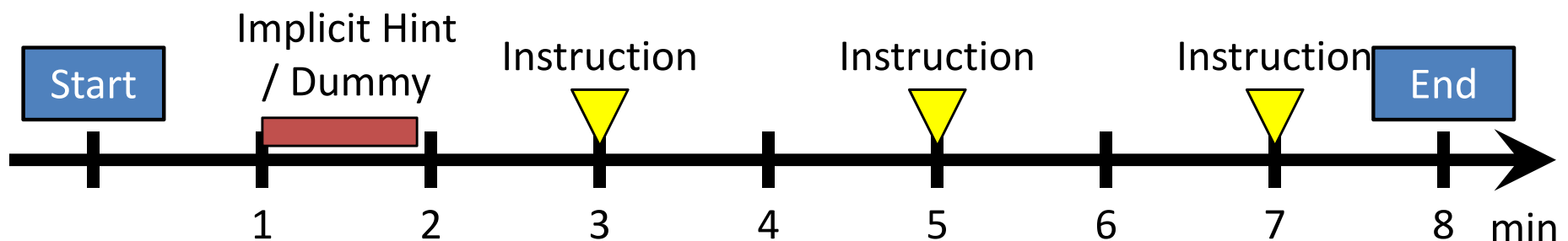
Result of Experiment 1: Subliminal Priming Effect



Experiment 2

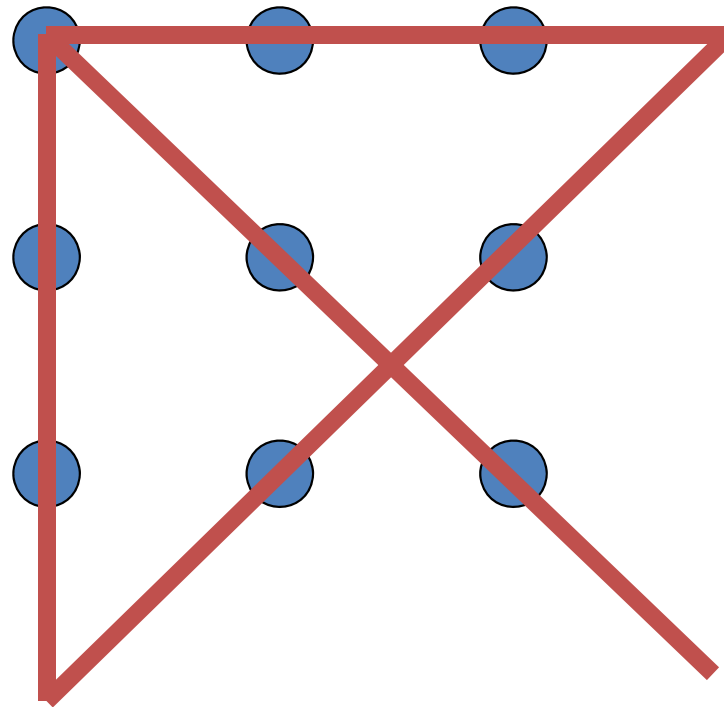
(Hattori, Sloman, & Orita, 2012, *ICP 30th*, Expt. 2)

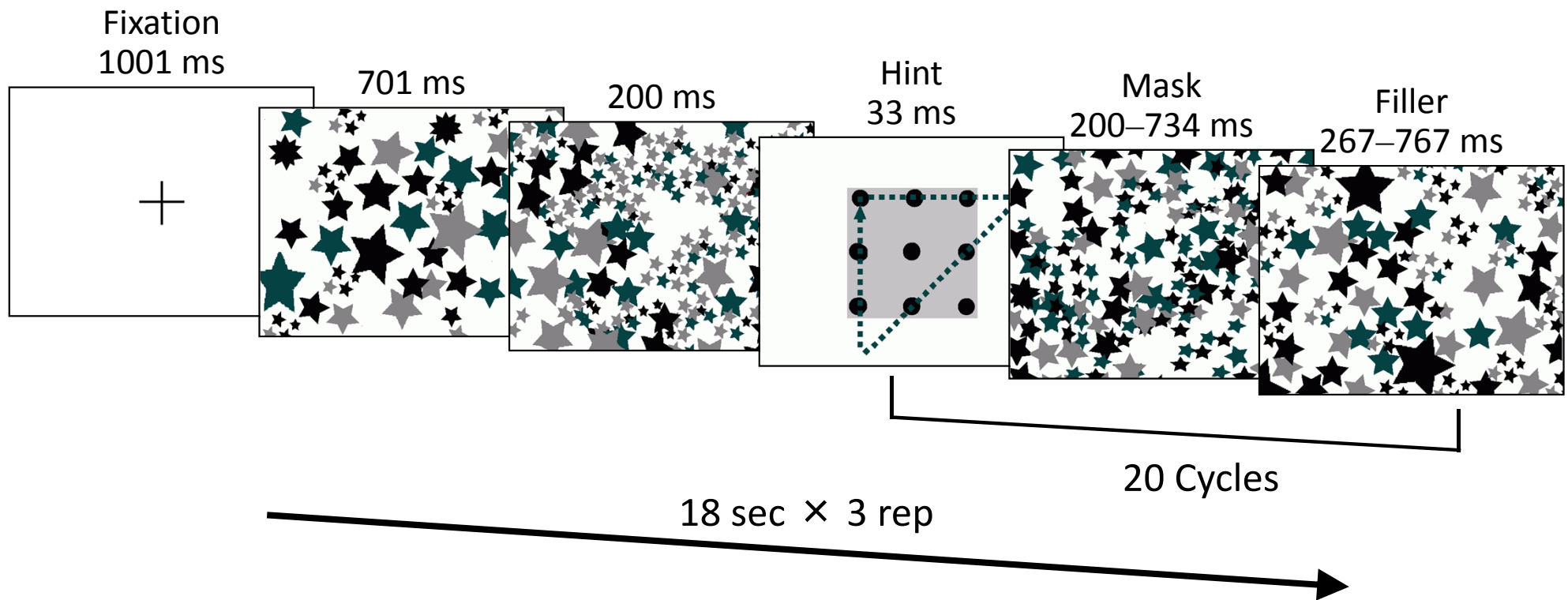
- Motivation
 - Interaction between implicit and explicit processes?
- Method
 - 203 Undergraduates (administered individually)
 - **Design (Conditions):**
 - 2 (Implicit Hint: Yes/No) × 2 (Novel Instruction: Yes/No)
 - Novel Instruction: e.g., “Think flexibly.”
 - **Procedure:**



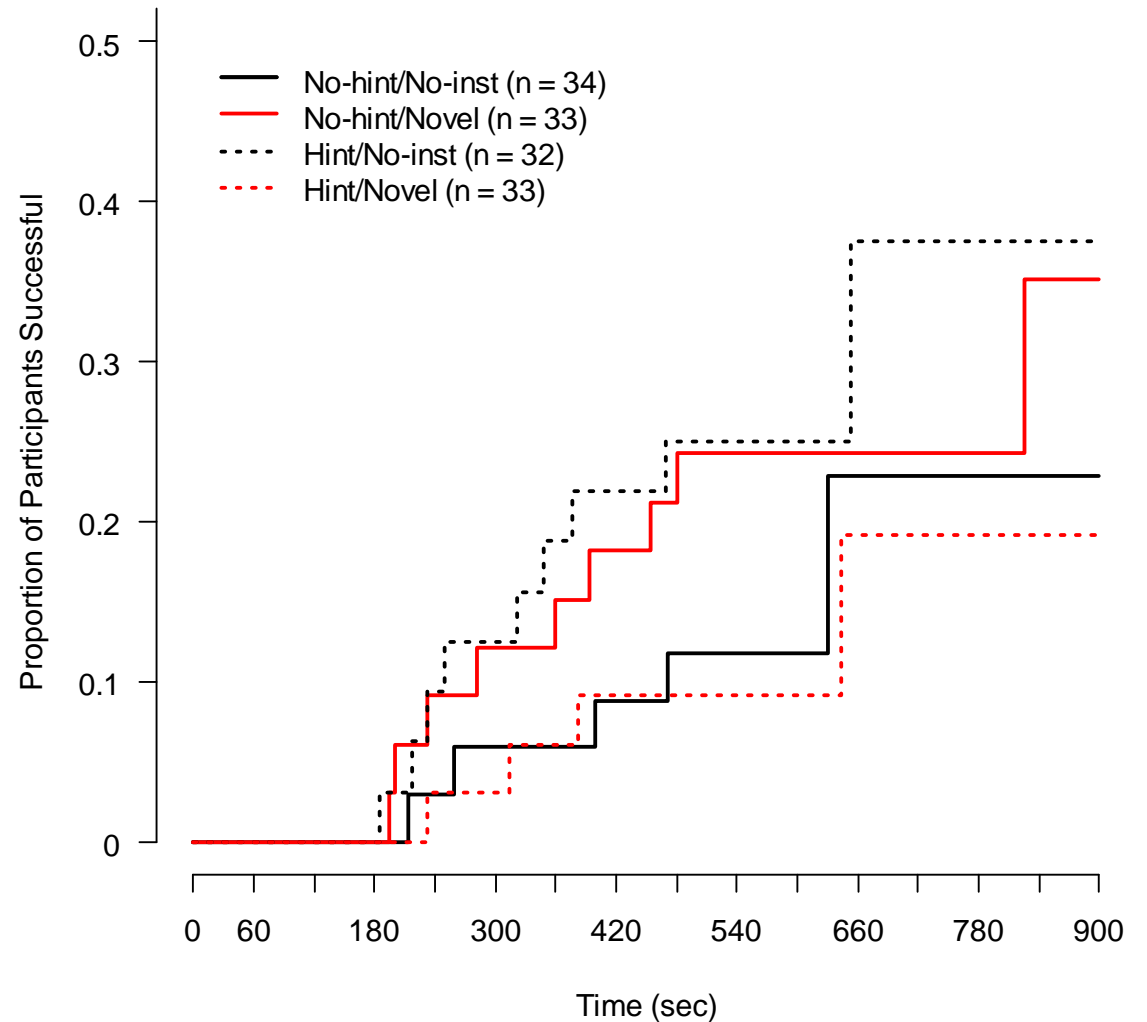
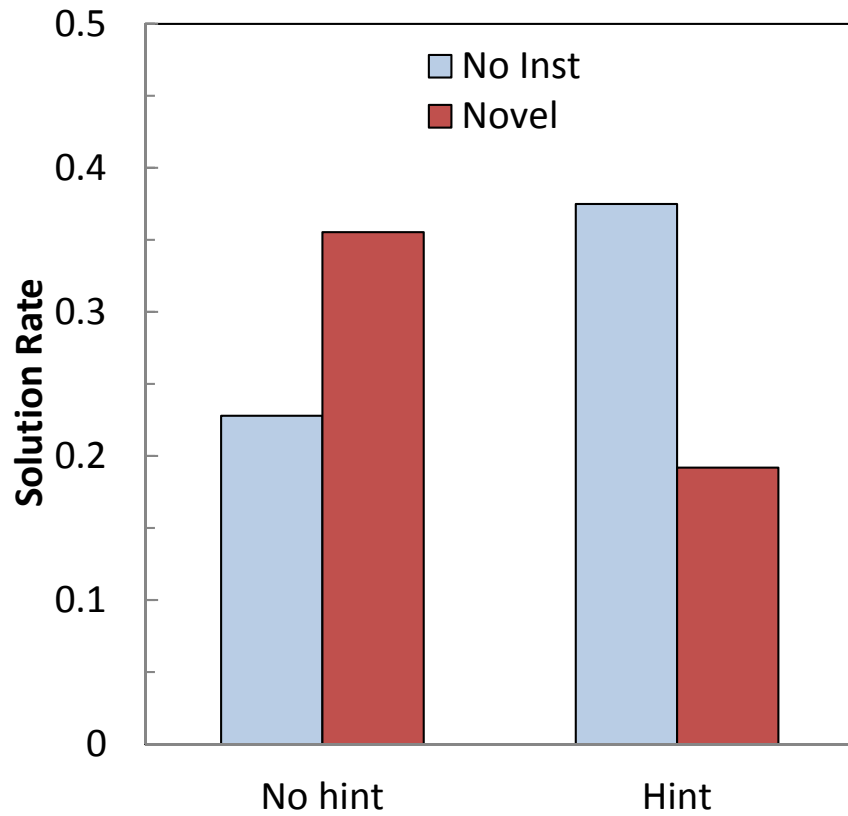
Nine Dot Problem

- Draw four lines with a single stroke that go through all nine dots.

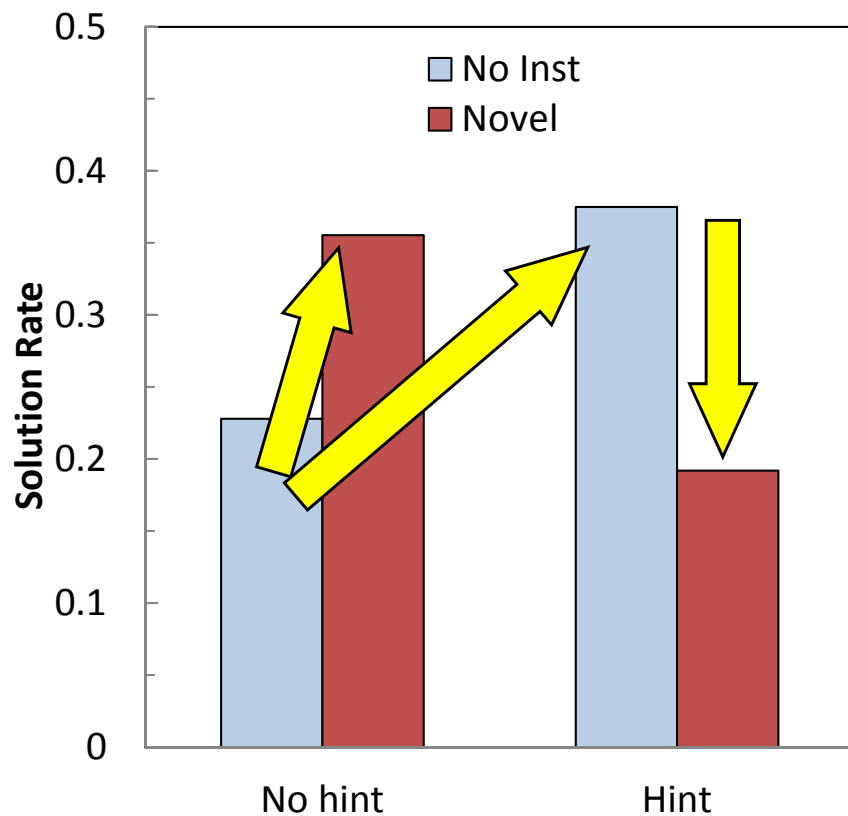




Result of Experiment 2: Conscious Control Interferes



Result of Experiment 2: Conscious Control Interferes



- Implicit hint facilitated
- Instruction facilitated
- Effects disappeared when both manipulations were introduced
- **Paradoxical inhibitory effect** of conscious control

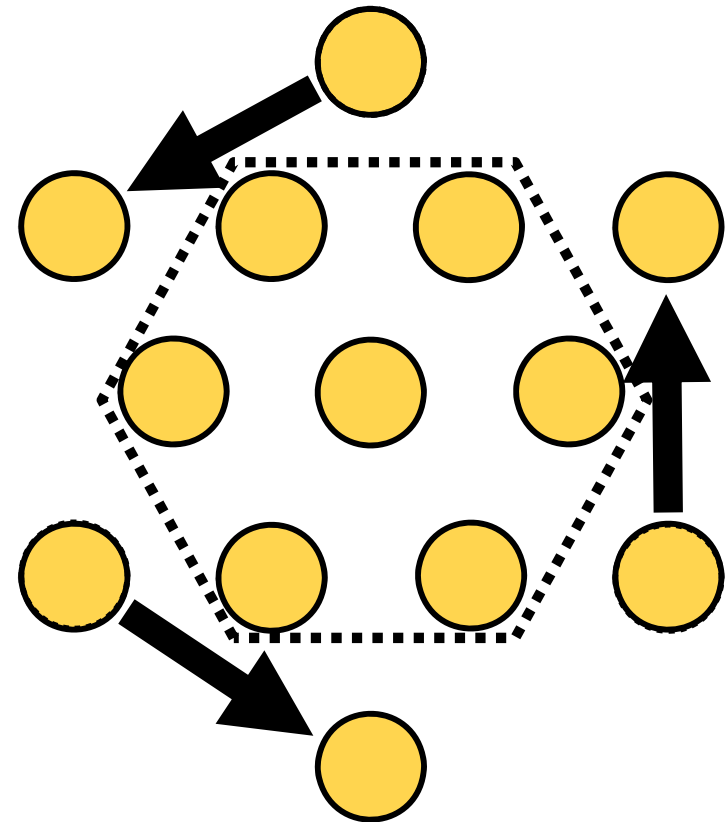
Experiment 3

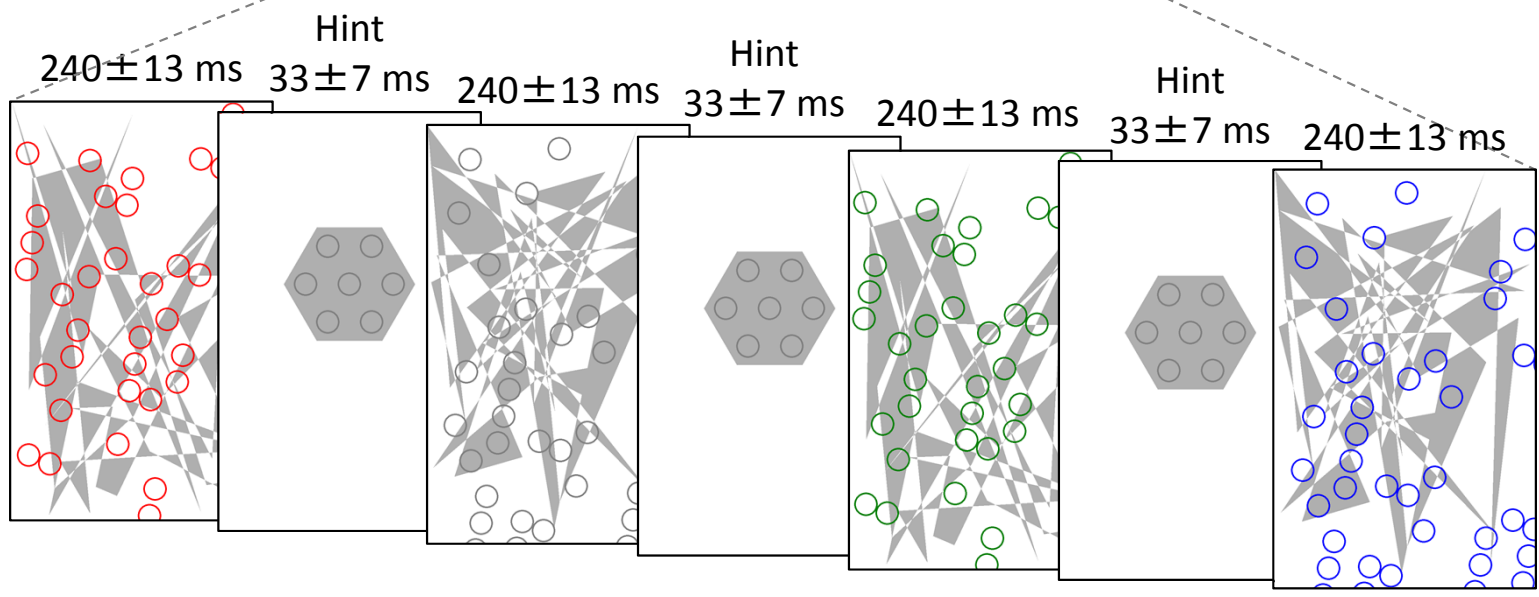
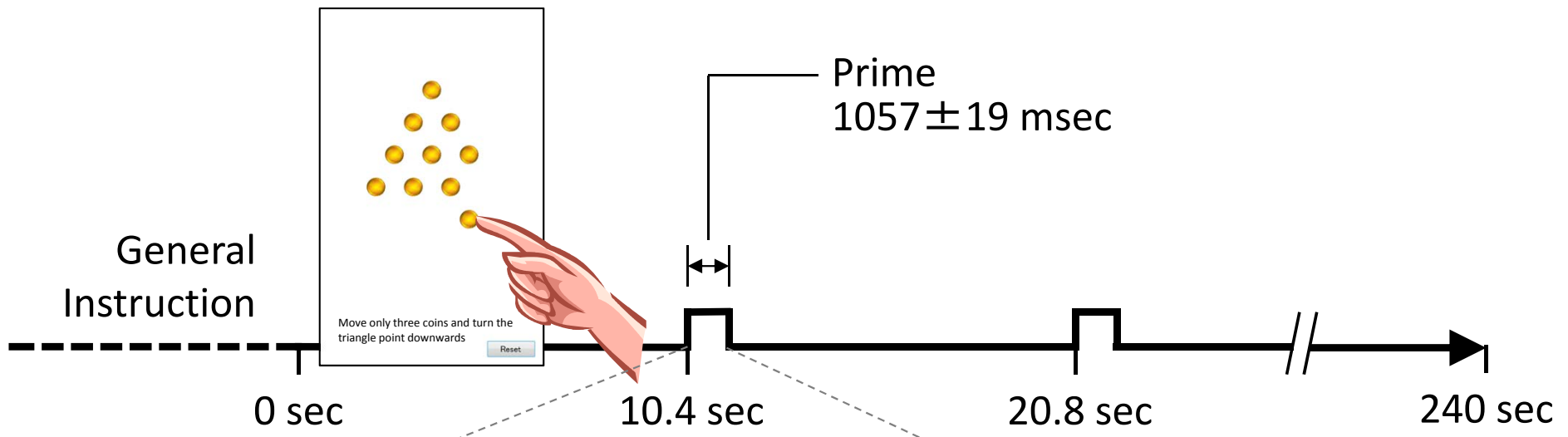
(Hattori, Sloman, & Orita, 2013, *PB&R*, Expt. 3)

- Motivation
 - More strict control – new method
 - Different task
- Method
 - 80 adults (administered individually)
 - 10 coin problem (4 min time limit)
 - **Conditions:** Hint vs. No-hint

Ten Coin Problem

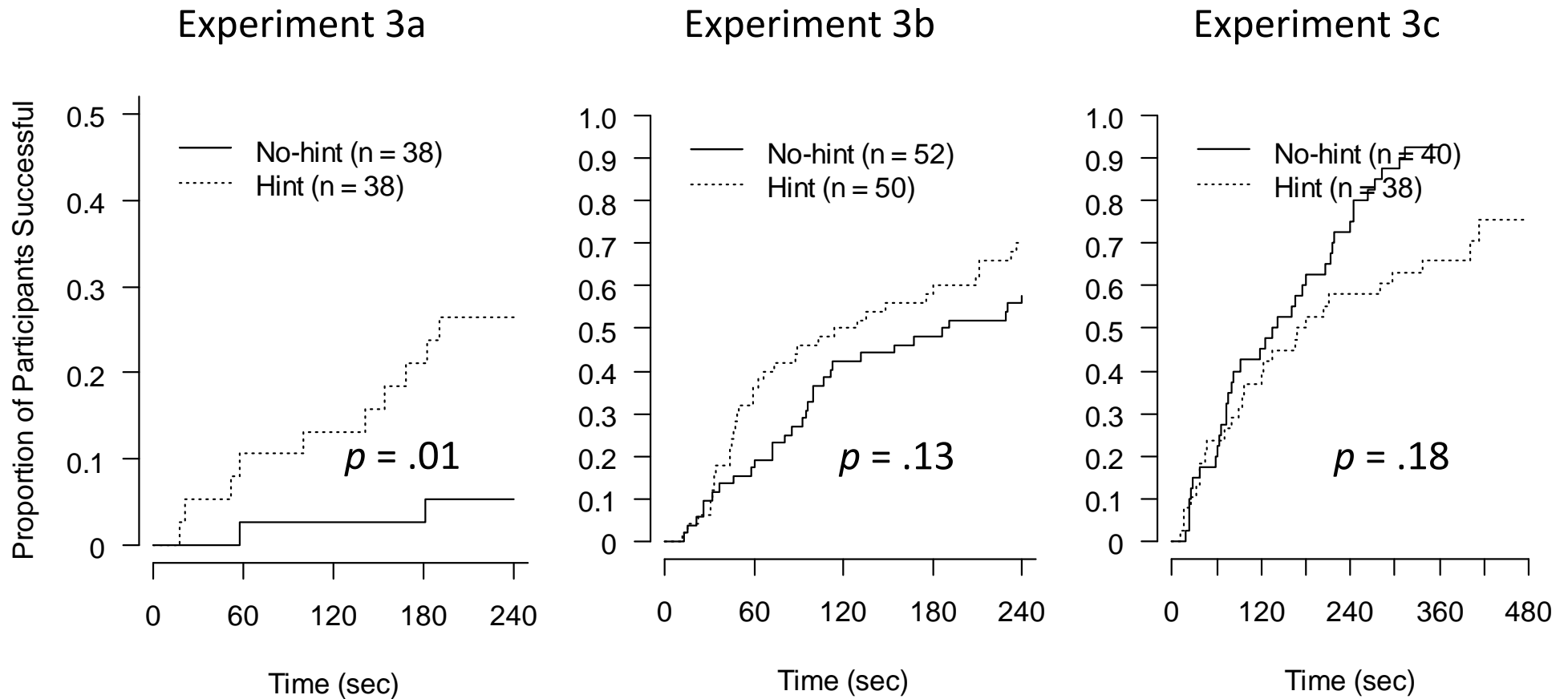
- Turn a triangle composed of 10 coins upside down by moving no more than 3 coins



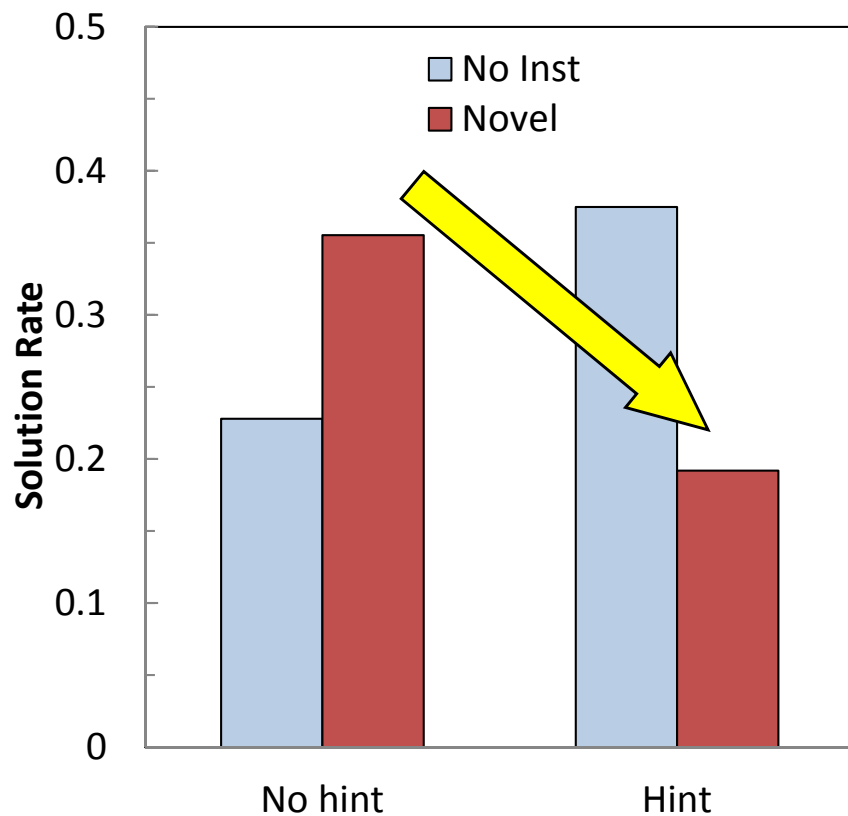




Result of Experiment 3: Subliminal Priming Affects, But...?



Result of Experiment 2: Conscious Control Interferes



- Implicit hint facilitated
- Instruction facilitated
- Effects disappeared when both manipulations were introduced
- **Paradoxical inhibitory effect** of conscious control

Hypothesis 1 - Overconcentration

- Too much focus is bad for creativity?
 - **Stuck:** Focusing blocks escape from fixation
 - **Insensitivity:** Concentration shuts out good cues

- Collateral evidence
 - Incubation
 - Many relevant phenomena...

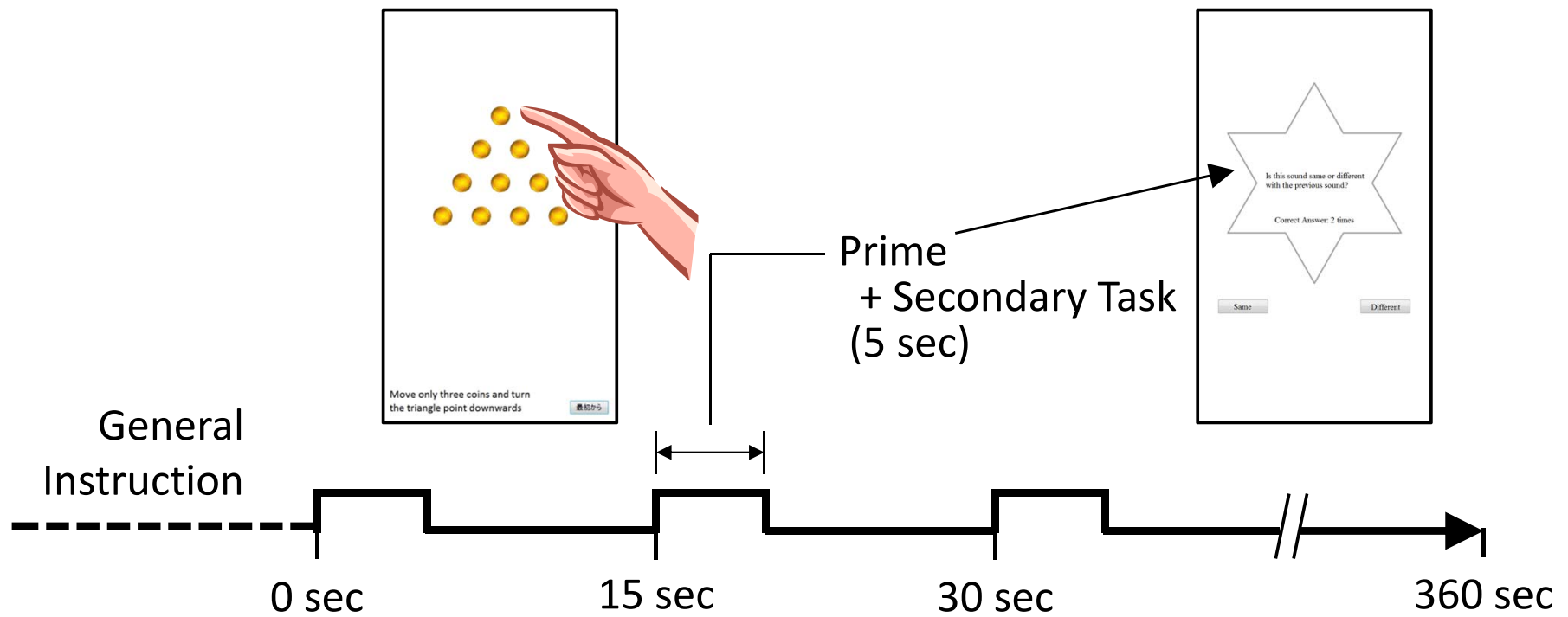
Relevant Phenomena

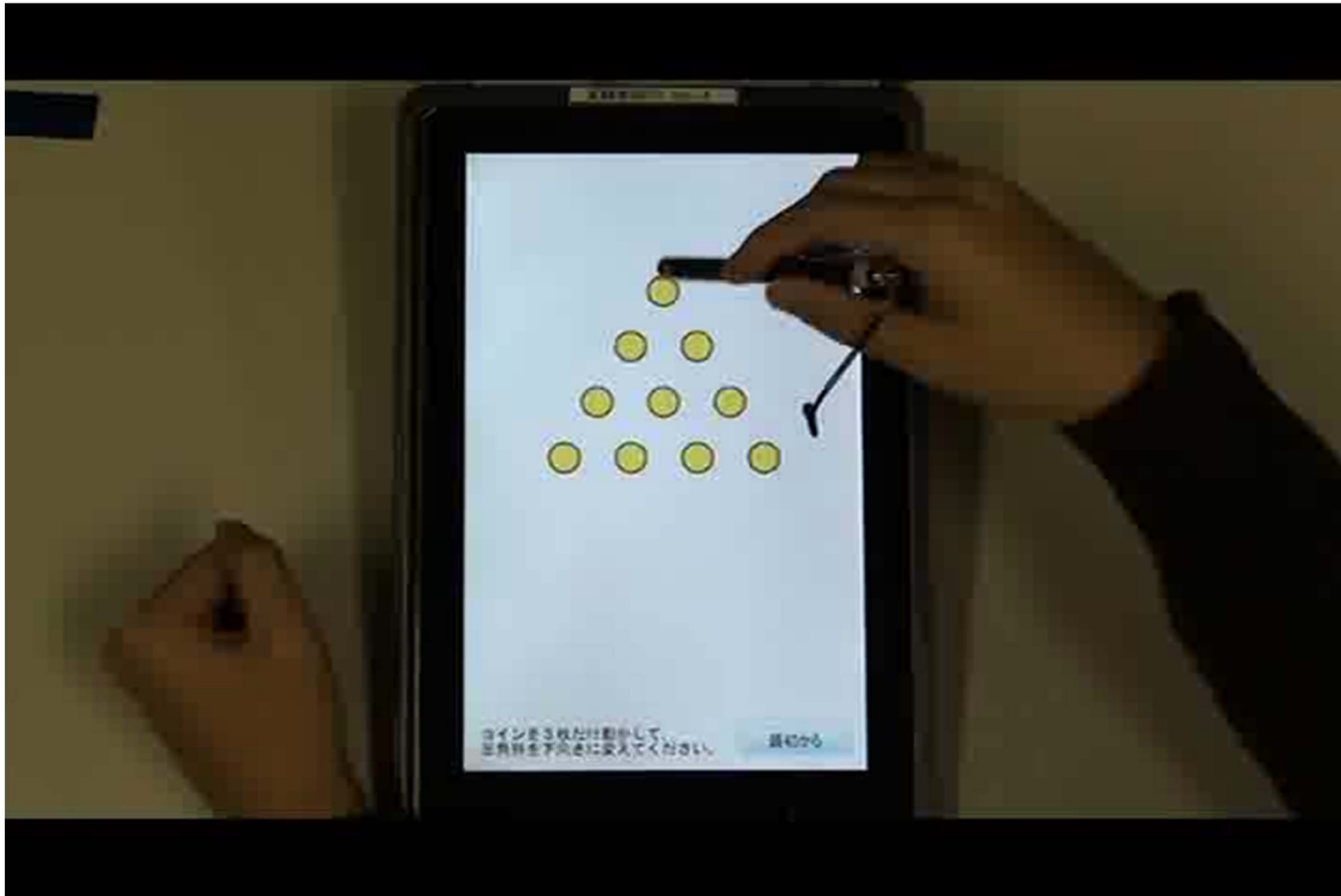
- Listening to **music** ameliorates **attentional blink** (Olivers & Nieuwenhuis, 2005, *Psychol Sci*)
- High working memory load releases **inattention blindness** (De Fockert & Bremner, 2011, *Cognition*)
- High working memory load increases **distractor processing** (Lavie, 2005, *Trends Cognit Sci*)
- **Alcohol** intoxication improves creative problem solving (Jarosz, Colflesh, & Wiley, 2012, *Conscious Cognit*)
- **Aged** person (low WMC) can be sensitive to peripheral cues (Kim, Hasher, & Zacks, 2007, *Psychonomic Bull Rev*)
- **Positive affect** increases the scope of semantic access (Rowe, Hirsh, & Anderson, 2007, *PNAS*)
- Less **mindful** students are affected by subliminal priming (Radel, Sarrazin, Legrain, & Gobance, 2009, *J Res Pers*)
- Heightened **self-focus** eliminates stereotype priming effects (Dijksterhuis & Van Knippenberg, 2000, *Soc Cognit*)

Experiment 4

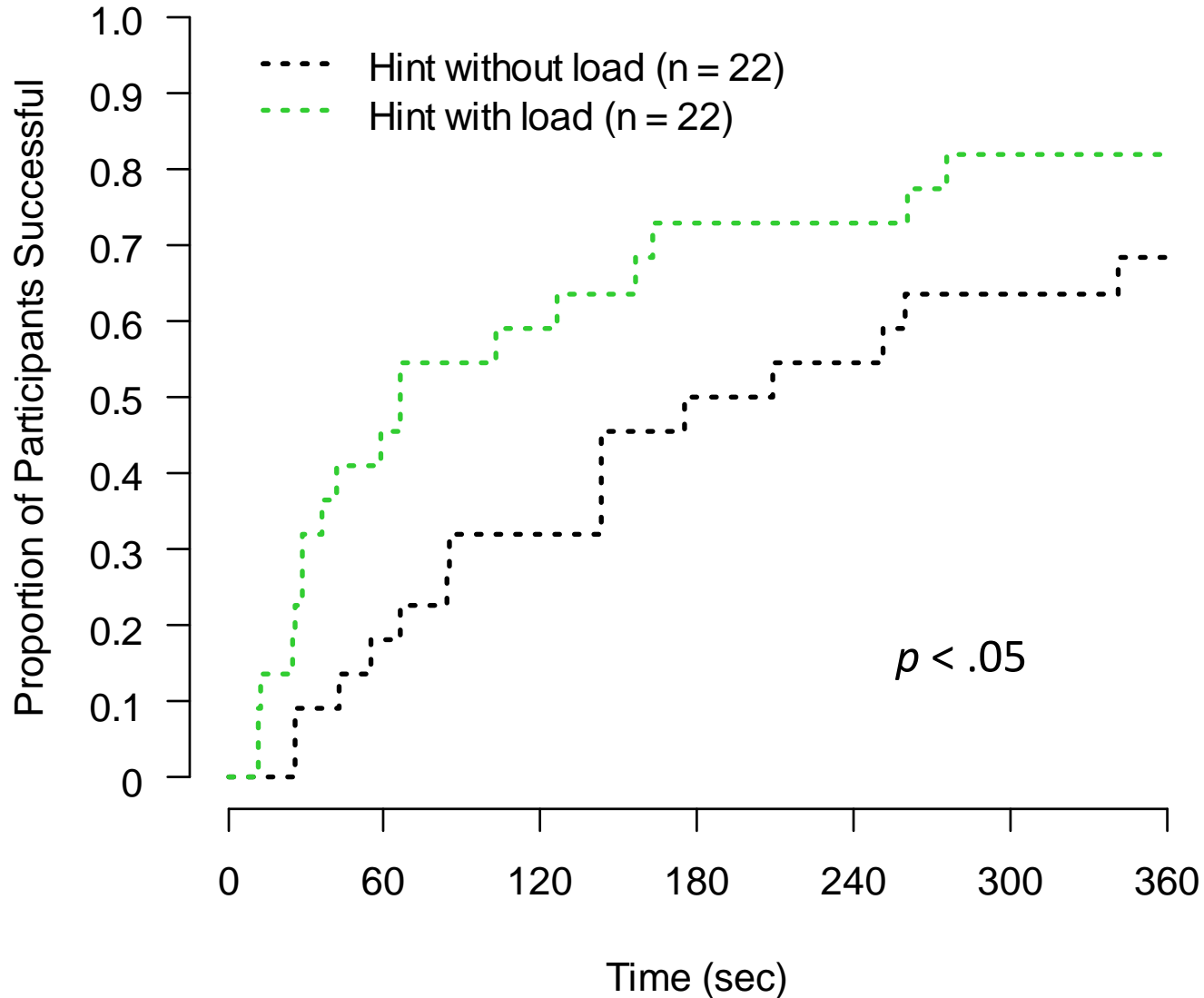
(Hattori & Orita, 2013, *JPA* 77th)

- Motivation
 - Too much focus is bad for insight problem solving?
- Method
 - 44 undergraduates (using PC in a classroom)
 - 10 coin problem (6 min time limit)
 - Supraliminal priming (inattentional hint)
 - **Conditions: Dual Task** vs. Single Task
 - Melody Identification Task





Result of Experiment 4: Cognitive Load Facilitates



Hypothesis 1 - Overconcentration

- Too much focus is bad for creativity?
 - Stuck: Focusing blocks escape from fixation
 - Insensitivity: Concentration shuts out good cues
- Collateral evidence
 - Incubation
 - Many relevant phenomena...
- Question
 - Why implicit hint hampers the effect of flexible thinking?

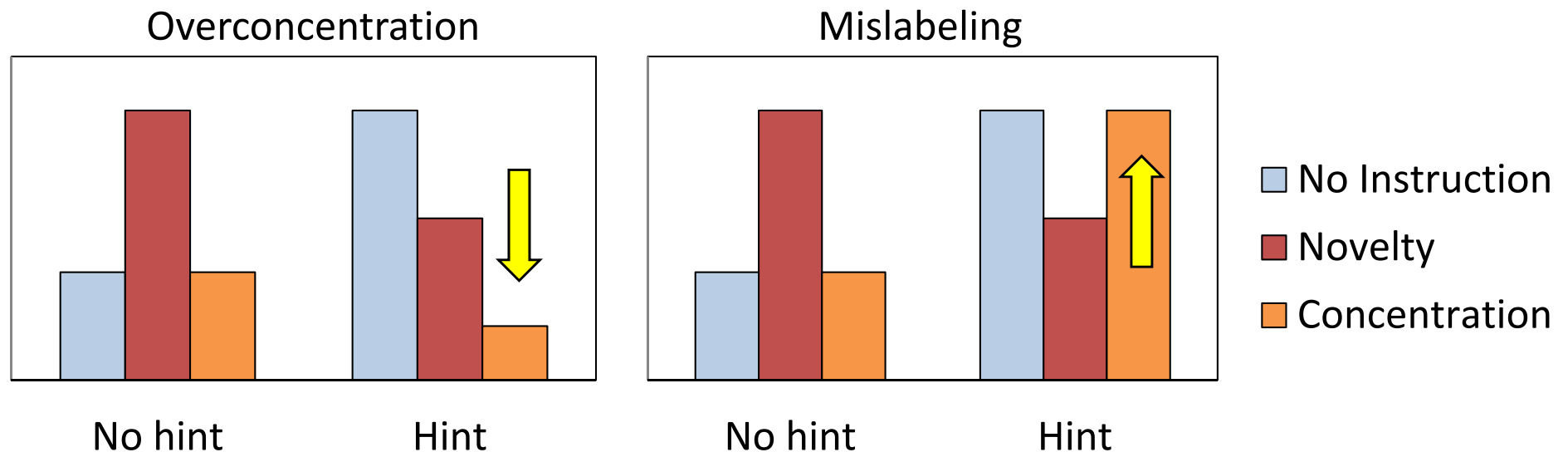
Hypothesis 2 - Mislabeling

- Subliminal stimulus can **negatively** affect
 - A cue subliminally slipped into mind is **falsely labeled** as obsolete, and subject to **inhibition**
- Relevance
 - Negative priming
 - Latent inhibition
- Implication
 - Control without monitoring
- Predictions
 - *Concentration Instructions* would be harmless
 - *Novelty Instructions* with a negative cue would be harmless

Experiment 6

(Hattori & Orita, 2014, *JSCP* 12th)

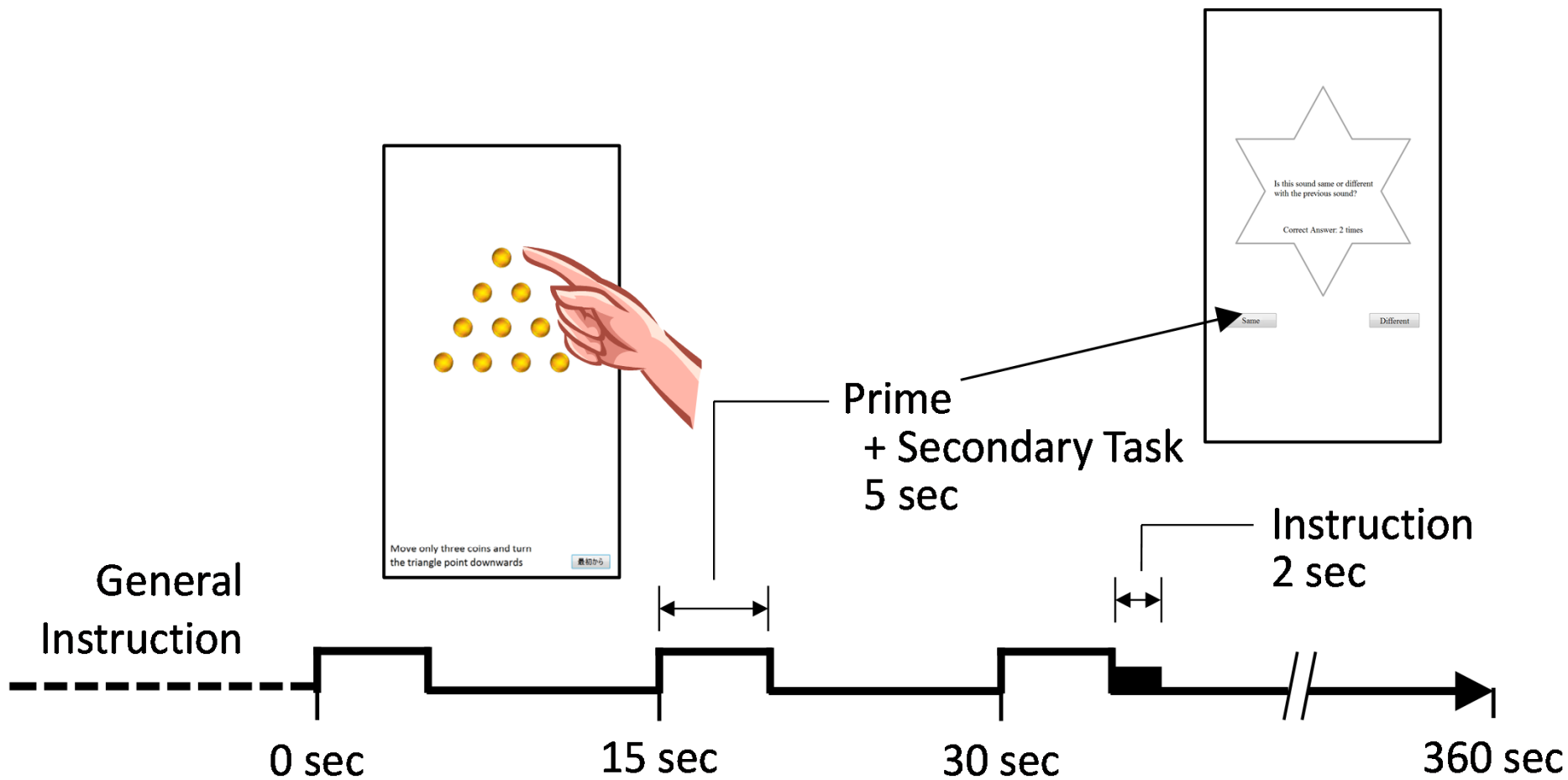
- Motivation (Predictions)
 - Overconcentration Hypothesis predicts ...
 - Stronger inhibitory effect of Concentration Instruction
 - Mislabeling Hypothesis predicts ...
 - No inhibitory effect of Concentration Instruction



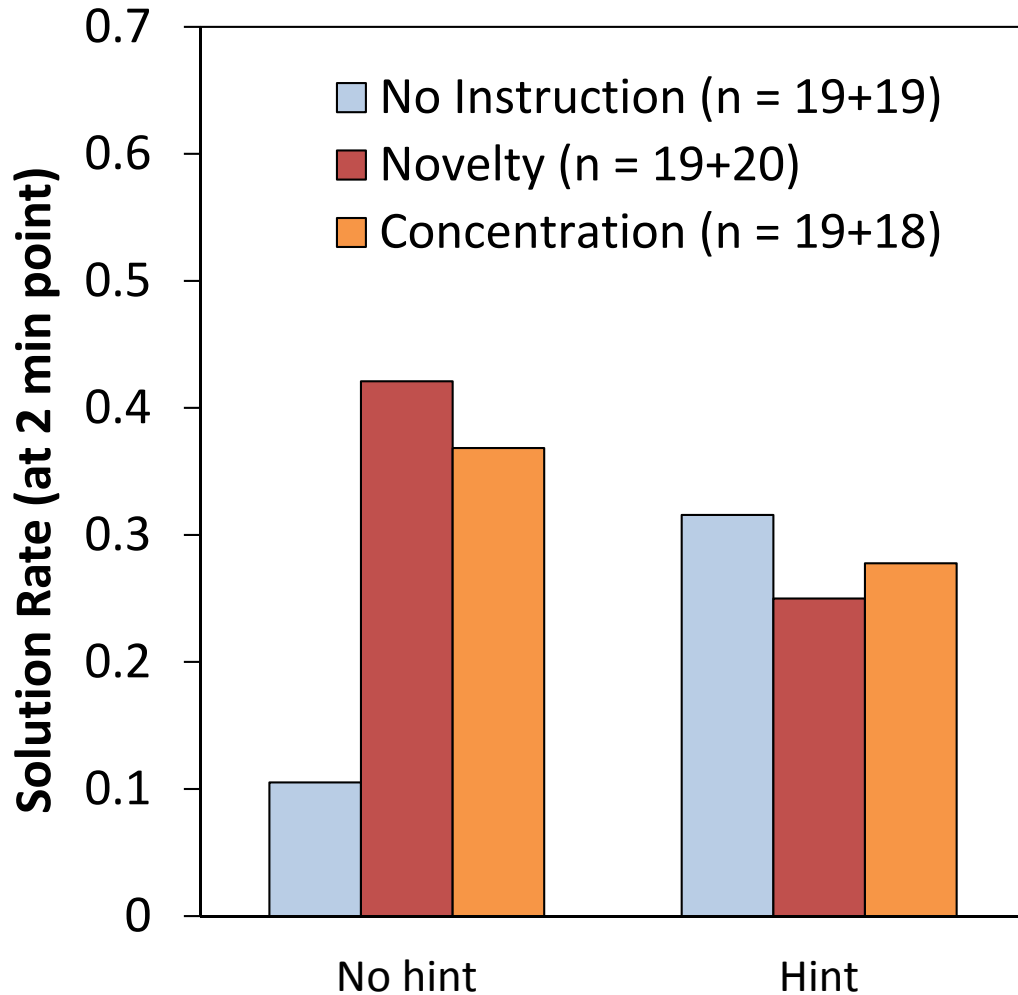
Experiment 6

(Hattori & Orita, 2014, *JSCP* 12th)

- Motivation (Predictions)
 - Overconcentration Hypothesis predicts ...
 - Stronger inhibitory effect of Concentration Instruction
 - Mislabeling Hypothesis predicts ...
 - No inhibitory effect of Concentration Instruction
- Method
 - 138 undergraduate students
 - 10 coin problem (6 min) with dual task procedure
 - **Conditions:** 2 (Hint vs. No-hint)
 - × 3 (Instruction: Novel/Concentration/None)
 - Concentrate Instructions:
e.g., “Concentrate on solving the problem”



Result of Experiment 6: Indecisive

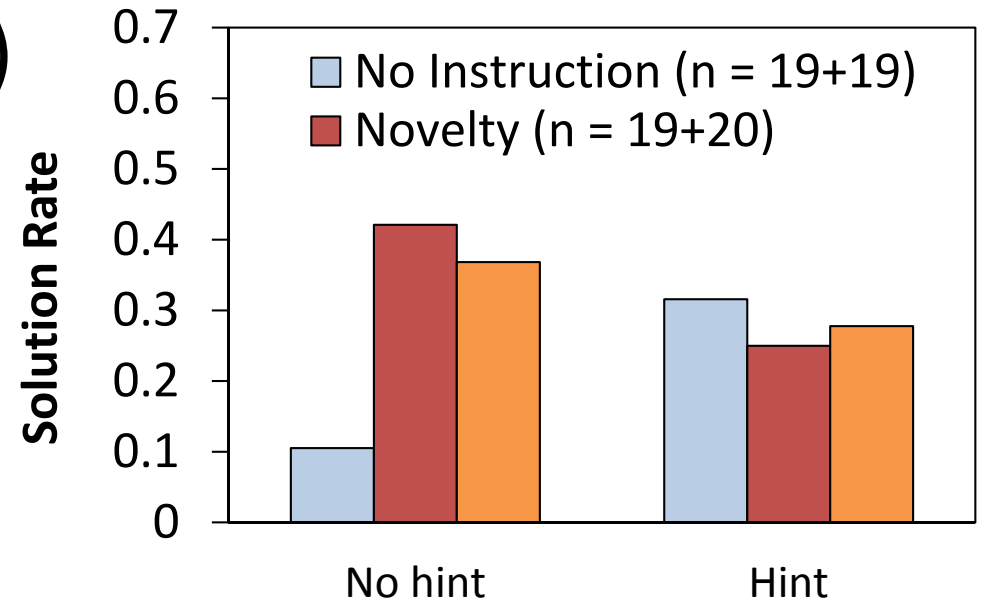


- Conc. did not cause stronger inhibition
 - Not supporting Mislabeled Hypothesis
- Conc. facilitated when no priming
 - Not supporting both hypothesis
 - Conc. inst. did not induce concentration?
- Inhibition was weaker than expected

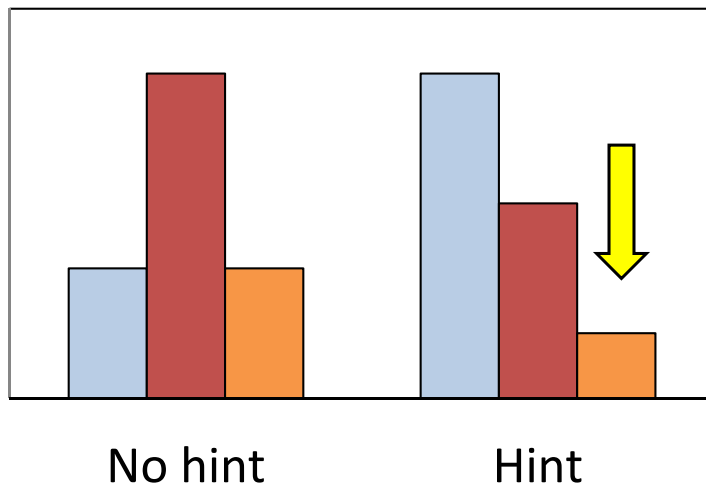
Experiment 6

(Hattori & Orita, 2014, *JSCP* 12th)

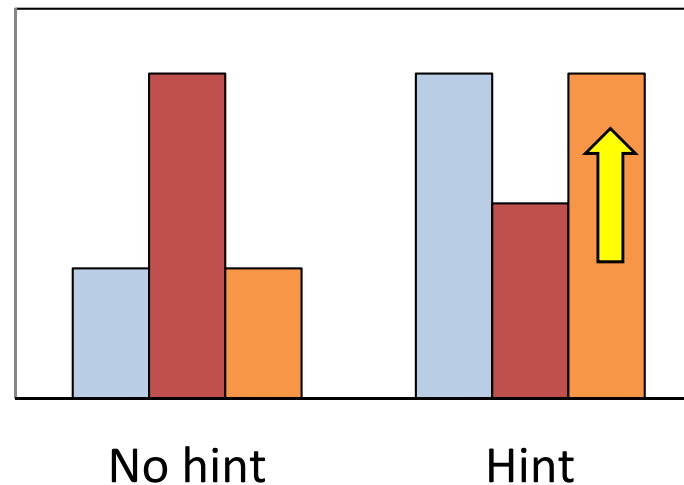
- Motivation (Predictions)
 - Overconcentration
 - Stronger inhibitory effect
 - Mislabeling
 - No inhibitory effect



Overconcentration



Mislabeling



■ No Instruction
■ Novelty
■ Concentration

Conclusions

- Subliminal effects for higher cognition
 - People implicitly make use of environmental cues
- It is not the case that subliminal priming is always effective for everyone
 - No effects for people who are not ready for that
- Two paradoxical phenomena
 - Inhibition by conscious control
 - Facilitation by cognitive load
- Two hypotheses
 - Overconcentration
 - Mislabeleding
- More data ...