

THE IMPACT OF NON-OCCURRENT EVENTS IN CAUSAL INDUCTION

IKUKO HATTORI

RITSUMEIKAN UNIV.

MASASI HATTORI

RITSUMEIKAN UNIV.

TATSUJI TAKAHASHI

TOKYO DENKI UNIV.

DAVID OVER

DURHAM UNIV.

CAUSAL INDUCTION BASED ON CONTINGENCY

If Mary takes a diet pill (p),
she loses her weight (q).

	Effect (q)	
Cause (p)	Lose weight (P)	Not lose weight (not-Q)
Take a pill (p)	a	b
Not take a pill (not-p)	c	d

The a, b, c and d cells denote the frequencies of event status.

COMPETITIVE MODELS FOR CAUSAL INDUCTION

- ΔP rule (Jenkins & Ward, 1965)
- Rescorla-Wagner model (Rescorla & Wagner, 1972)
- Weighted ΔP model (Anderson & Sheu, 1995)
- Power PC model (Cheng, 1997)
- Dual-factor heuristic model (DFH) (Hattori M., 2001)
- Bayes-net model (Griffiths & Tenenbaum, 2005)
- etc.

→ discrepancies in experimental results

D-CELL NEGLECT: DIFFERENCE IN CAUSAL IMPACT

If Mary takes a diet pill (p), she loses her weight (q).

$$\Delta P = P(q | p) - P(q | \neg p) = \frac{a}{a+b} - \frac{c}{c+d} > 0$$

- **Difference in causal impact: $a > b > c > d$**
(Anderson & Sheu, 1995)

	Effect (q)	
Cause (p)	Lose weight (q)	Not lose weight (not- q)
Take a pill (p)	a	b
Not take a pill (not- p)	c	d

d-cell
neglect

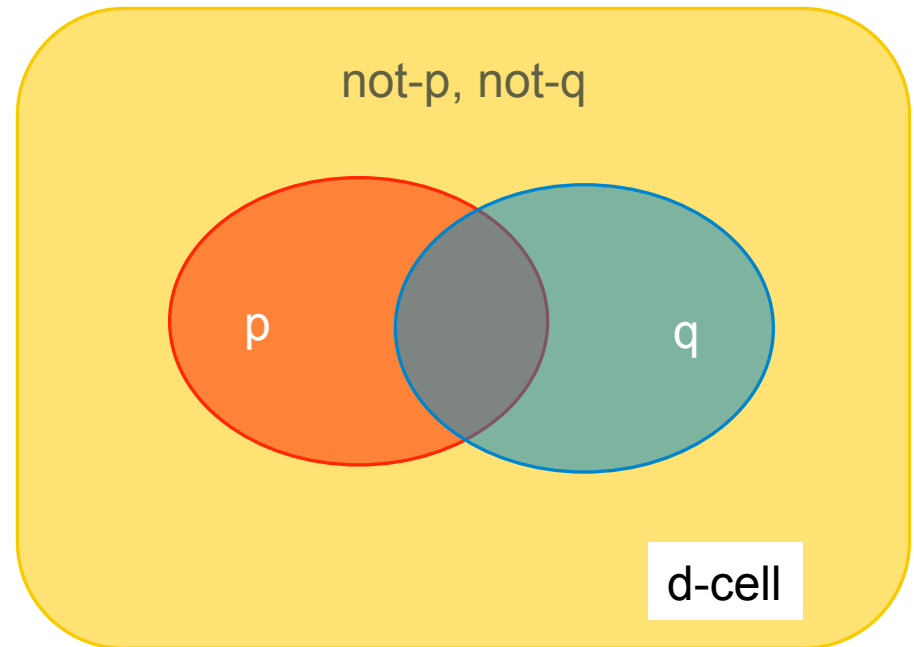
AMBIGUITY OF NON-OCCURRENT EVENTS

If Mary takes a diet pill (p), she loses her weight (q)

- **What is the “not-p” case?**

What if she ...

- drinks coffee?
- eats a cake?
- watches TV?
- takes bath?
- takes a nap?
- etc.



D-CELL NEGLECT AND CAUSAL STRENGTH MEASURES

ΔP rule (Jenkins & Ward, 1965)

$$\Delta P = P(q | p) - P(q | \neg p) = \frac{a}{a + b} - \frac{c}{c + d}$$

DFH model (Hattori M., 2001)

$$H = \sqrt{P(q | p)P(q | \neg p)} = \frac{a}{\sqrt{(a + b)(a + c)}}$$

AB-FRAMES

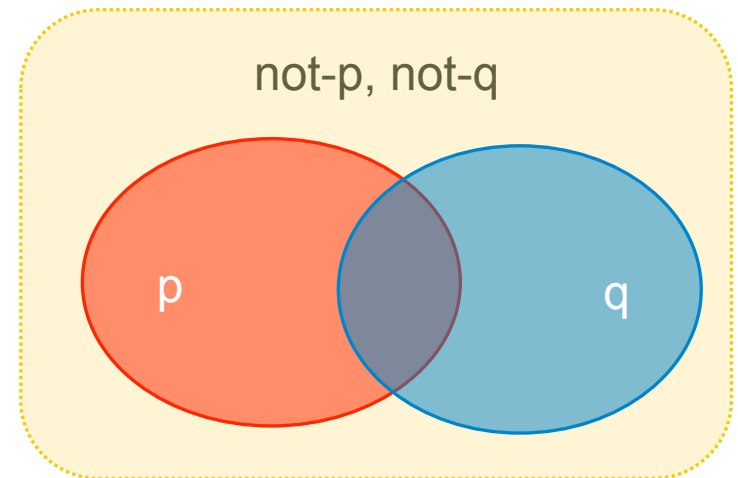
	A-frame (attentional)	B-frame (balanced)
	Positivity focus	Comparative view
	Symbolically unexchangeable	Symbolically exchangeable
	Relevance mode	Differentiation mode
	D-cell disregard	D-cell respect (DP-like)
	Monopolar causality (null/effective)	Bipolar causality (preventive/generative)
System	Heuristic	Analytic
Invasiveness	Observation	Intervention
Negation	Explicit negation	Implicit negation
Property	Attribution	Action
Dynamism	Static	Kinetic
Commitment	Uncommitted	Committed
Activeness	Passive	Active
Base rate	Rare	Non-rare (moderate)

UNEXCHANGEABLE CAUSES: (FIGURE-GROUND)

Mary wants to lose her weight.

She is now wondering whether she should take a diet pill or not.

If she takes pill A (p), she loses her weight (q).

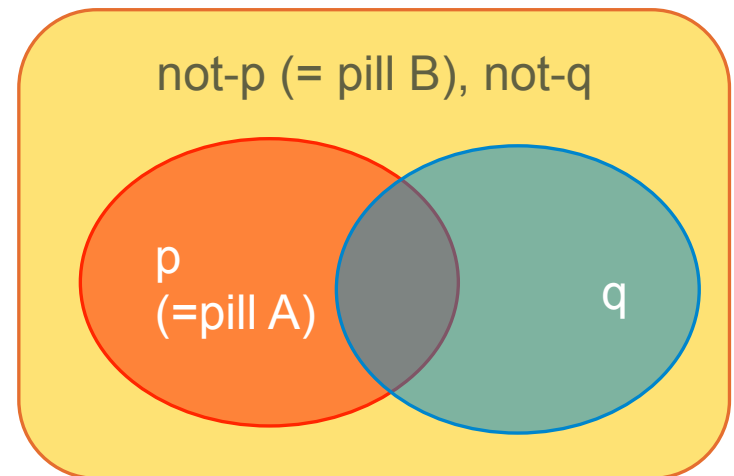


EXCHANGEABLE CAUSES

Mary has decided to take a diet pill to lose her weight.

She is now wondering whether she should take the pill A or the other one, B.

If she takes pill A (p), she loses her weight (q).



AB-FRAMES

	A-frame (attentional)	B-frame (balanced)
	Positivity focus	Comparative view
	Symbolically unexchangeable	Symbolically exchangeable
	Relevance mode	Differentiation mode
	D-cell disregard	D-cell respect (DP-like)
	Monopolar causality (null/effective)	Bipolar causality (preventive/generative)
System	Heuristic	Analytic
Invasiveness	Observation	Intervention
Negation	Explicit negation	Implicit negation
Property	Attribution	Action
Dynamism	Static	Kinetic
Commitment	Uncommitted	Committed
Activeness	Passive	Active
Base rate	Rare	Non-rare (moderate)

EXPERIMENT1: DESIGN AND PREDICTION

	Exchangeable (XC)	Figure-Ground (FG)
Intervention (IV)	Delta-P like	?
Observation (OB)	?	d-cell neglect

- **XC vs. FG: Between participants**
- **IV vs. OB: Between participants**
- **68 undergraduates participated in exp. 1**

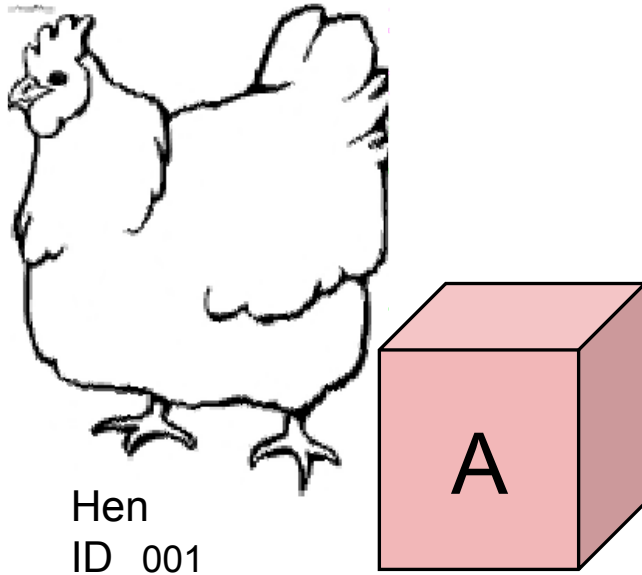
EXPERIMENT1: MATERIAL

- **Judgment about the Causal Strength**
 - The influences of the feeding products for hen on its egg production

	Cause	Effect
Exchangeable (XC)	Hen feed (A / B)	Egg (Yes / No)
Figure-Ground (FG)	Supplement (Give / Not)	Egg (Yes / No)

EXAMPLE OF STIMULI: EXCHANGEABLE

Com. A's hen feed was given



An egg was laid
tomorrow morning.

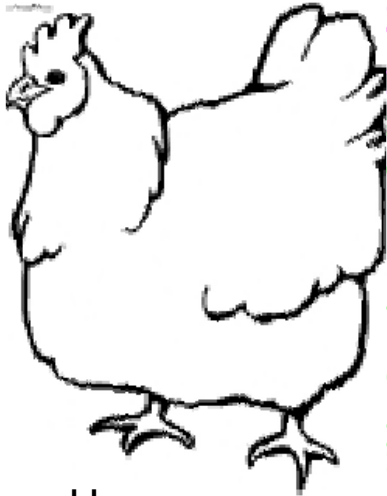


Please tick off two correct events you observed above.

- Fed Company A's sample
- Fed Company B's sample
- Laid an egg
- Did not lay an egg

AN EXAMPLE OF STIMULI: UNEXCHANGEABLE

Supplement was NOT given



Hen
ID 001

NO egg was laid
tomorrow morning.

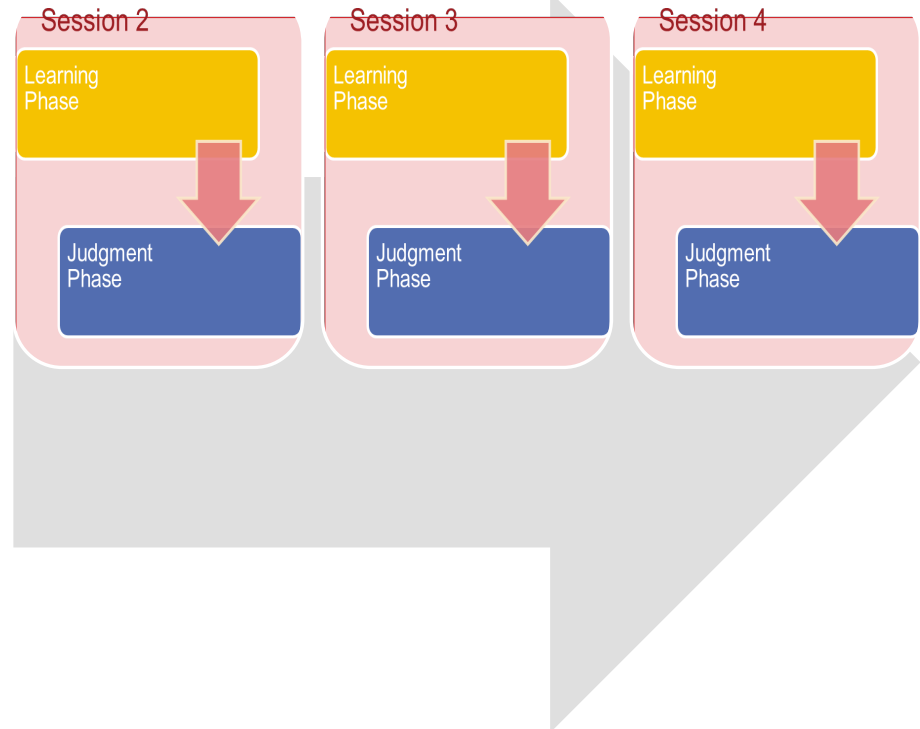
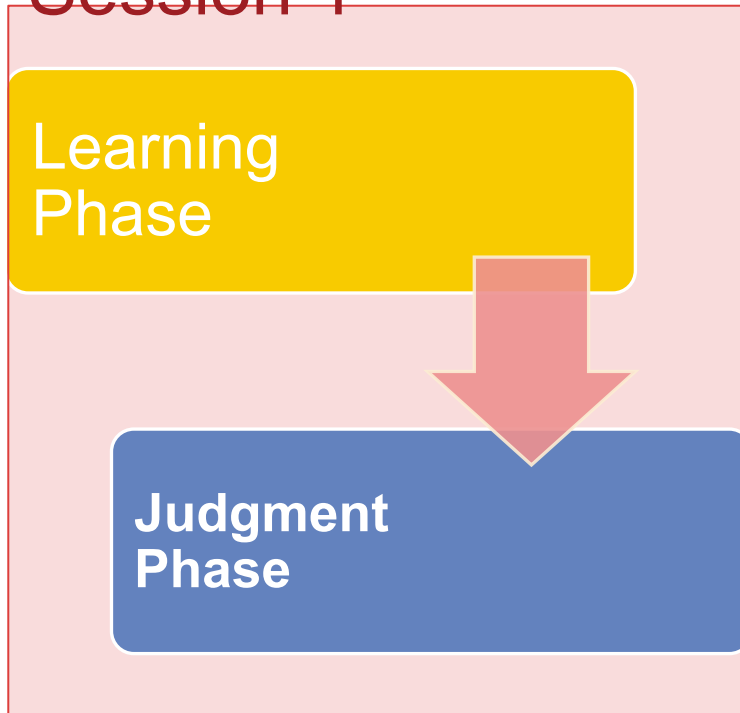


Please tick off two correct events you observed above.

- Fed Company A's sample
- Fed Company B's sample
- Laid an egg
- Did not lay an egg

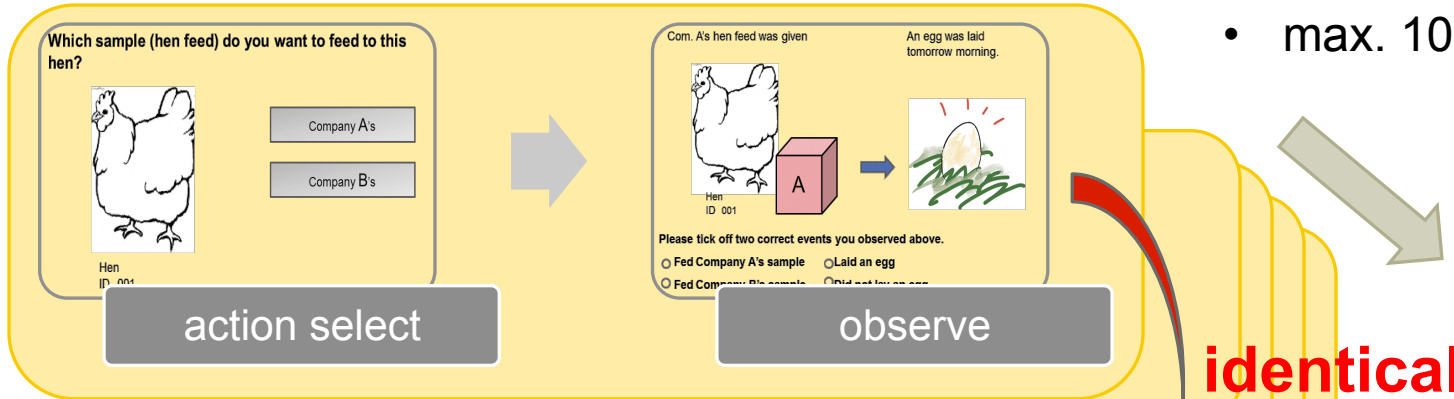
EXPERIMENT 1: PROCEDURE

Session 1



LEARNING PHRASE: YOKING OF STIMULI

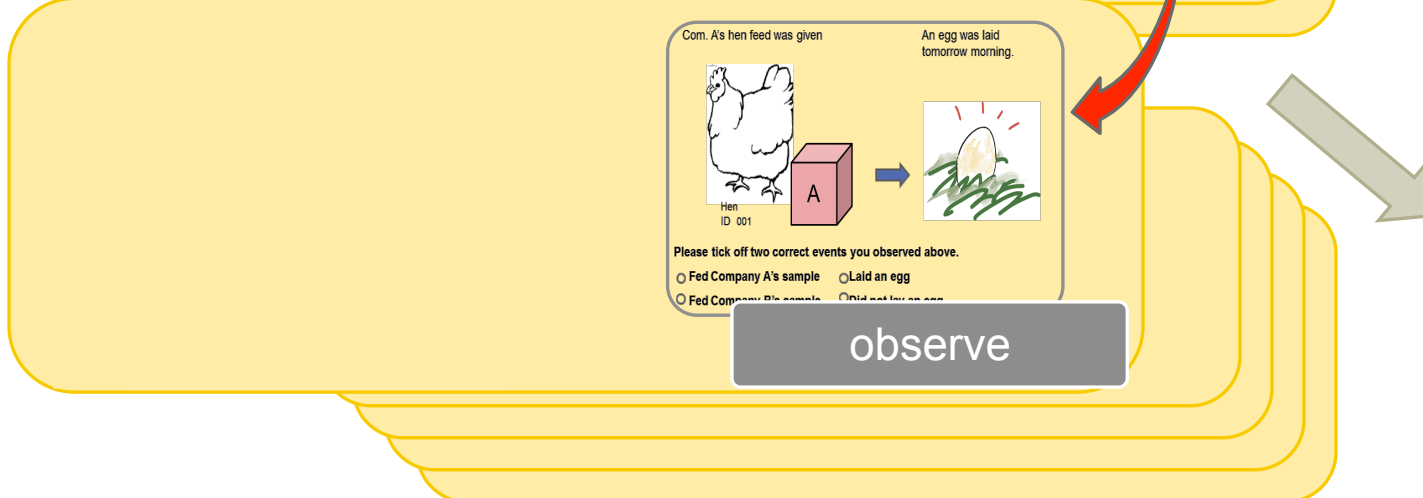
- **Interventional condition**



Number of trials

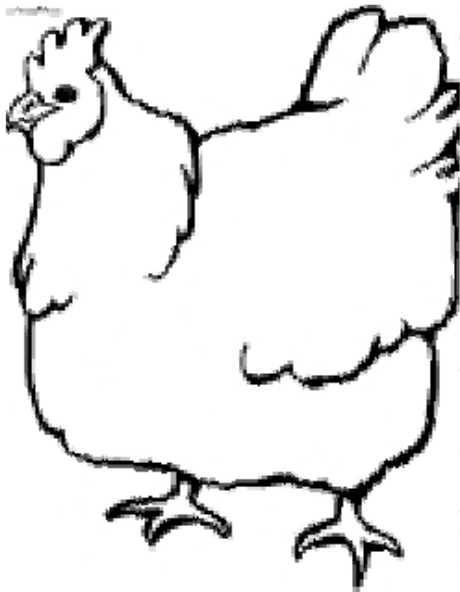
- min. 10
- max. 100

- **Observational condition**



EXAMPLE OF STIMULI : LEARNING PHASE (INTERVENTION)

Which sample (hen feed) do you want to feed to this hen?



Hen
ID 001

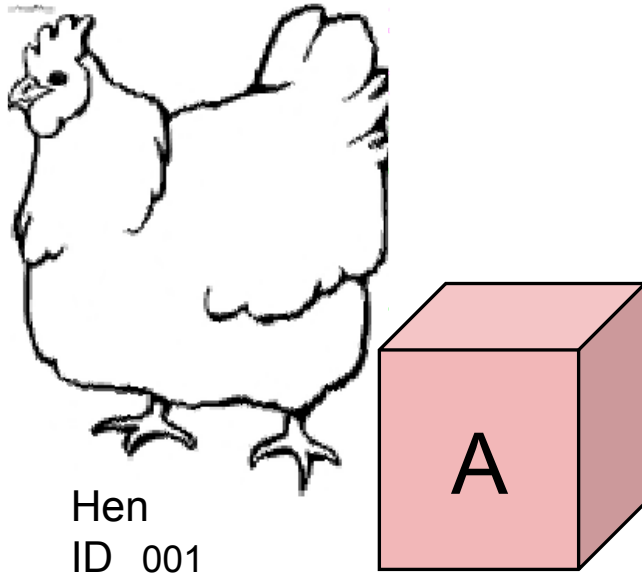
Company A's

Company B's

Evaluate

AN EXAMPLE OF STIMULI: EXCHANGEABLE (A-CELL)

Com. A's hen feed was given



An egg was laid
tomorrow morning.



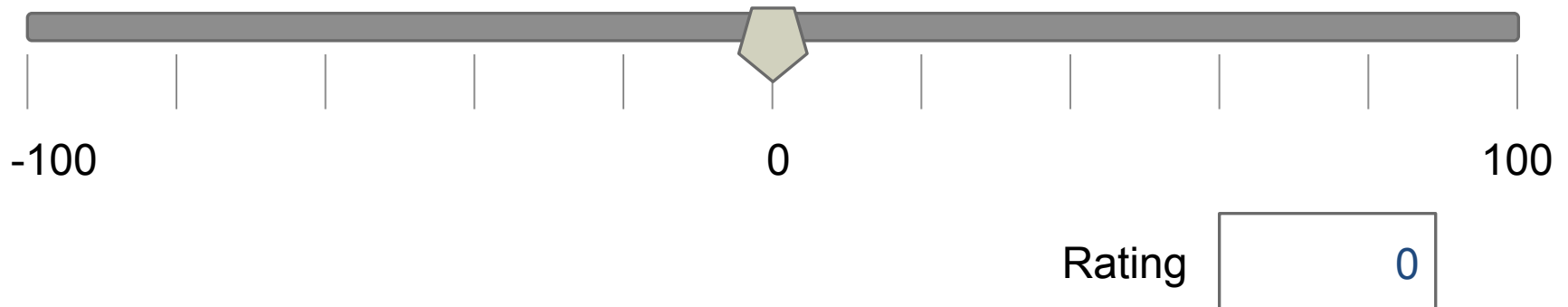
Please tick off two correct events you observed above.

- Fed Company A's sample
- Fed Company B's sample
- Laid an egg
- Did not lay an egg

Please evaluate what degree the change of hen feed from the Company B that you have adopted so far to the Company A influences on the egg production?

Indicate your judgment in value between -100 and 100 by means of the slide bar below.

- The value of 100 means that the change of hen feed facilitates the egg production and the effect is very strong.
- The value of 0 means that the change of hen feed does not have any effect on the egg production at all.
- The value of -100 means that the change of hen feed suppresses the egg production and the effect is very strong.



Are you satisfied with your evaluation?

Click the button when you are ready to proceed the next session.

Go Next

PROBABILITY OF STIMULI

Every Participant took 4 sessions

- Probability

- Order

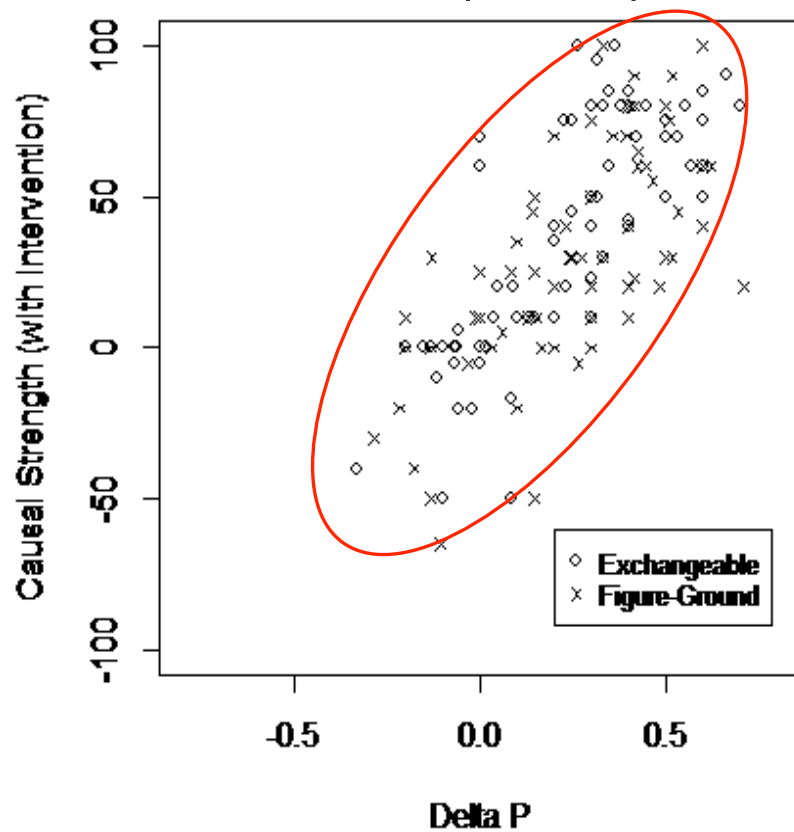
- BFRG
- FGBR
- GRFB
- RBGF

Hen	P (E C)	P (E not-C)	Delta P
B (Black Sander)	0.3	0.3	0
G (Golden Tail)	0.6	0.2	0.4
F (Fatty Brown)	0.7	0.7	0
R (Rainbow Back)	0.8	0.4	0.2

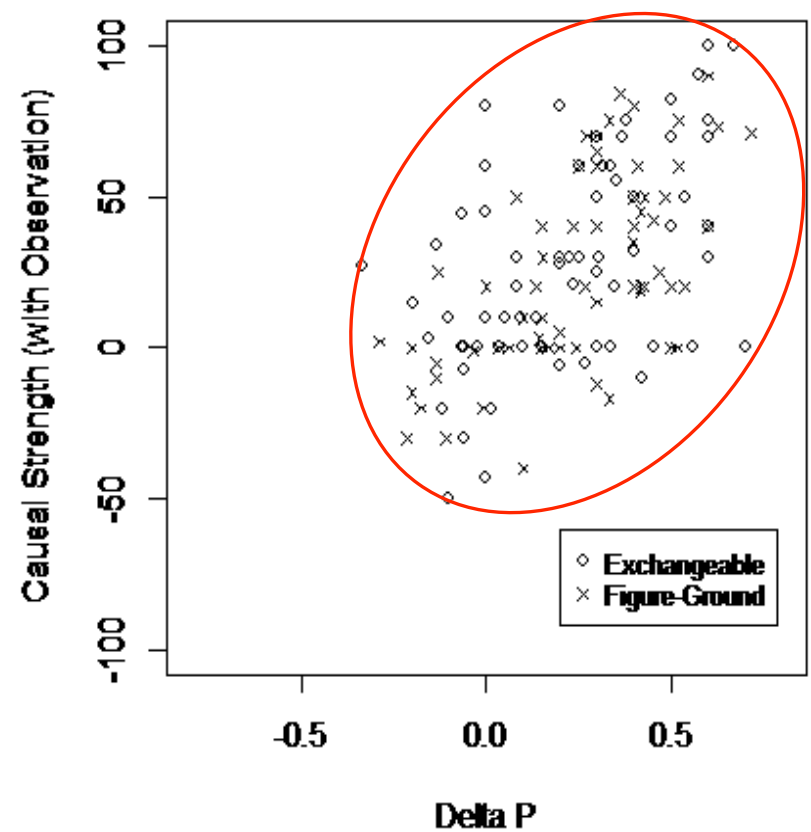
- These 4 orders are adopted according to the Latin square

CONGRUITY WITH DELTA P RULE: INTERVENTION VS. OBSERVATION

IV (N=34)

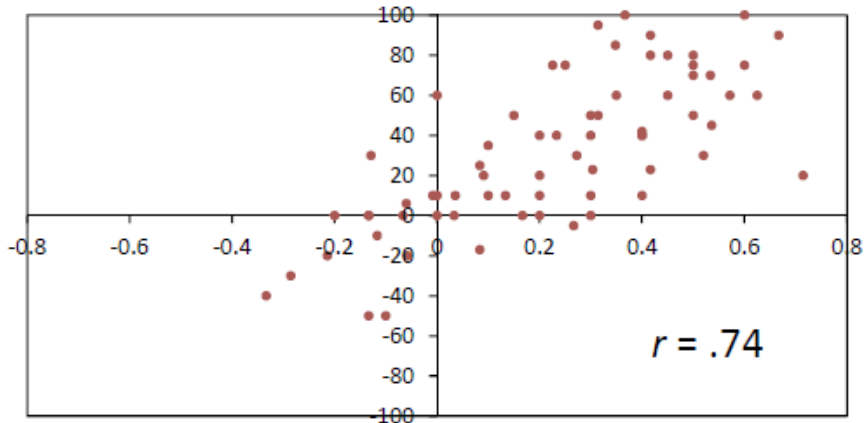


OB (N=34)

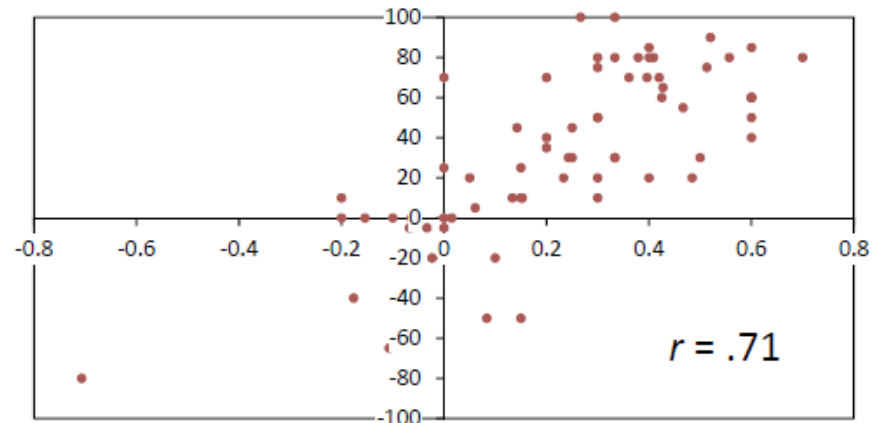


CONGRUITY WITH DELTA P

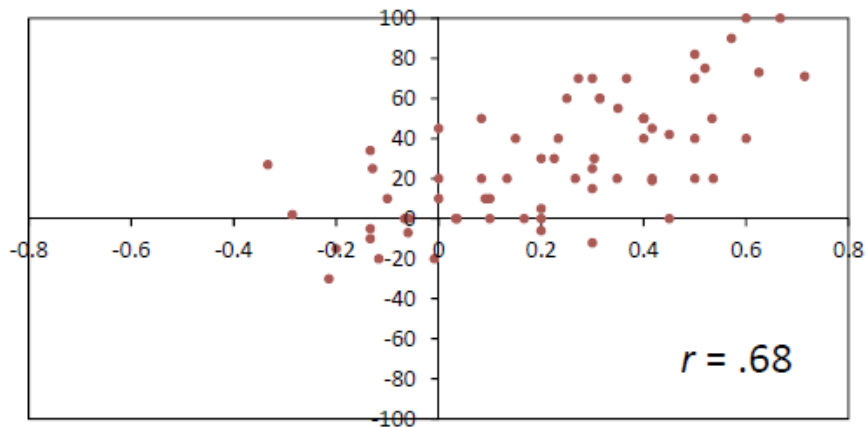
IV-XC



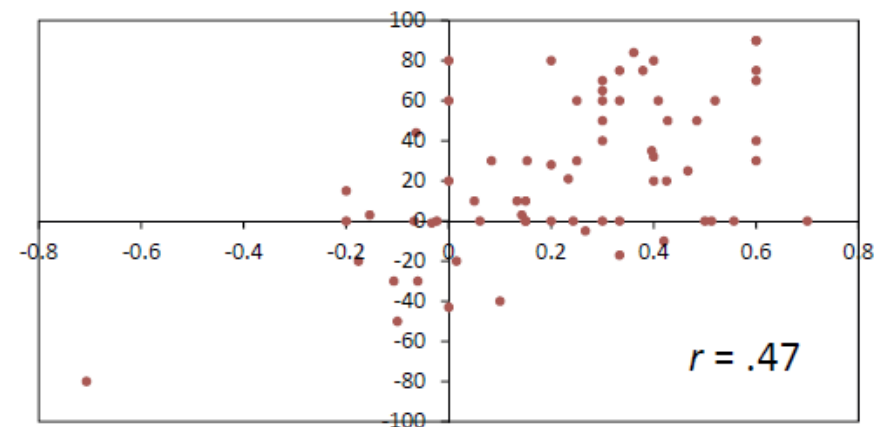
IV-FG



OB-XC

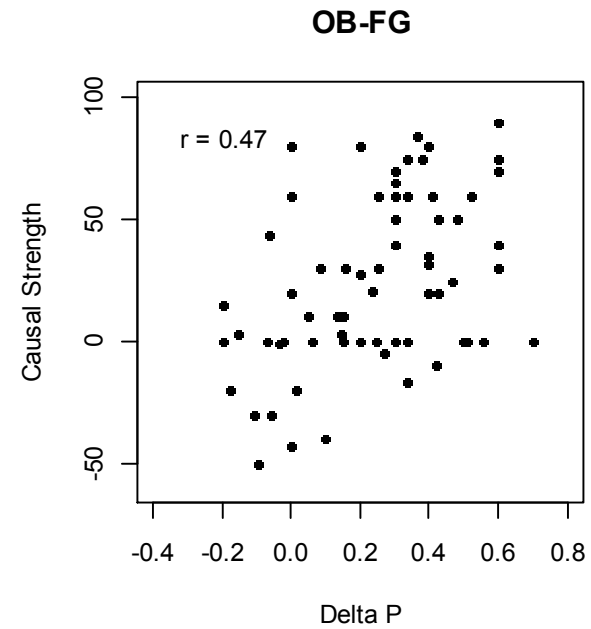
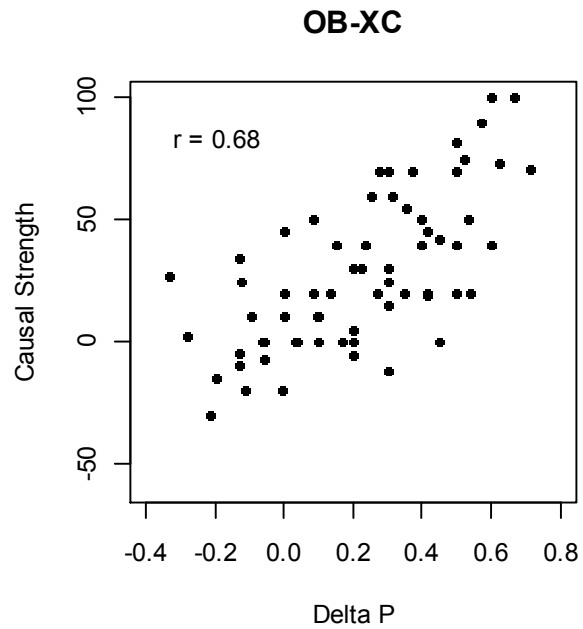
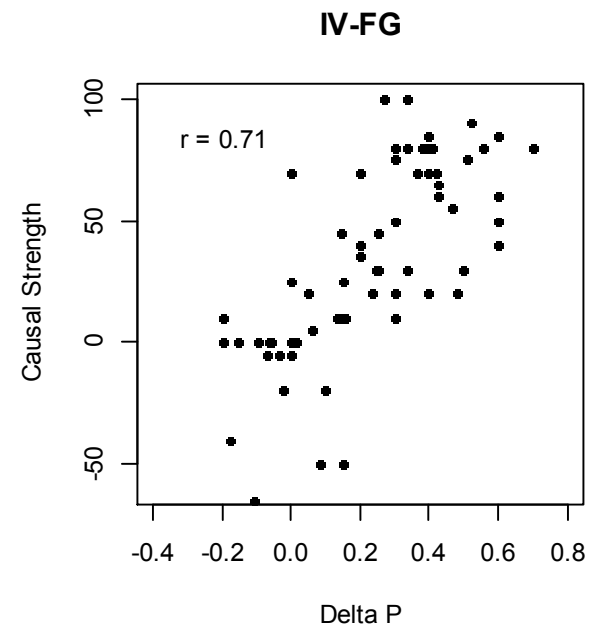
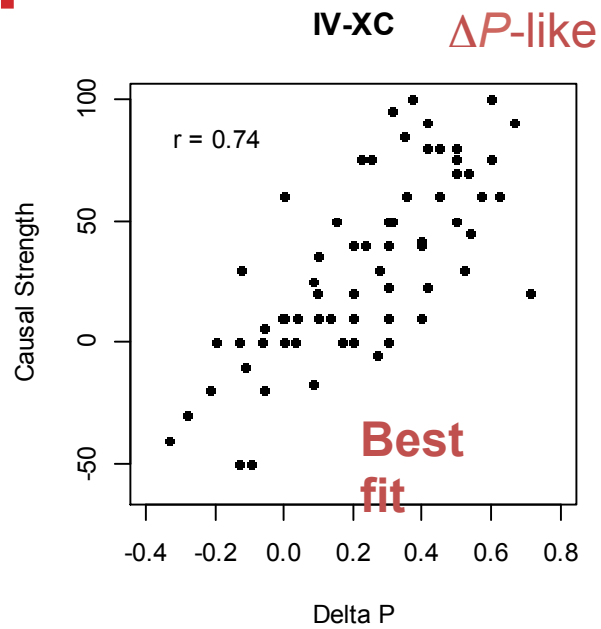


OB-FG

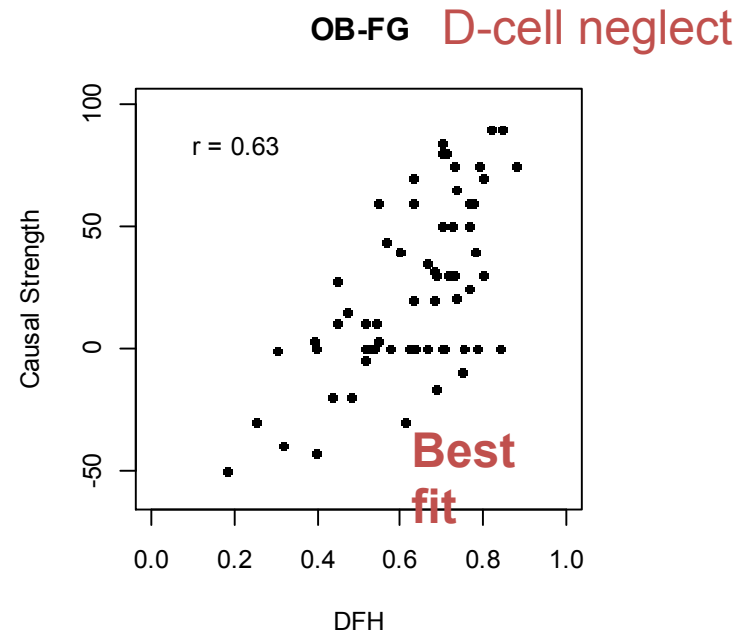
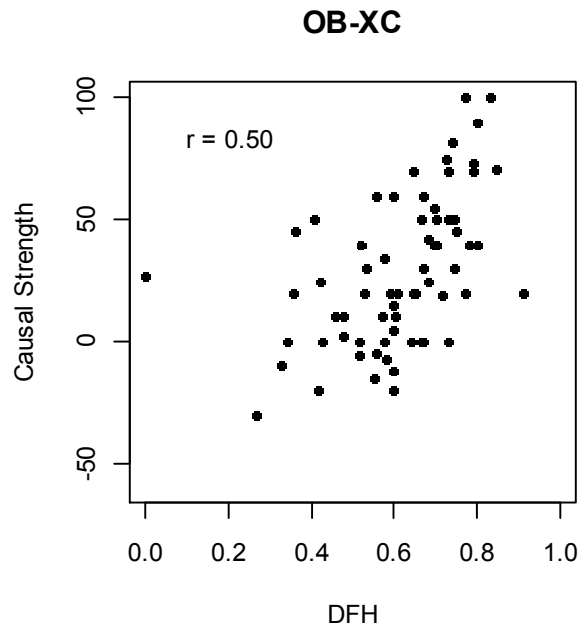
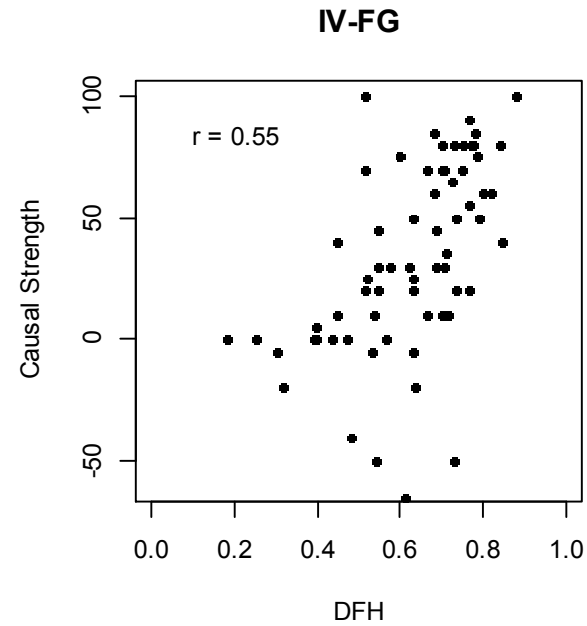
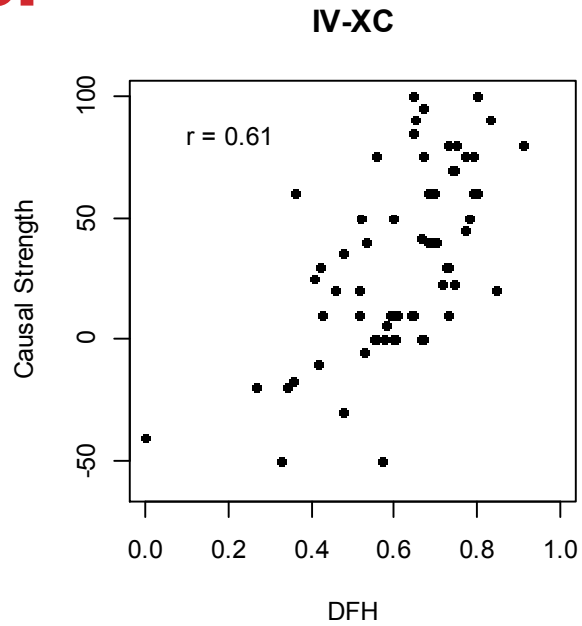


Vertical axis: Participants' judgment, Horizontal axis: Measurement by Delta P rule

Fitness for Delta P



Fitness for DFH



EXPERIMENT1: SUMMARY OF RESULT

	Exchangeable (XC)	Figure-Ground (FG)
Intervention (IV)	Delta-P like ($r=.74$)	Delta-P like ($r=.71$)
Observation (OB)	Delta-P like ($r=.68$)	d-cell neglect ($r=.47$)

AB-FRAMES

	A-frame (attentional)	B-frame (balanced)
	Positivity focus	Comparative view
	Symbolically unexchangeable	Symbolically exchangeable
	Relevance mode	Differentiation mode
	D-cell disregard	D-cell respect (DP-like)
	Monopolar causality (null/effective)	Bipolar causality (preventive/generative)
System	Heuristic	Analytic
Invasiveness	Observation	Intervention
Negation	Explicit negation	Implicit negation
Property	Attribution	Action
Dynamism	Static	Kinetic
Commitment	Uncommitted	Committed
Activeness	Passive	Active
Base rate	Rare	Non-rare (moderate)

MONOPLAR VS. BIPOLAR

If Mary takes a diet pill (p), she loses her weight (q).

$$\Delta P = P(q | p) - P(q | \neg p) = \frac{a}{a+b} - \frac{c}{c+d} \not\approx 0$$

	Effect (q)	
Cause (p)	Lose weight (q)	Not lose weight (not-q)
Take a pill (p)	a	b
Not take a pill (not-p)	c	d

AB-FRAMES

	A-frame (attentional)	B-frame (balanced)
	Positivity focus	Comparative view
	Symbolically unexchangeable	Symbolically exchangeable
	Relevance mode	Differentiation mode
	D-cell disregard	D-cell respect (DP-like)
	Monopolar causality (null/effective)	Bipolar causality (preventive/generative)
System	Heuristic	Analytic
Invasiveness	Observation	Intervention
Negation	Explicit negation	Implicit negation
Property	Attribution	Action
Dynamism	Static	Kinetic
Commitment	Uncommitted	Committed
Activeness	Passive	Active
Base rate	Rare	Non-rare (moderate)

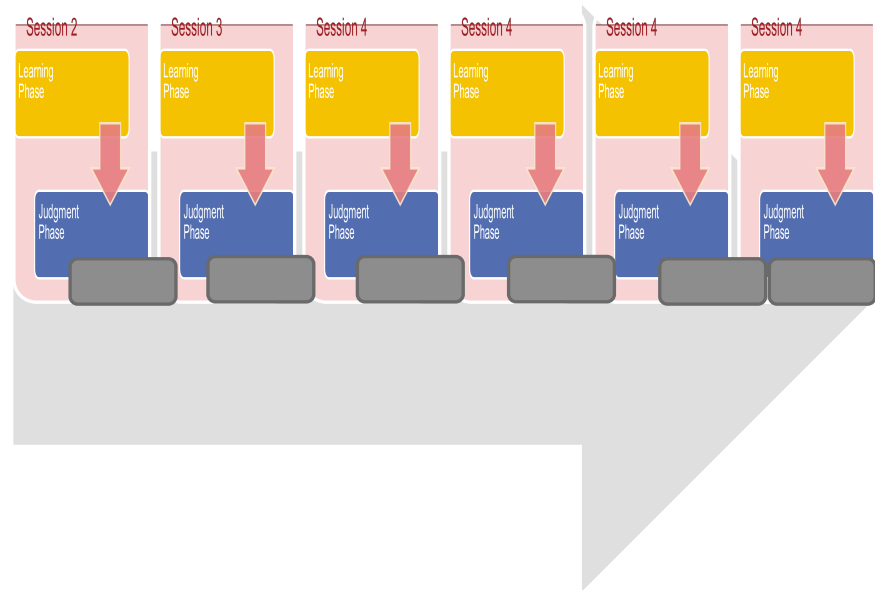
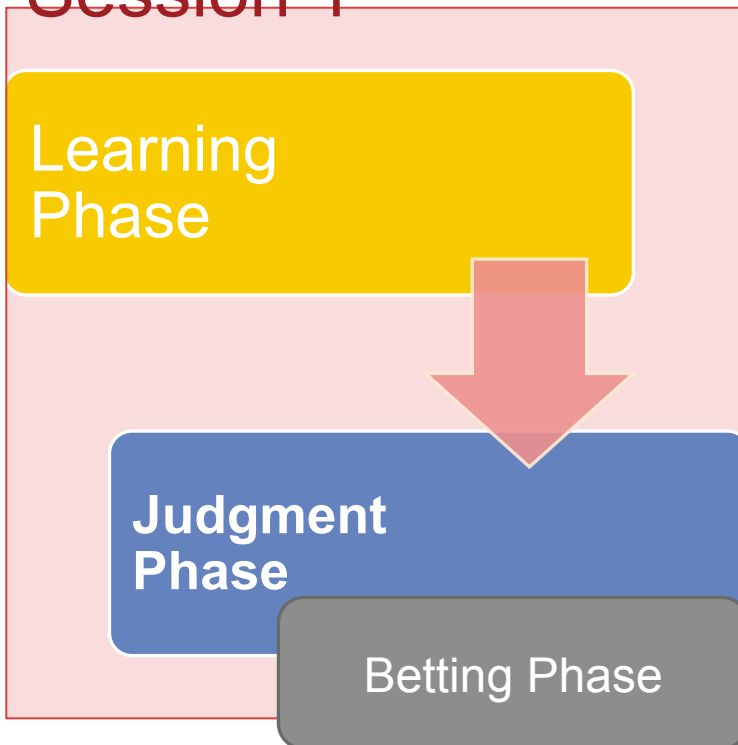
EXPERIMENT2: DESIGN AND PREDICTION

	Exchangeable (XC)	Figure-Ground (FG)
Committed (CM)	Delta-P like	Delta-P like ?
Uncommmited (UCM)	Delta-P like ?	d-cell neglect

- **XC vs. FG: Between participants**
- **CM vs. UCM: Between participants**
- **82 undergraduates participated in exp. 2**

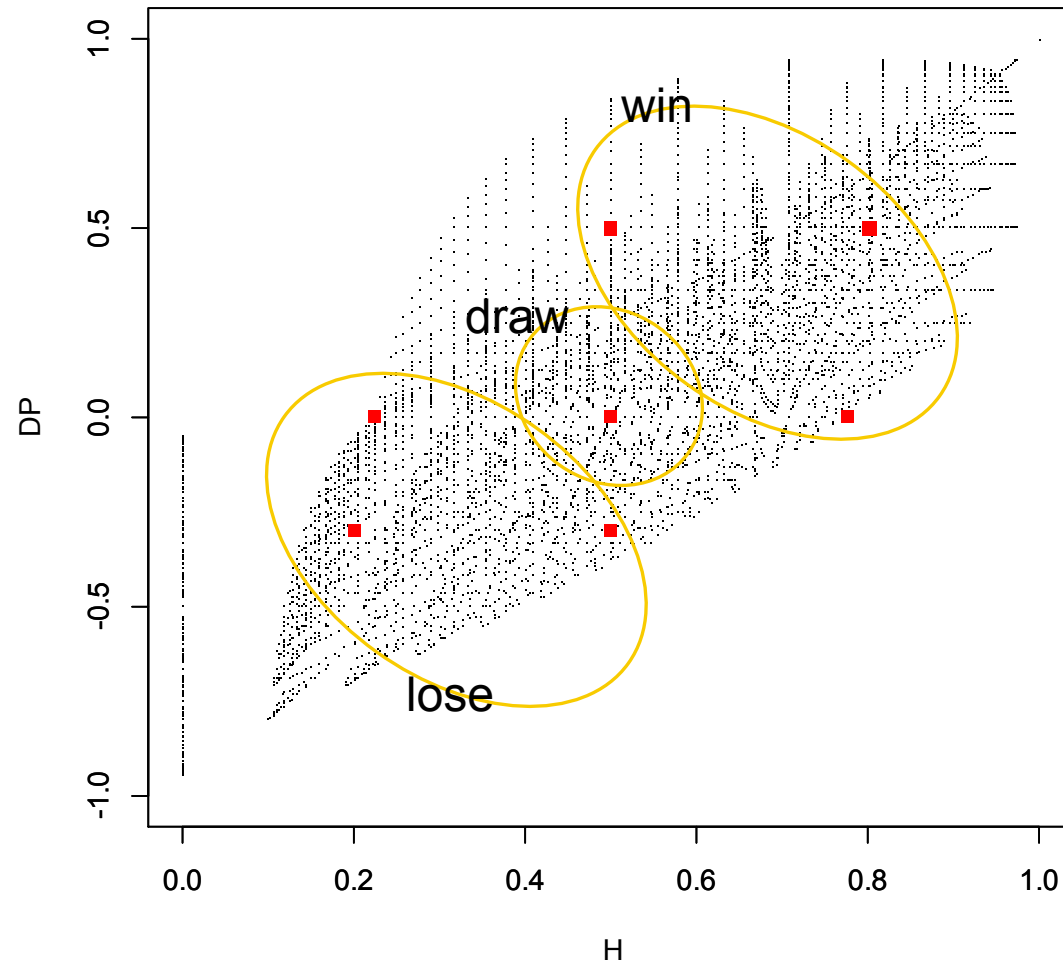
EXPERIMENT 2: PROCEDURE

Session 1



Do you want to bet 1000 yen (9 euro) on the change of feeding is effective?

PROBABILITY OF THE STIMULI



AB-FRAMES

	A-frame (attentional)	B-frame (balanced)
	Positivity focus	Comparative view
	Symbolically unexchangeable	Symbolically exchangeable
	Relevance mode	Differentiation mode
	D-cell disregard	D-cell respect (DP-like)
	Monopolar causality (null/effective)	Bipolar causality (preventive/generative)
System	Heuristic	Analytic
Invasiveness	Observation	Intervention
Negation	Explicit negation	Implicit negation
Property	Attribution	Action
Dynamism	Static	Kinetic
Commitment	Uncommitted	Committed
Activeness	Passive	Active
Base rate	Rare	Non-rare (moderate)

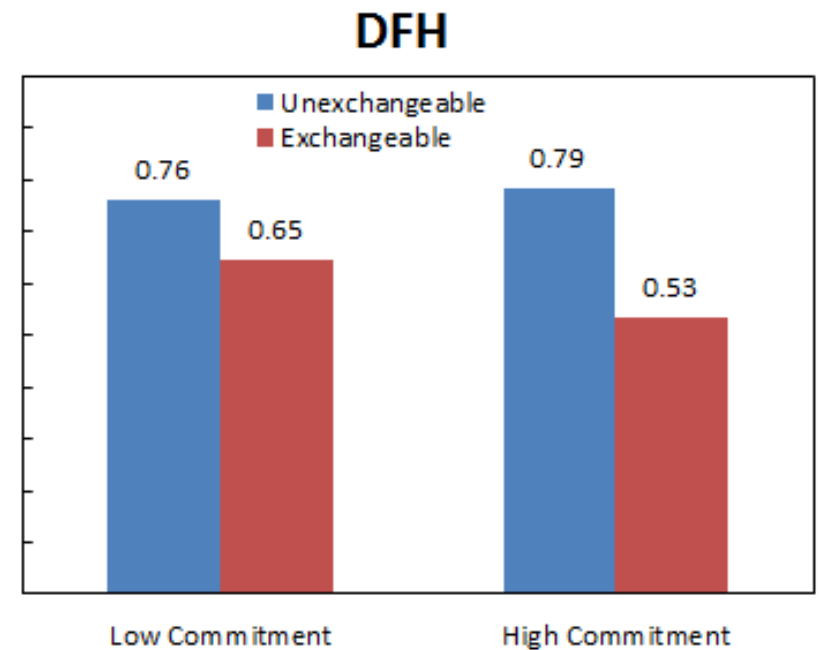
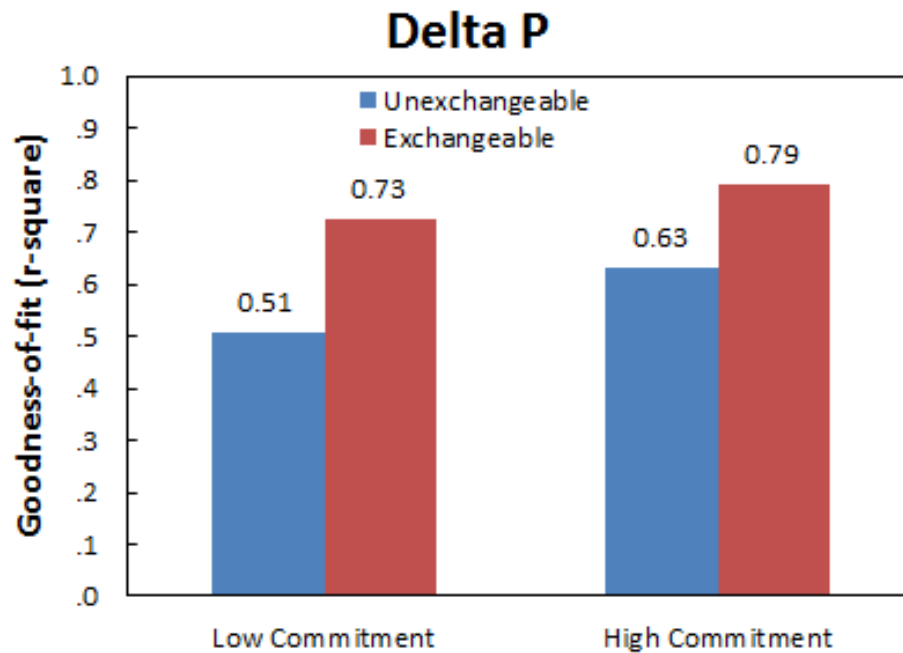
EXPERIMENT 2:

MATERIAL

- **Judgment about the Causal Strength**
 - The influences of the feeding products for hen on its egg production

	Cause	Effect
Exchangeable (XC)	Hen feed (A / B)	Egg (Brown / White)
Figure-Ground (FG)	Supplement (Give / Not)	Egg (Yes / No)

CONGRUITY WITH MODELS: DELTA P VS. DFH



AB-FRAMES

	A-frame (attentional)	B-frame (balanced)
	Positivity focus	Comparative view
	Symbolically unexchangeable	Symbolically exchangeable
	Relevance mode	Differentiation mode
	D-cell disregard	D-cell respect (DP-like)
	Monopolar causality (null/effective)	Bipolar causality (preventive/generative)
System	Heuristic	Analytic
Invasiveness	Observation	Intervention
Negation	Explicit negation	Implicit negation
Property	Attribution	Action
Dynamism	Static	Kinetic
Commitment	Uncommitted	Committed
Activeness	Passive	Active
Base rate	Rare	Non-rare (moderate)

CONCLUSION

- People use two frames for recognizing relationships between two things or events in the environment: A-frame and B-frame (“A” stands for *attentional* and “B” stands for *balanced*). These frames are considered to be closely related to the attitudes toward *d*-cell information and preventive causes.
- With A-frame, we pay attention to positive features of events. Occurrence is focused on and non-occurrence is ignored, just like *figure-ground* relationship discussed in perceptual psychology (Rubin, 1915/1958).