Back to the Rescorla-Wagner (1972) model

1. RW is designed to account for conditioning in situations involving compound stimuli.

2. RW assumes that the presentation of even a single CS is a compound conditioning trial involving that CS and the context in which it is presented.

3. If the CS is called “A,” the context is called “X,” and the presentation of the US is called “+,” then a CS-US pairing is represented as an AX+ trial.

4. The basic RW equation, $\Delta V = \alpha \beta (\lambda - V)$, is then computed for each stimulus present in a given trial.

5. Thus, for an AX+ trial, we have:
   1. $\Delta V_A = \alpha_A \beta (\lambda - V_{AX})$
   2. $\Delta V_X = \alpha_X \beta (\lambda - V_{AX})$
   3. $V_{AX} = V_A + V_X$

6. The discrepancy is now a difference score between the asymptotic strength supported by the US in the training situation minus the sum of the associative strength of all the stimuli present in that trial.

7. This is called the **shared associative strength rule.**

Examples of compound conditioning effects

Overshadowing (AB+ / B?): A target CS acquires less strength when conditioned with an accompanying CS than when conditioned alone.

Blocking (A+ / AB+ / B?): Prior conditioning with one CS impairs subsequent conditioning to a second CS presented in compound with the first CS.

Cue-validity effect (concurrent blocking) (A+,AB+ / B?): Same as blocking, except the two types of trials are concurrent.

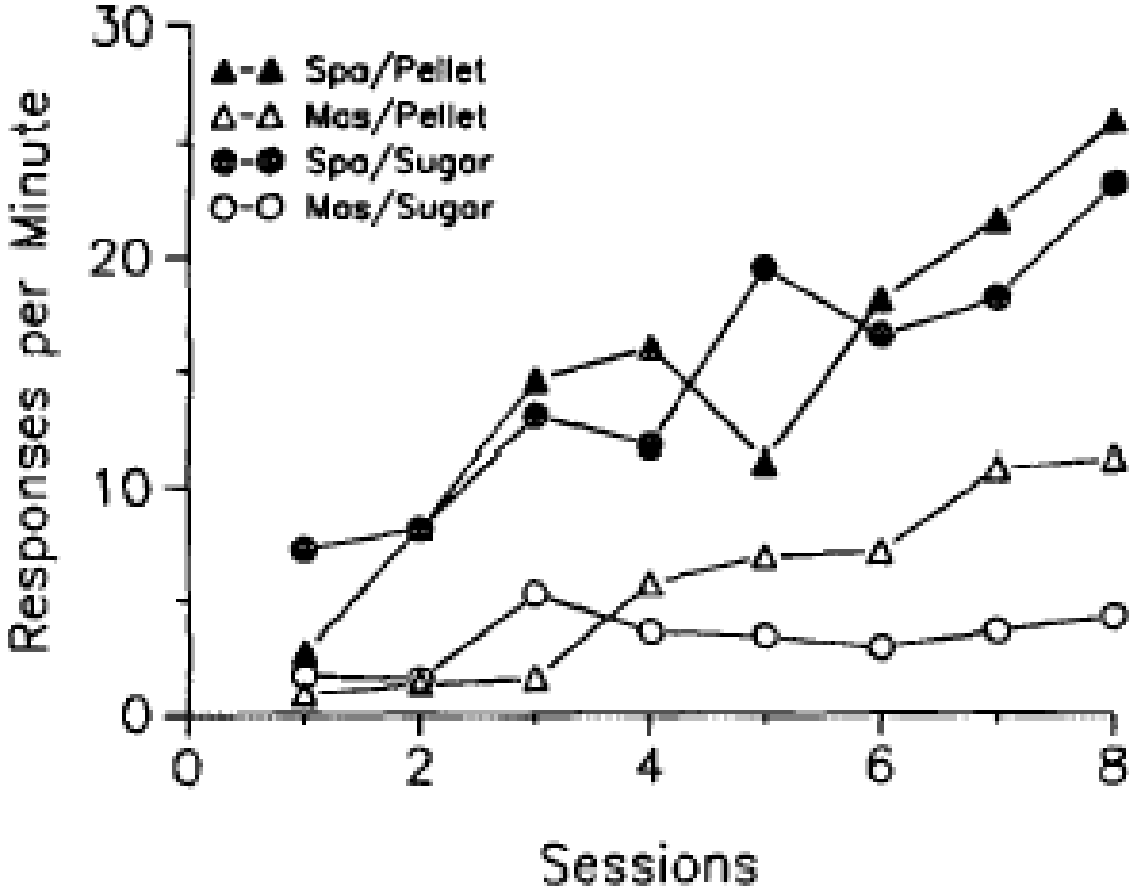
Overexpectation effect (A+,B+ / AB+ / B?): Compound CSs lose value when previously reinforced in isolation.

Conditioned inhibition training (A+,AB- / B?): A CS becomes inhibitory if nonreinforced in compound with an excitatory CS.

Superconditioning (A+,AC- / CB+ / B?): A CS acquires abnormally high strength if reinforced in compound with an inhibitory CS.

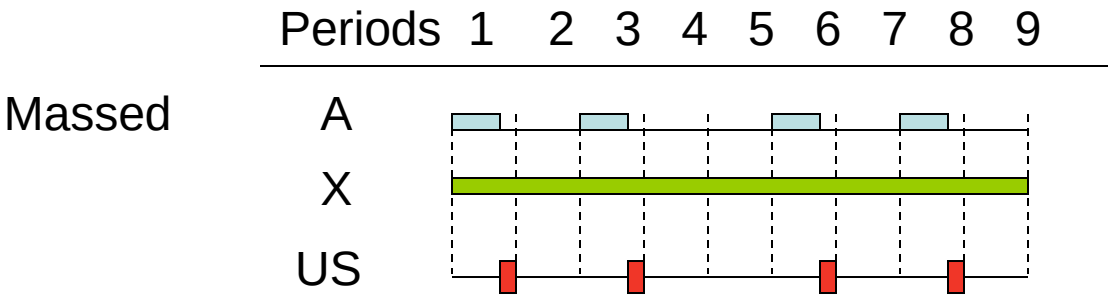
Trial-spacing effect : Long ITIs lead to faster acquisition than short it is.

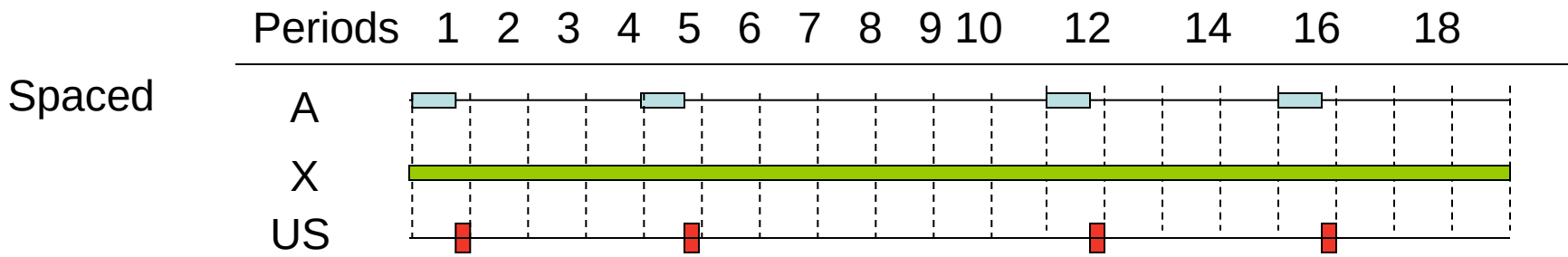
Trial-spacing effect



Papini & Brewer, 1994, Learning & Motivation, 25, 201-215.

Simulating the trial-spacing effect





Computations

For each AX+ trial:

$\Delta V_A = \alpha_A \beta (\lambda - V_{AX})$

$\Delta V_X = \alpha_X \beta (\lambda - V_{AX})$

For each X- "trial": $\Delta V_X = \alpha_X \beta (\lambda - V_X)$

Update: V_X = previous $V_X + \Delta V_X$

Updates:

V_A = previous $V_A + \Delta V_A$

V_X = previous $V_X + \Delta V_X$

Summation rule: $V_{AX} = V_A + V_X$

Rate parameters: $\alpha = \beta = 0.5$
On AX+ trials: $\lambda = 100$
On X- trials: $\lambda = 0$
Initial values: $V_A = V_X = 0$

MASSED

Period 1: $\Delta V_A = .5(.5)(100-0) = 25$
$\Delta V_X = .5(.5)(100-0) = 25$
$V_A = 0+25 = 25$
$V_X = 0+25 = 25$
$V_{AX} = 25+25 = 50$

Period 2: $\Delta V_X = .5(.5)(0-25) = -6.25$
$V_X = 25+(-6.25) = 18.75$

Period 3: $\Delta V_A = .5(.5)(100-43.75) = 14.06$
$\Delta V_X = .5(.5)(100-43.75) = 14.06$
$V_A = 25+14.06 = 39.06$
$V_X = 18.75+14.06 = 32.81$
$V_{AX} = 39.06+32.81 = 71.87$

SPACED

Period 1: $\Delta V_A = .5(.5)(100-0) = 25$
$\Delta V_X = .5(.5)(100-0) = 25$
$V_A = 0+25 = 25$
$V_X = 0+25 = 25$
$V_{AX} = 25+25 = 50$

Period 2: $\Delta V_X = .5(.5)(0-25) = -6.25$
$V_X = 25+(-6.25) = 18.75$

Period 3: $\Delta V_X = .5(.5)(0-18.75) = -4.69$
$V_X = 18.75+(-4.69) = 14.06$

Period 4: $\Delta V_X = .5(.5)(0-14.06) = -3.52$
$V_X = 14.06+(-3.52) = 10.54$

Period 5: $\Delta V_A = .5(.5)(100-35.54) = 16.12$
$\Delta V_X = .5(.5)(100-35.54) = 16.12$
$V_A = 25+16.12 = 41.12$
$V_X = 10.54+16.12 = 26.66$
$V_{AX} = 41.12+26.66 = 67.78$

Rate parameters: $\alpha = \beta = 0.5$
On AX+ trials: $\lambda = 100$
On X- trials: $\lambda = 0$
Initial values: $V_A = V_X = 0$

MASSED

Period 4: $\Delta V_X = .5(.5)(0- 32.81) = -8.20$
$V_X = 32.81+(-8.20) = 24.61$

Period 5: $\Delta V_A = .5(.5)(100-63.67) = 9.08$
$\Delta V_X = .5(.5)(100-63.67) = 9.08$
$V_A = 39.06+9.08 = 48.14$
$V_X = 24.61+9.08 = 33.69$
$V_{AX} = 48.14+33.69 = 81.83$

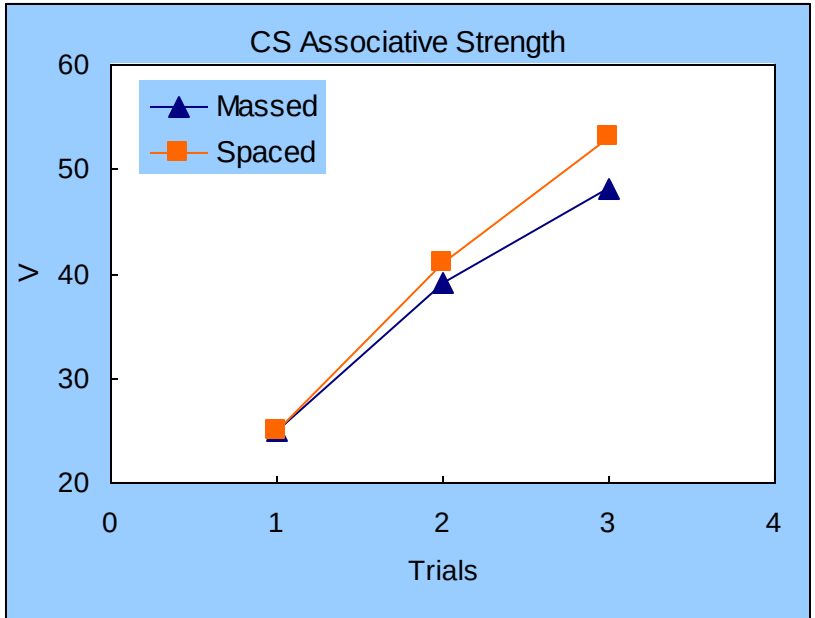
SPACED

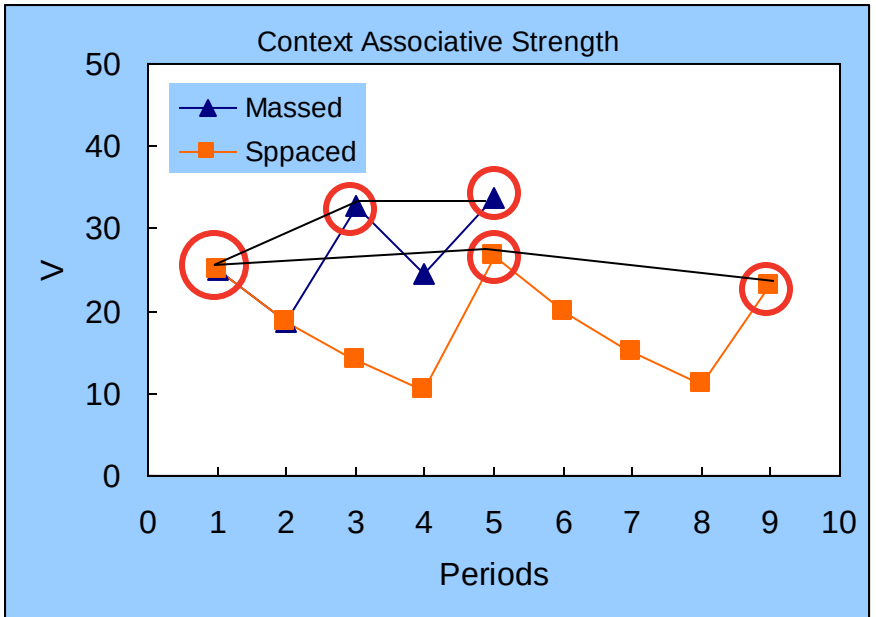
Period 8: $\Delta V_X = .5(.5)(0-26.66) = -6.67$
$V_X = 26.66+(-6.67) = 19.99$

Period 9: $\Delta V_X = .5(.5)(0-19.99) = -5.00$
$V_X = 19.99+(-5.00) = 14.99$

Period 10: $\Delta V_X = .5(.5)(0-14.99) = -3.75$
$V_X = 14.99+(-3.75) = 11.24$

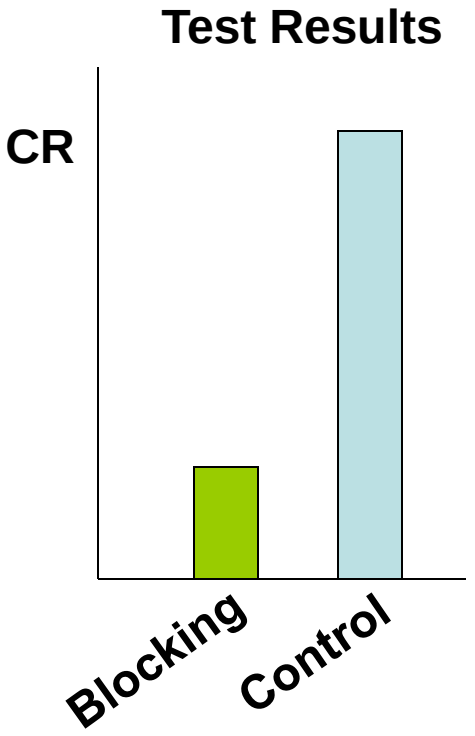
Period 11: $\Delta V_A = .5(.5)(100-52.36) = 11.91$
$\Delta V_X = .5(.5)(100-52.36) = 11.91$
$V_A = 41.12+11.91 = 53.03$
$V_X = 11.24+11.91 = 23.15$
$V_{AX} = 53.03+23.15 = 76.18$





Forward blocking

Group	Phase 1	Phase 2	Test
Blocking	A+	AB+	B?
Control	C+	AB+	B?



How does RW explain blocking?

(1) Assume A+ training in Phase 1 reaches a near asymptotic value.

(2) The addition of B in Phase 2 is redundant because A already predicts the US.

(3) In contrast, both A and B are good predictors of the US in the control group.

Learning theories

Acquisition failure

Example: Rescorla-Wagner (1972)

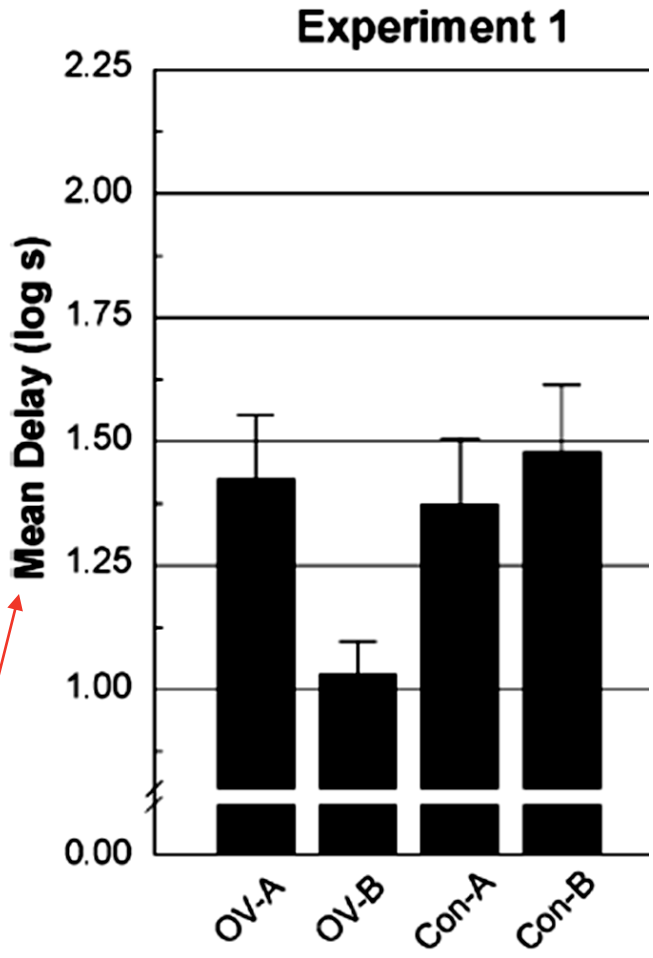
Retrieval failure

Example: Comparator hypothesis (1985)

Overshadowing: Acquisition or retrieval failure? (Denniston et al., 2003)

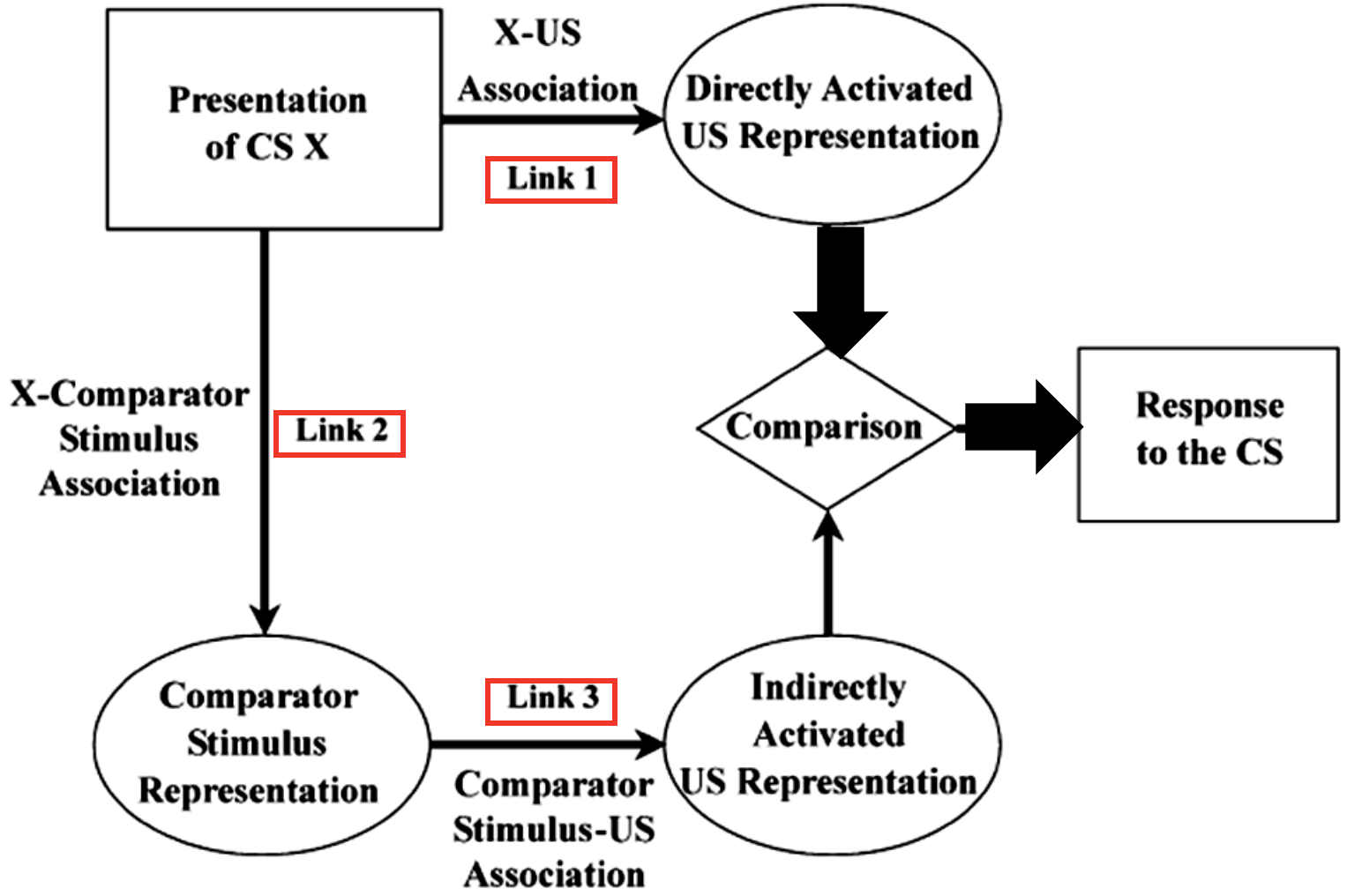
Group	Phase 1	Phase 2	Test
OV-A	AX+, BY+	A-	X?
OV-B	AX+, BY+	B-	X?
Con-A	X+, BY+	A-	X?
Con-B	X+, BY+	B-	X?

A & B: Tone and Light, counterbalanced.
X & Y: Click and Noise, counterbalanced.
+: foot shock, 1-s long, 0.7 mA.

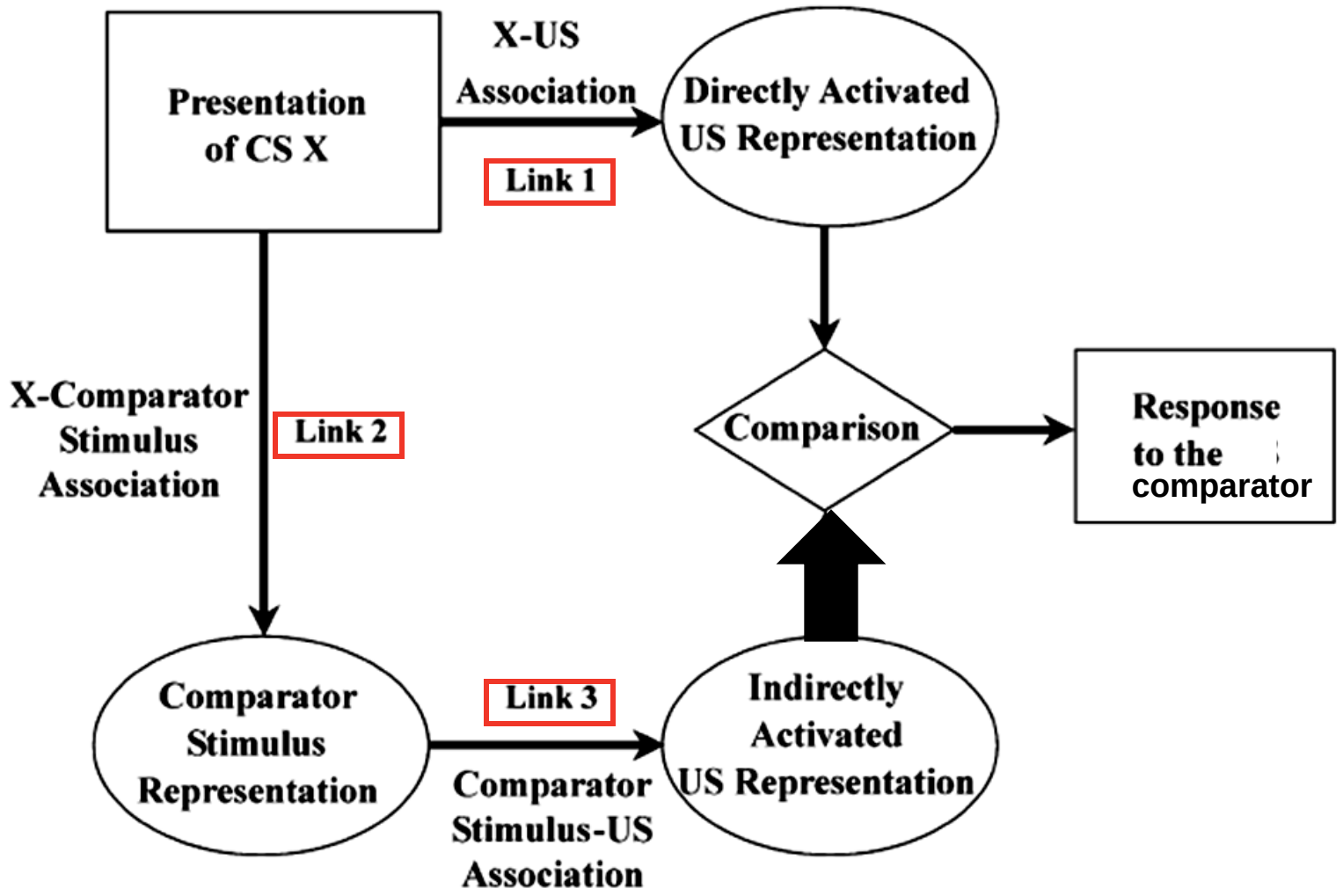


Latency to complete 5 cummulative seconds of drinking in the presence of the target CS.

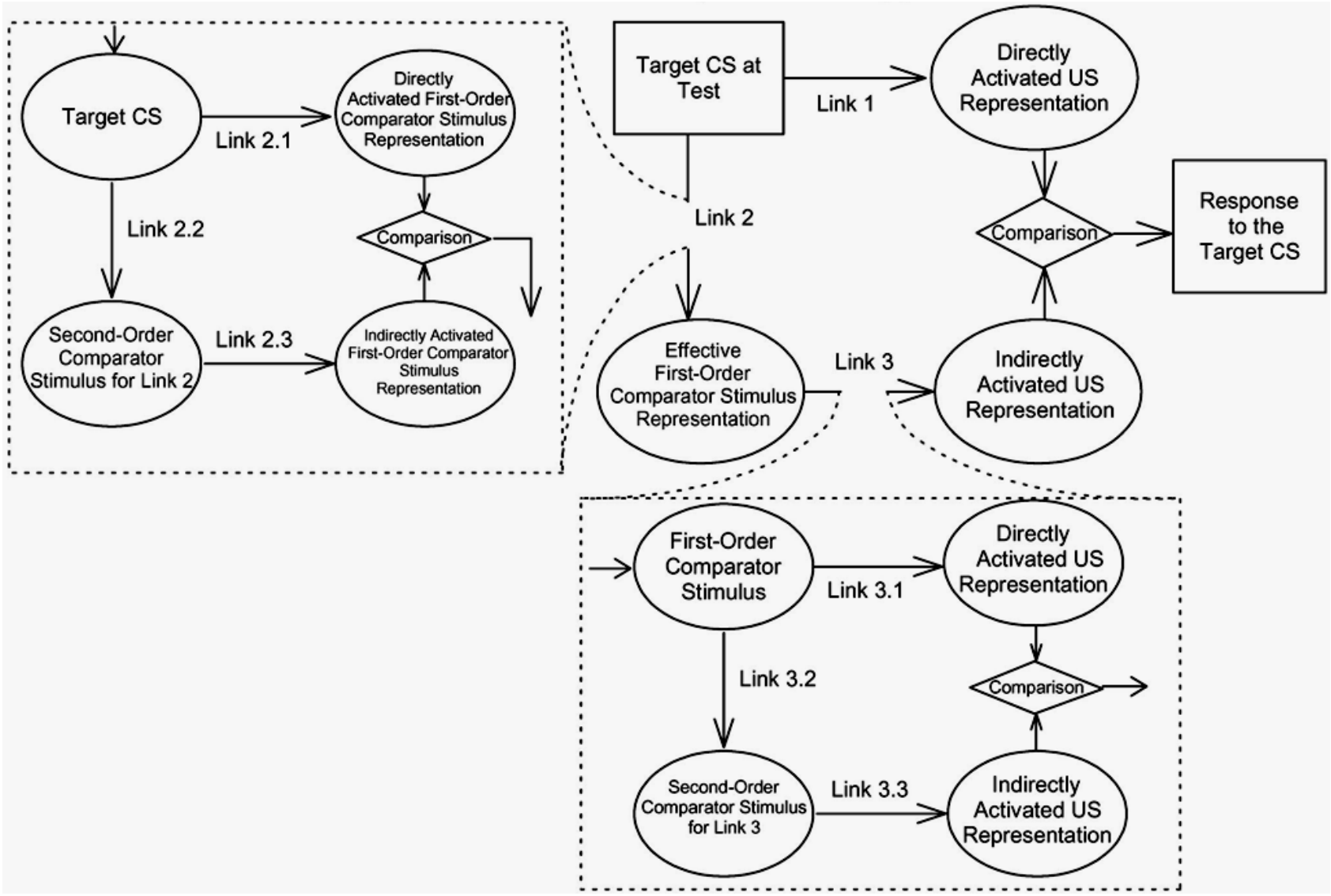
The comparator hypothesis



The comparator hypothesis



The extended comparator hypothesis



Testing the extended comparator hypothesis

A unique (counterintuitive) prediction from the extended comparator hypothesis:

> Latent inhibition and overshadowing treatments, if combined, should counteract each other to cancel each other's effects.

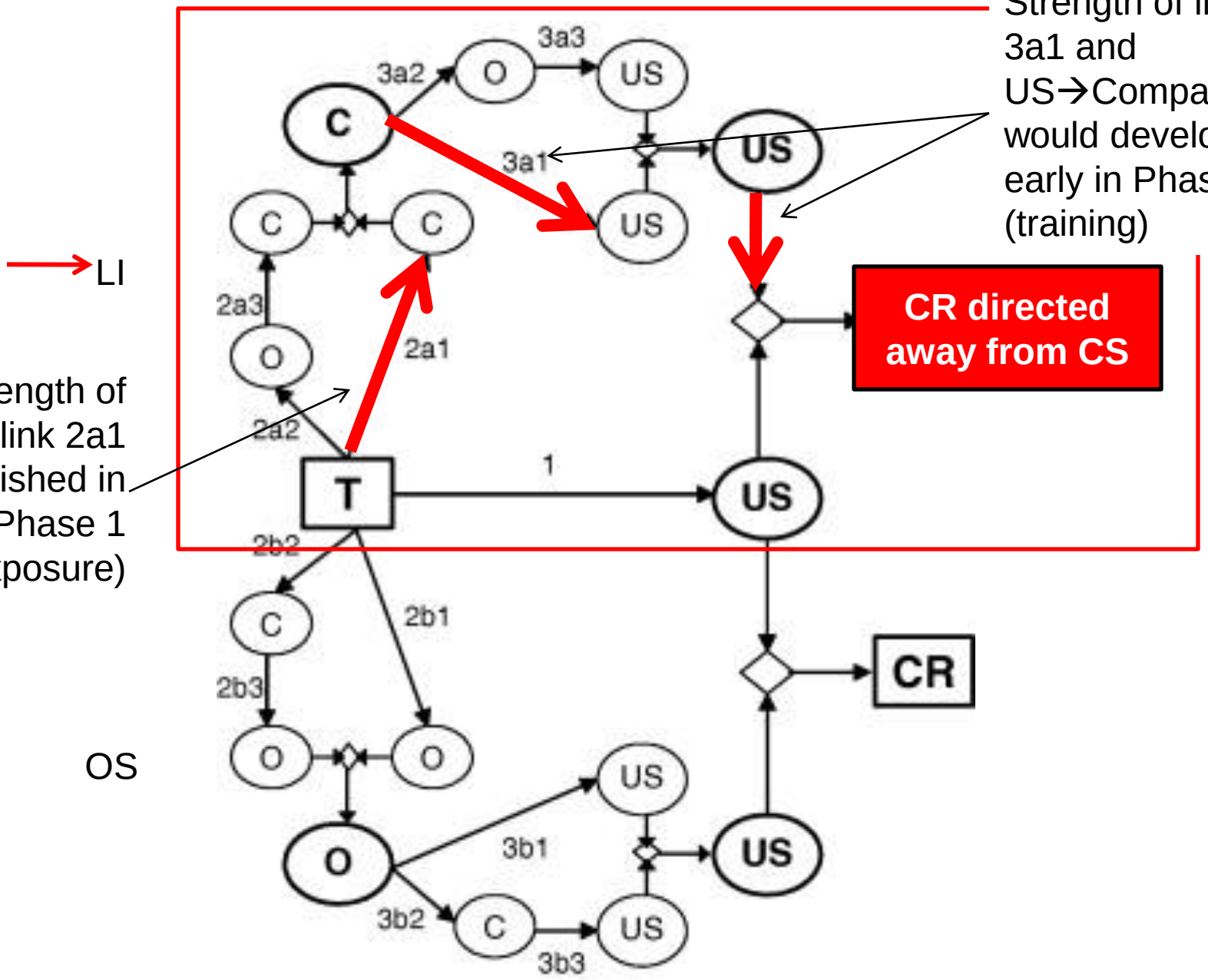
Latent inhibition:

Groups	Preexposure	Training	Results
LI	AX-	AX+	$A_{LI} < A_{Control}$
Control	BX-	AX+	

Overshadowing:

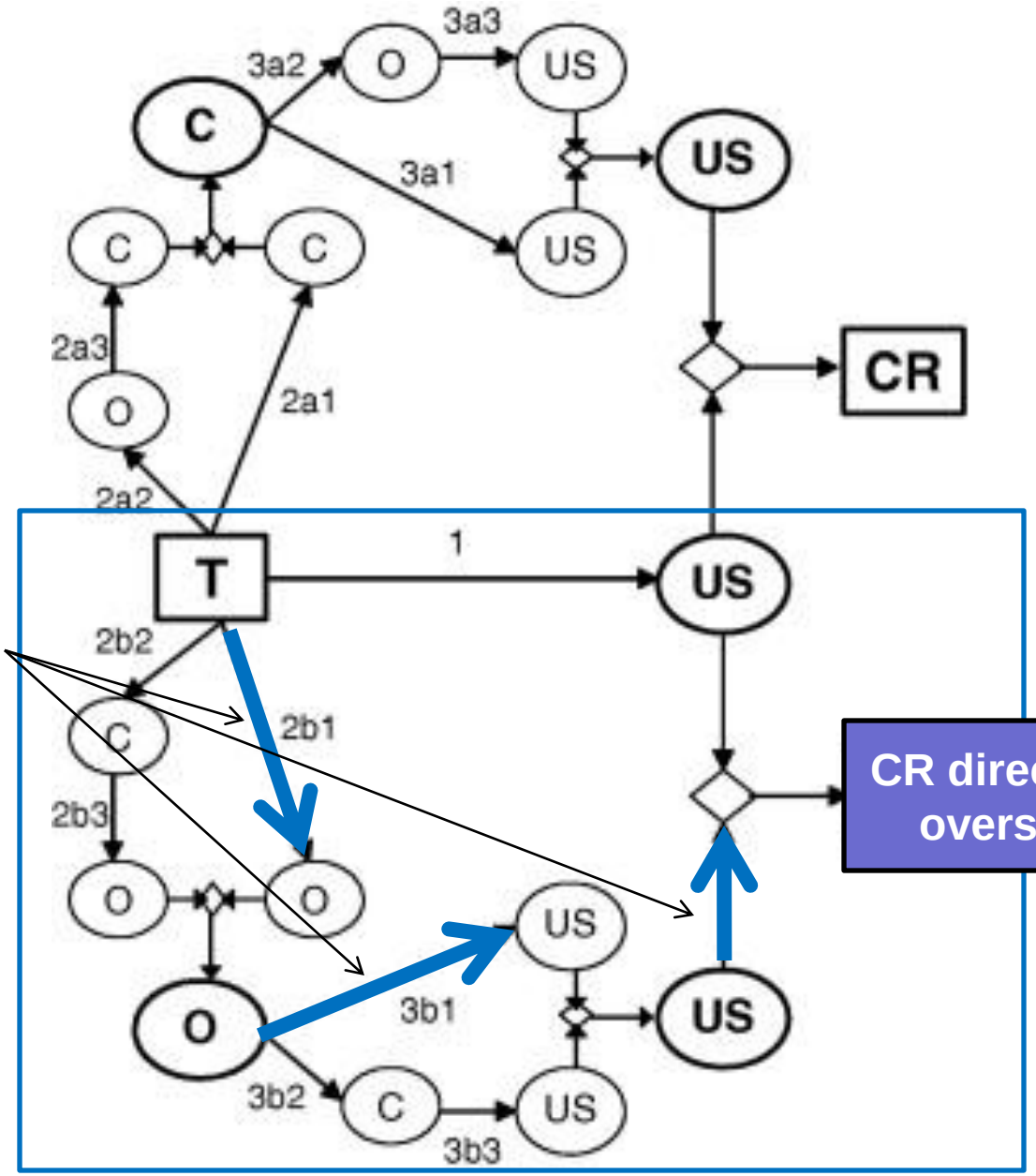
Groups	Training	Testing	Results
OS	ABX+	B?	$B_{OS} < B_{Control}$
Control	BX+	B?	

The extended comparator hypothesis: explaining latent inhibition



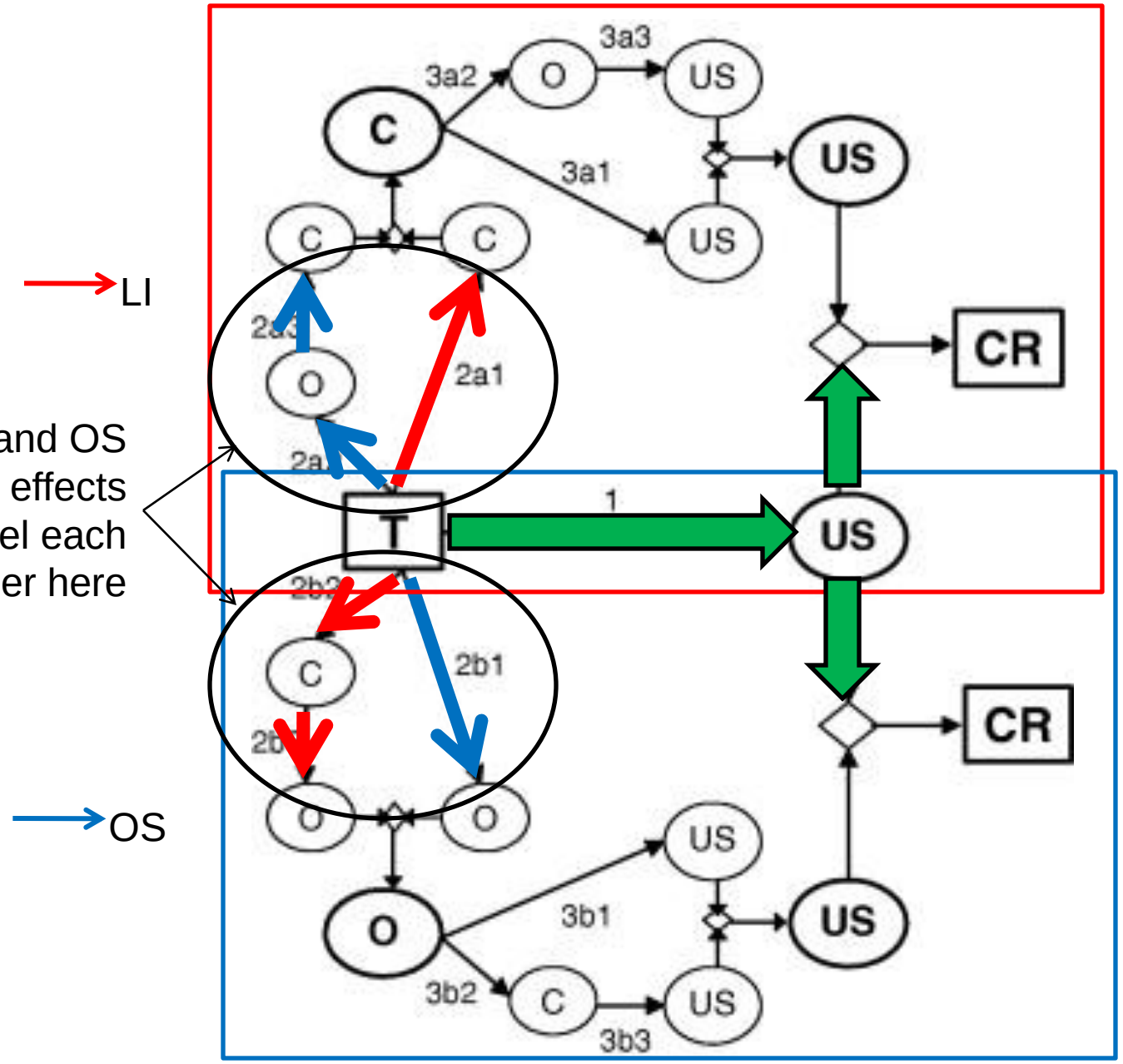
Nagaishi & Nakajima, 2008, Learn Motiv

The extended comparator hypothesis: explaining overshadowing



Nagaishi & Nakajima, 2008, Learn Motiv

The extended comparator hypothesis: combining both associative structures



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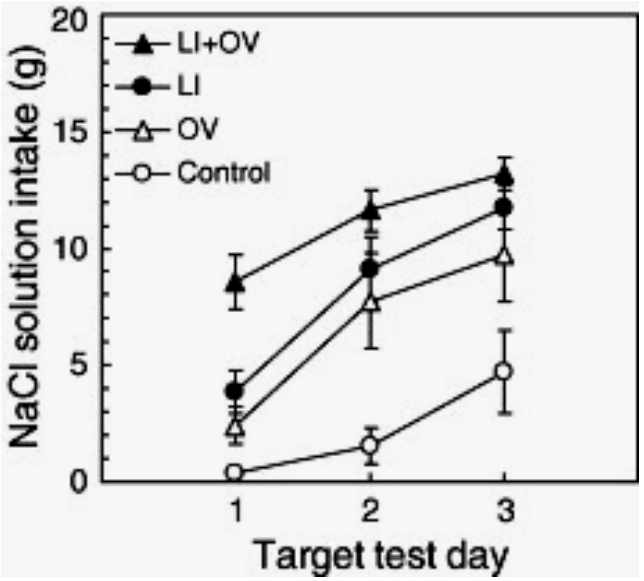
Do LI and OS cancel each other? (Experiment 3)

Group	Phase 1 (Preexposure)	Phase 2 (Conditioning)	Test (Target, N)
LI+OV	N→W	N→S→+ / W→W / Rec	N?
LI	N→W	N→W→+ / W→S / Rec	N?
OV	W→W	N→S→+ / W→W / Rec	N?
Control	W→W	N→W→+ / W→S / Rec	N?

N: sodium chloride
W: water
S: sucrose
Rec: recovery (no conditioning)
+: lithium chloride (poison)



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