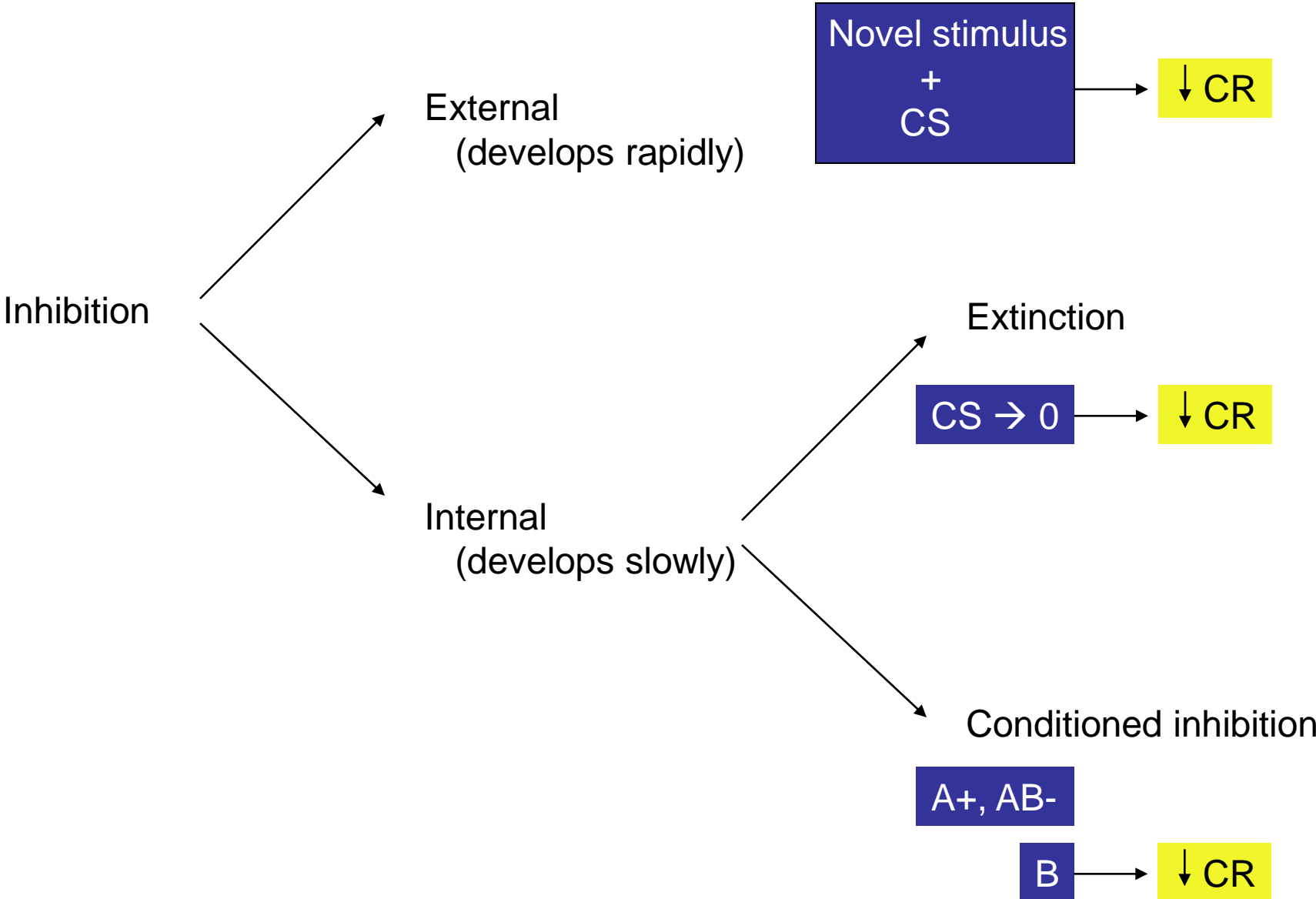


Pavlov's classification of inhibitory processes



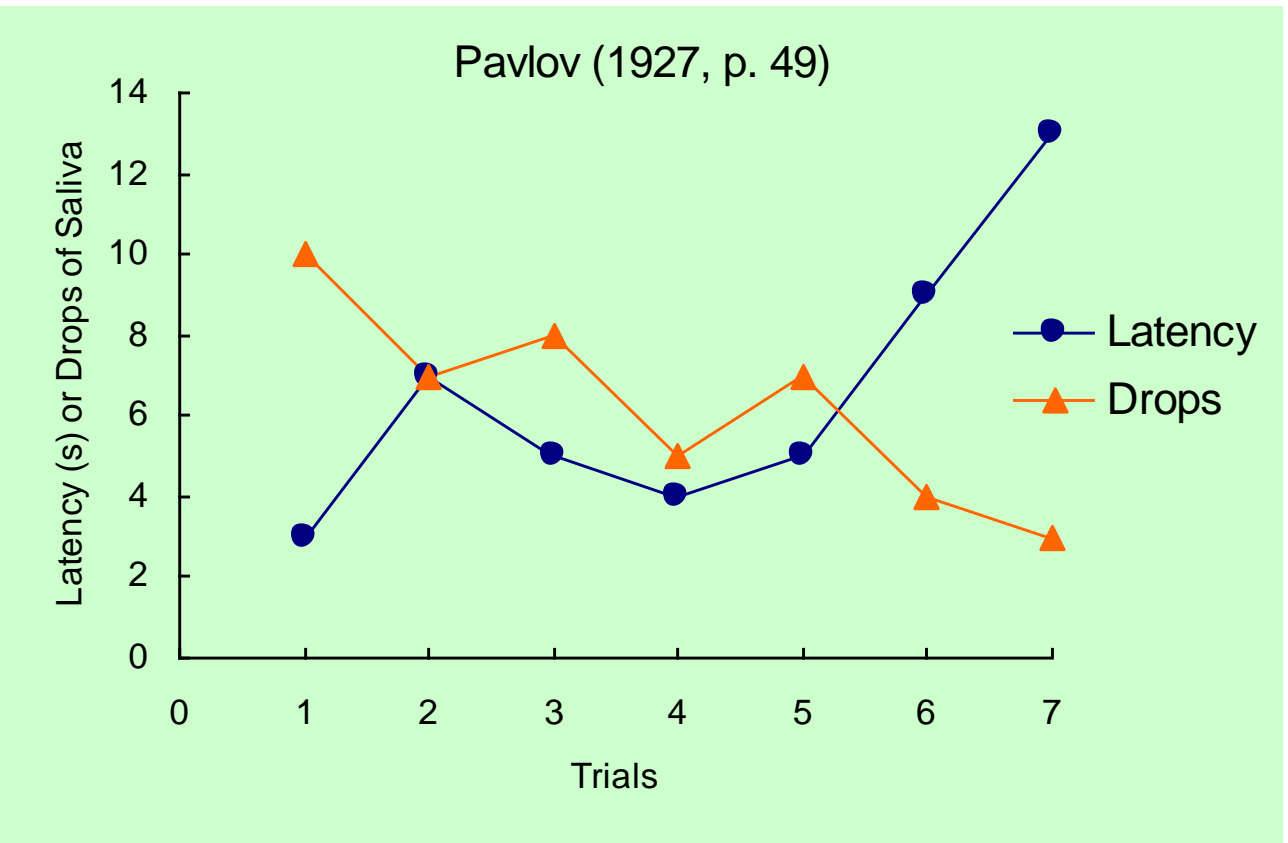
Extinction

Extinction has three meanings:

- **Procedural:** technique of presenting the CS without the US (Pavlovian conditioning) or omitting the S^R after an occurrence of the instrumental response (instrumental conditioning).
- **Behavioral:** a decrease in the CR (Pavlovian) or the R_i (instrumental) as a result of (procedural) extinction.
- **Explanatory:** a reduction in the associative strength of a CS-US association (Pavlovian) or S-R (or R-O) association (instrumental) or some other change that accounts for (behavioral) extinction during (procedural) extinction.

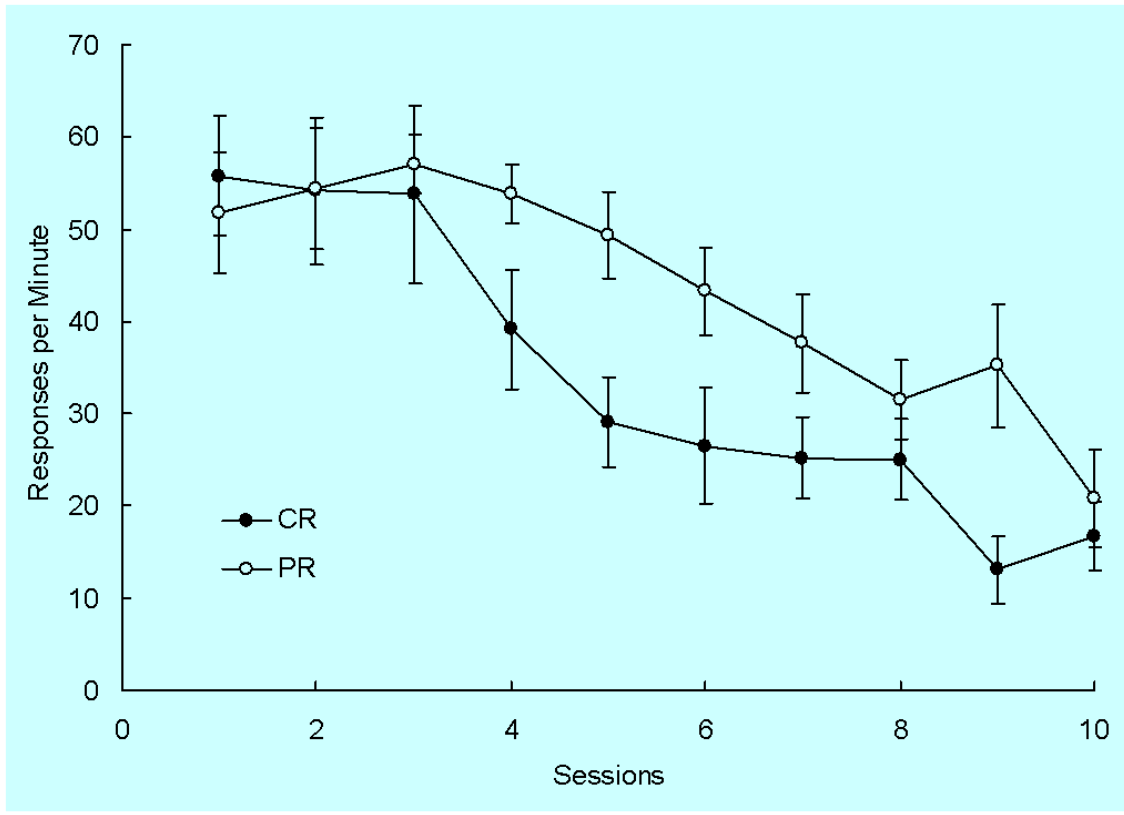
Extinction of salivary responses in dogs

- CS: metronome
- US: food
- CR: salivation
- No change in context
- Response-independent procedure
- Two dependent measures



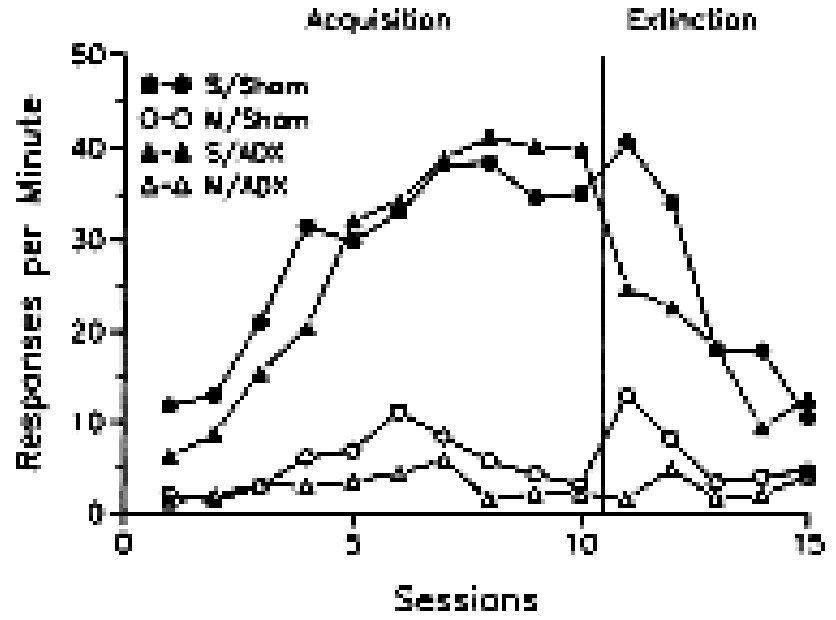
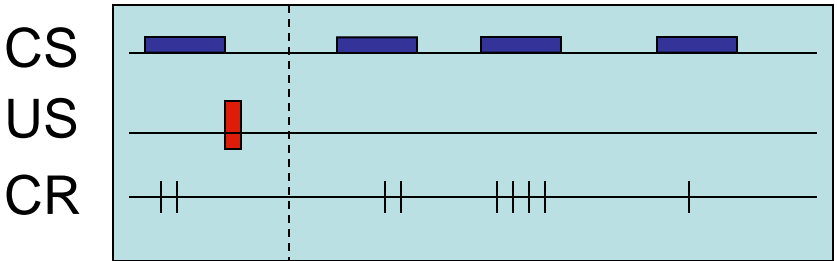
Extinction of autoshaped lever pressing in rats

- CS: presentation of lever
- US: food pellets
- CR: lever pressing
- Acquisition: CR vs. PR
- No change in context
- Response-independent procedure



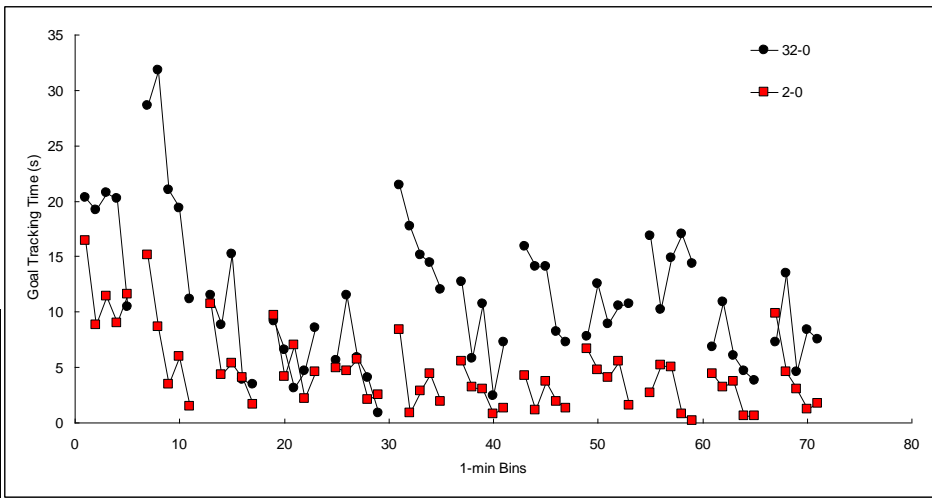
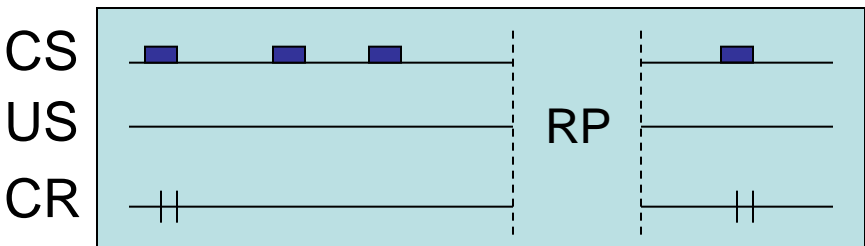
Properties of extinction

• **Extinction burst or spike:** An increase in the strength of the behavior during the early trials in extinction.



Thomas & Papini, 2001, *Physiol Behav*, 72, 543-547.

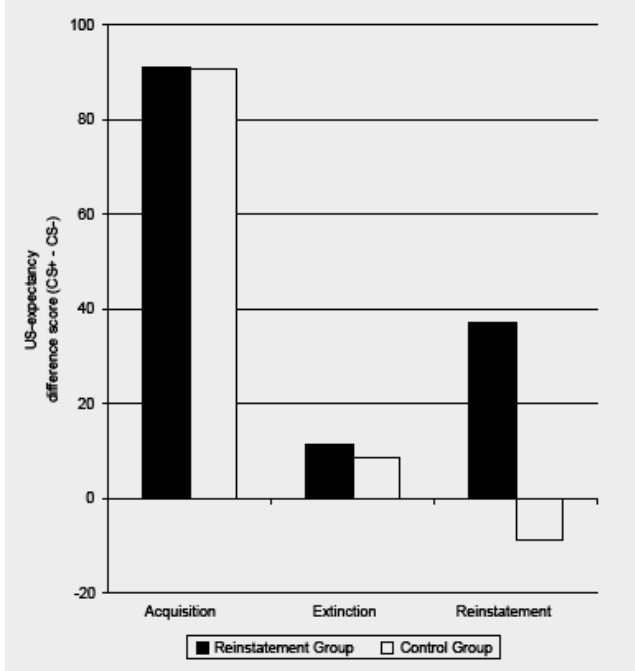
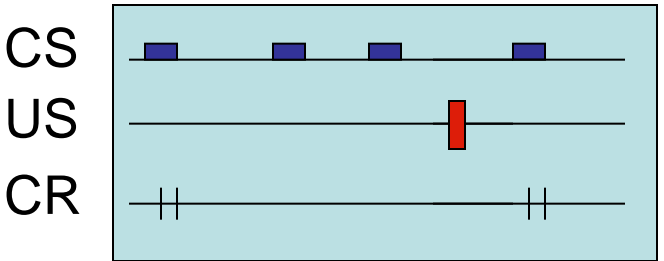
• **Spontaneous recovery:** An increase in the strength of the extinguished behavior after a period of rest (i.e., no exposure to training events).



Mustaca et al., 2002, *Int J Comp Psychol*, 15, 1-10.

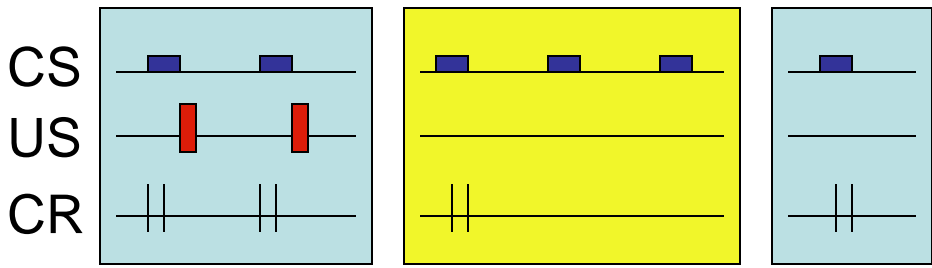
Properties of extinction

• **Reinstatement:** An increase in the strength of the extinguished behavior after exposure to unsignaled USs.

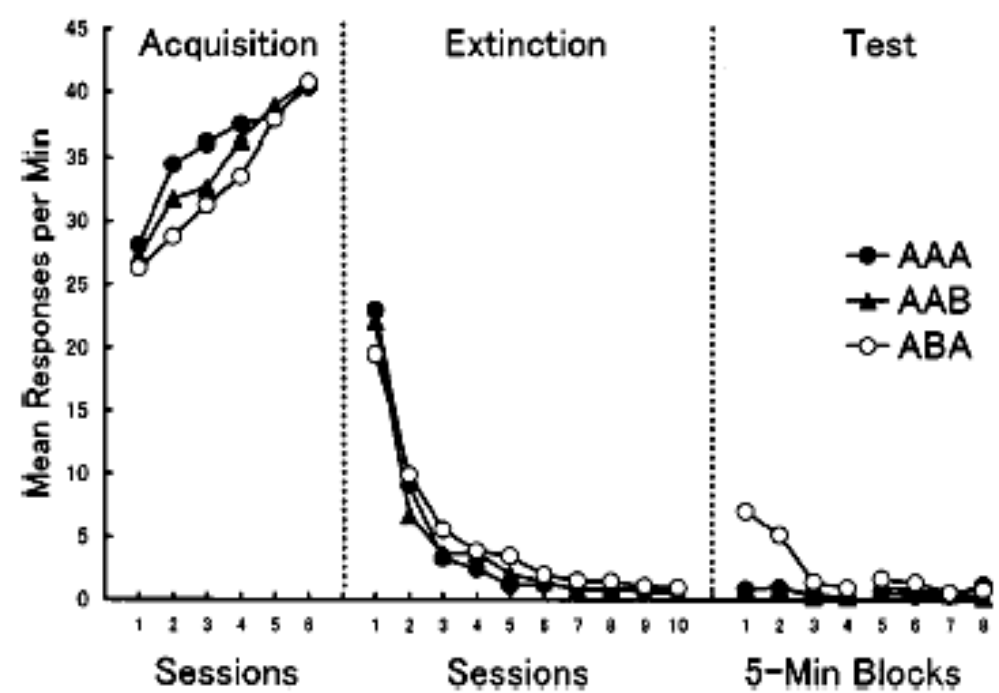
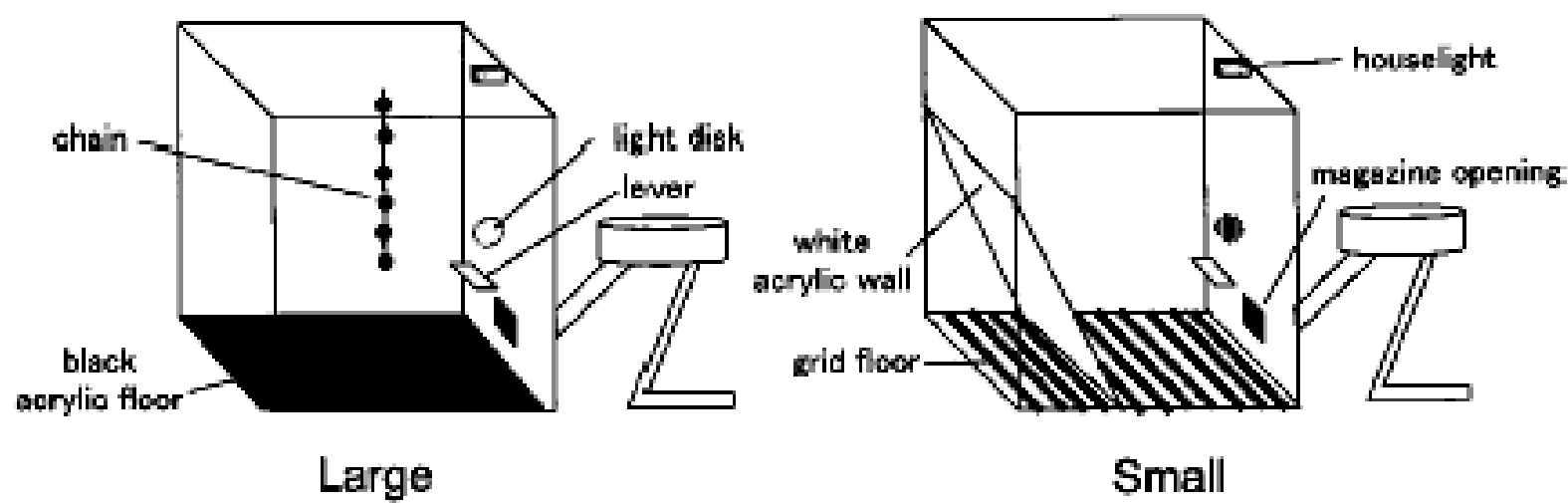


Hermanns et al., 2005, Behav Res Ther, 43, 533-551.

• **Renewal:** When extinction occurs in a new context, a further change in context (whether going to the acquisition context or to a novel context) results in an increase in the strength of the extinguished behavior.



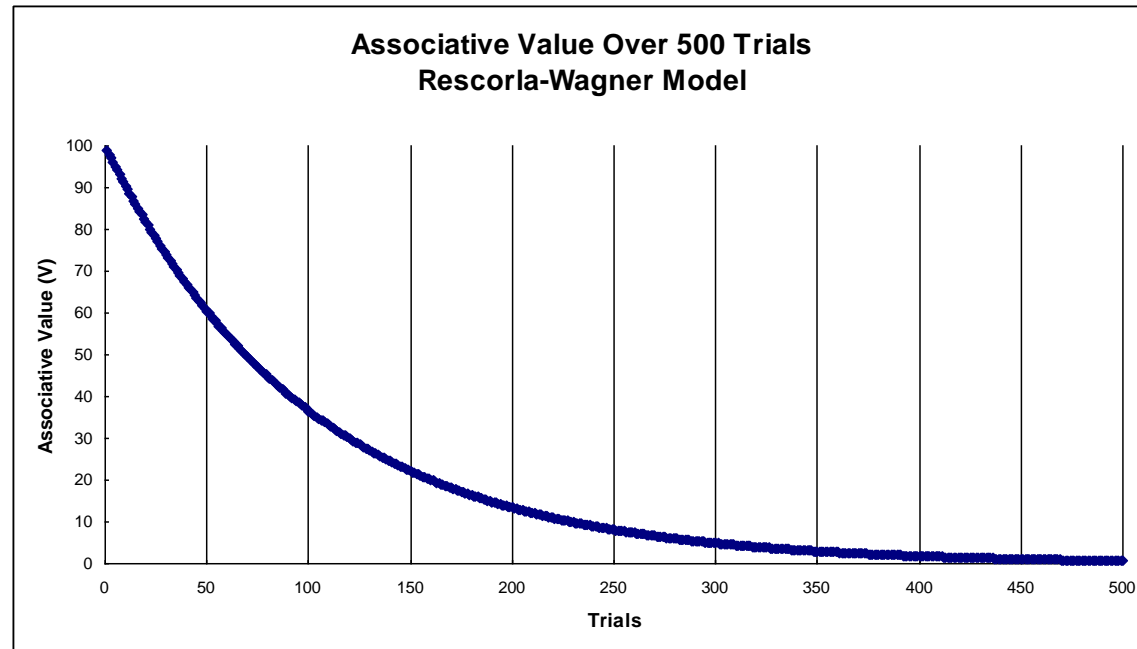
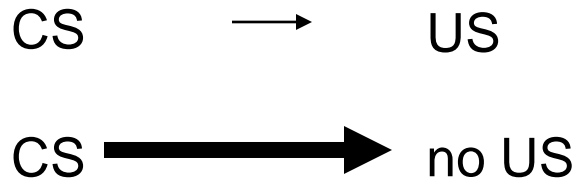
Renewal of instrumental behavior



Nakajima et al., 2000, Learn Motiv, 31, 416-431.

Two theoretical views: Pavlov and the RW model

- Does extinction lead to a weakening of associations (RW)?



- Does extinction lead to new learning (Pavlov)?

Acquisition:



Extinction:



Pavlov further assumed that inhibitory links were more labile, decaying spontaneously in time.

Theoretical implications of extinction properties

- A simple weakening theory (e.g., RW) applied without any modifications would be inconsistent with the four properties outlined previously.
- Additional factors are needed to account for these properties.
- **Extinction spike:** is the CR modulated by factors triggered by the extinction procedure, like emotional arousal? → Sometimes...
- **Spontaneous recovery:** are stimuli characteristic of the early portions of a session differentially encoded (timing)? → Quite possible...
- **Reinstatement:** is the CS getting a boost from contextual conditioning during reinstatement? → Not always...
- **Renewal:** is extinction a context-dependent effect? → In some cases

Context is not always relevant in extinction

Spontaneous recovery:

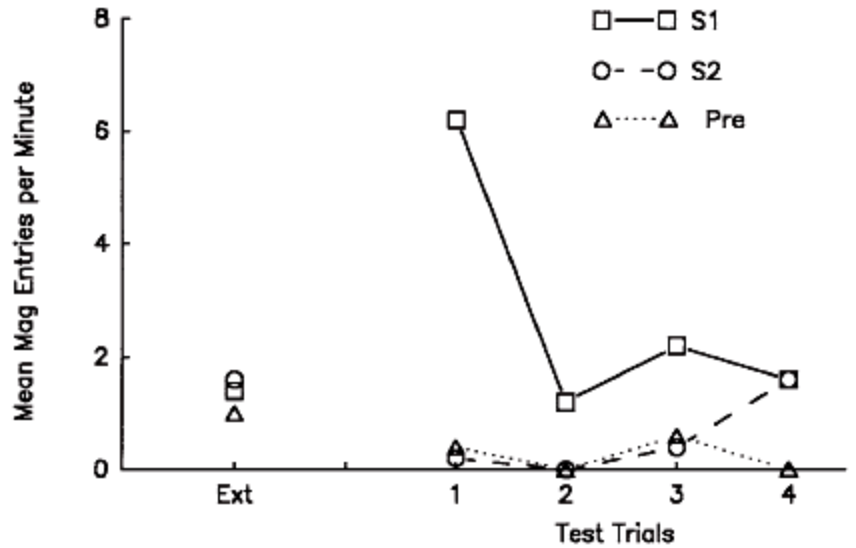
Acq	Ext	Test
A+	A- →6 days→	A?
B+	B- →1 day →	B?

A & B counterbalanced.

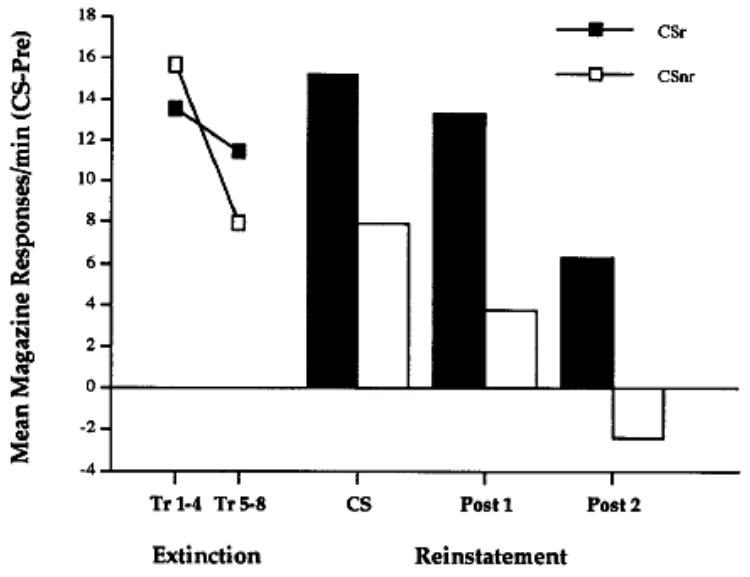
Reinstatement:

Acq	Ext	Reinst	Test
A→pel	A-	pel	A?
B→suc			B?

pel & suc counterbalanced.



Rescorla, 1997, Anim Learn Behav, 25, 99-107.



Delamater, 1997, Anim Learn Behav, 25, 400-412.

Extinction: Unlearning vs. inhibitory learning

- Extinction effects (e.g., renewal) may reflect:

That the original CS-US learning remains intact, or

That extinction was not complete.

- One assessment involves reacquisition of the CS-US association.
- Faster reacquisition than original acquisition would suggest that response suppression during extinction is due to inhibition.
- Equal reacquisition and acquisition rates would suggest that response suppression during extinction is due to unlearning.
- Evidence:

Faster reacquisition: nictitating membrane conditioning

Slower reacquisition: taste aversion, conditioned suppression

Effects of massive extinction on reacquisition

- Massive extinction (ME) involves extensive exposure to A- (after A+ training)
- Slow reacquisition after ME may be explained:

As unlearning of the original CS→US association, or

As the accumulation of inhibitory learning.

- Inhibitory learning tends to be labile and decay in time.
- Thus, the effects of ME tested at different retention intervals should differentiate between these possibilities.
- If ME leads to the unlearning of the original association, the ME group should be just as suppressed after a short vs. long retention interval.
- If ME leads to strong inhibitory learning, the ME group should be suppressed after a short, but not after a long retention interval.

Massive extinction treatment

														Retention interval		
Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	...or...	25
Cond													X+	X?	or	X?
CE									X+	X-	X-	X-	X+	X?	or	X?
ME	X+	X-	X-	X-	X-	X-	X-	X-	X-	X-	X-	X-	X+	X?	or	X?

Contextual fear conditioning

X: context

+: electric shock

Dep Var: freezing

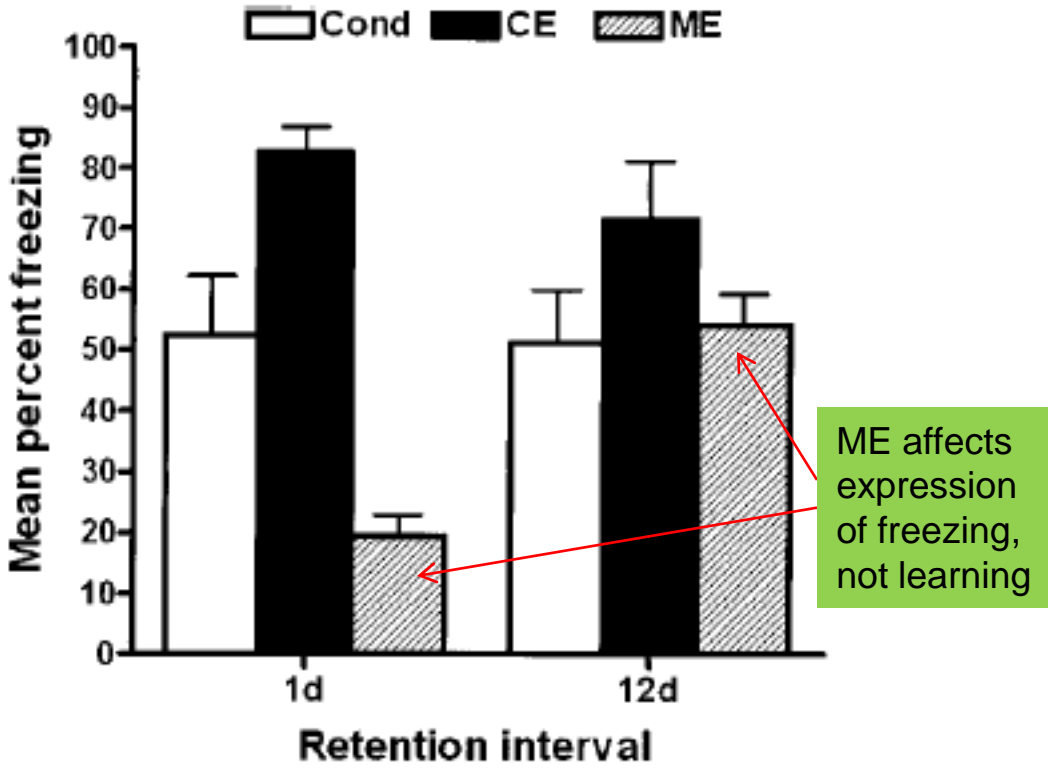
X+: rats placed in box, a single shock delivered 1 min later, rats stayed in box for an additional 2 min

X-: 20 min exposure to context, no shocks administered

Cond: control conditioning

CE: criterion extinction (3 sessions)

ME: massive extinction (11 sessions)



Extinction in multiple contexts and renewal

- In ABA renewal, extinction in one context (B) does not eliminate the CR after a switch to the original acquisition context (A).
- Does renewal reflect that the original CS→US association is intact?
- Or does it reflect incomplete unlearning of the original CS→US association?
- Extinction in multiple contexts may differentiate between these two.
- If the original association is intact, then extinction in multiple contexts should not affect renewal.
- If ABA renewal is due to incomplete extinction, then extinction in multiple contexts should diminish renewal.

Extinction in multiple contexts and renewal

Group	Acq	Ext 1	Ext 2	Ext 3	Test
Same	W:A+	W:A-	W:A-	W:A-	W:A?
NE	W:A+	W:-	W:-	W:-	W:A?
Diff-S	W:A+	X:A-	X:A-	X:A-	W:A?
Diff-M	W:A+	X:A-	Y:A-	Z:A-	W:A?

Conditioned taste aversion

W, X, Y, Z: contexts

+: LiCl

Dep Var: sucrose consumption

A+: rats placed in box for 14 min, then 30 min access to sucrose, then LiCl injection, then stayed in box for an additional 14 min

Ext: same as above except no LiCl

Same: AAA
 NE: no extinction (A_A)
 Diff-S: ABA
 Diff-M: ABCDA

