

# Topography of the CR and UR

## Basic components

(1) Early in training

CS



US



UR

(2) Late in training

CS



CR

## Salivary conditioning (dogs)

(1) Early in training

Metronome



Food



Salivation

(2) Late in training

Metronome



Salivation

## Eye-blink conditioning (rabbits, rats, humans)

(1) Early in training

Tone



Airpuff



Blink

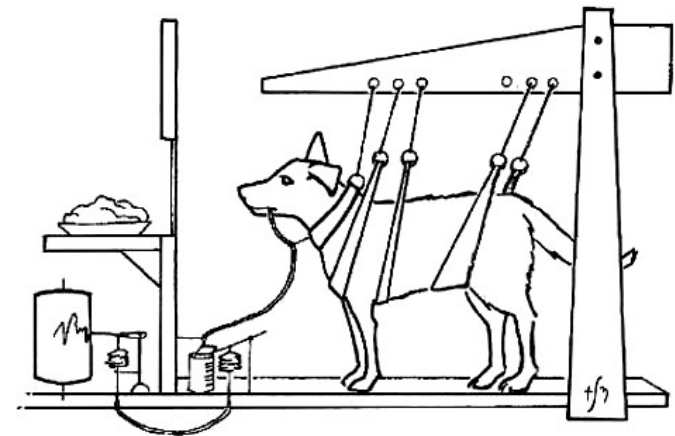
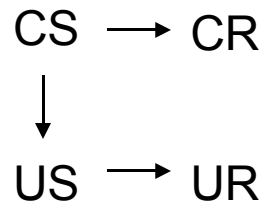
(2) Late in training

Tone



Blink

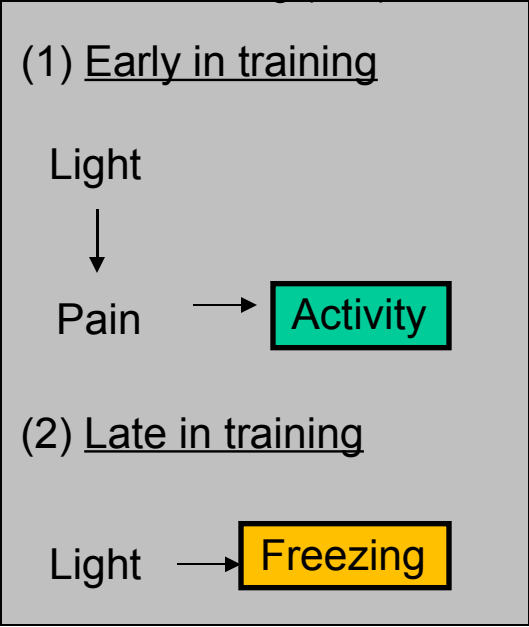
# Pavlov's principle of stimulus substitution



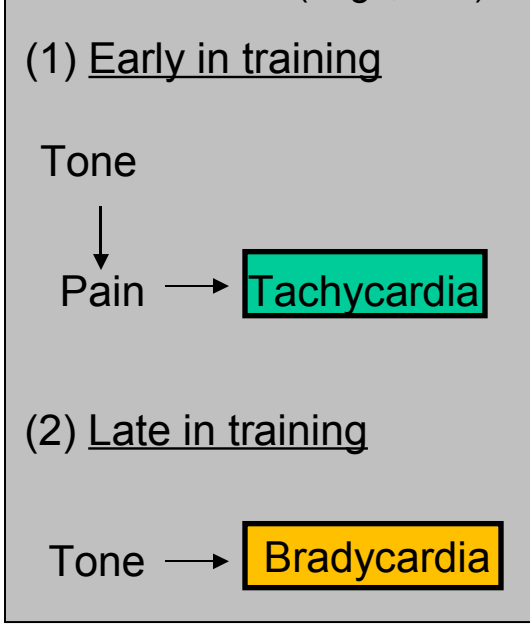
- In salivary conditioning,  $\text{UR} = \text{CR}$  (in both cases, salivation is induced).
- Thus, Pavlov argued that the CS comes to function as a substitute for the US.
- According to the stimulus-substitution hypothesis of CR form,  $\text{CR} = \text{UR}$  should apply to all conditioning situations.
- But we have known for a long time that the CR need not be equal to the UR.
- Dogs released from their harness actually exhibit increased activity, barking, and tail wagging in the presence of a CS for food, none of which occurs in response to the food US (Zenner, 1935).
- More importantly, Subkov & Zilov (1937) reported that whereas adrenaline caused increased heart rate, exposure to a CS for adrenaline caused dogs to exhibit a decrease in heart rate.

# Preparations in which CR ≠ UR

Fear conditioning (rats)

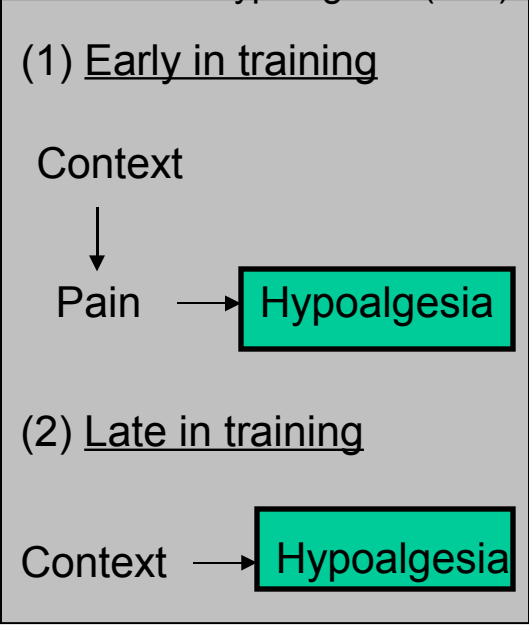


Heart-rate condit (dogs, rats)

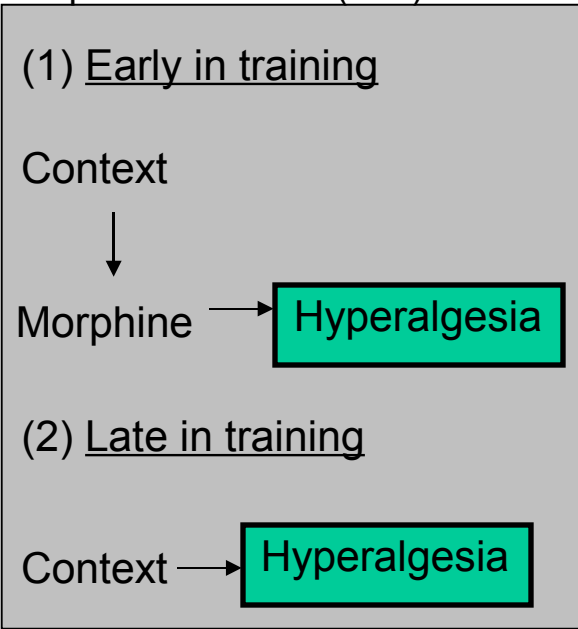


# Preparations in which CR-UR relationship is not what it seems

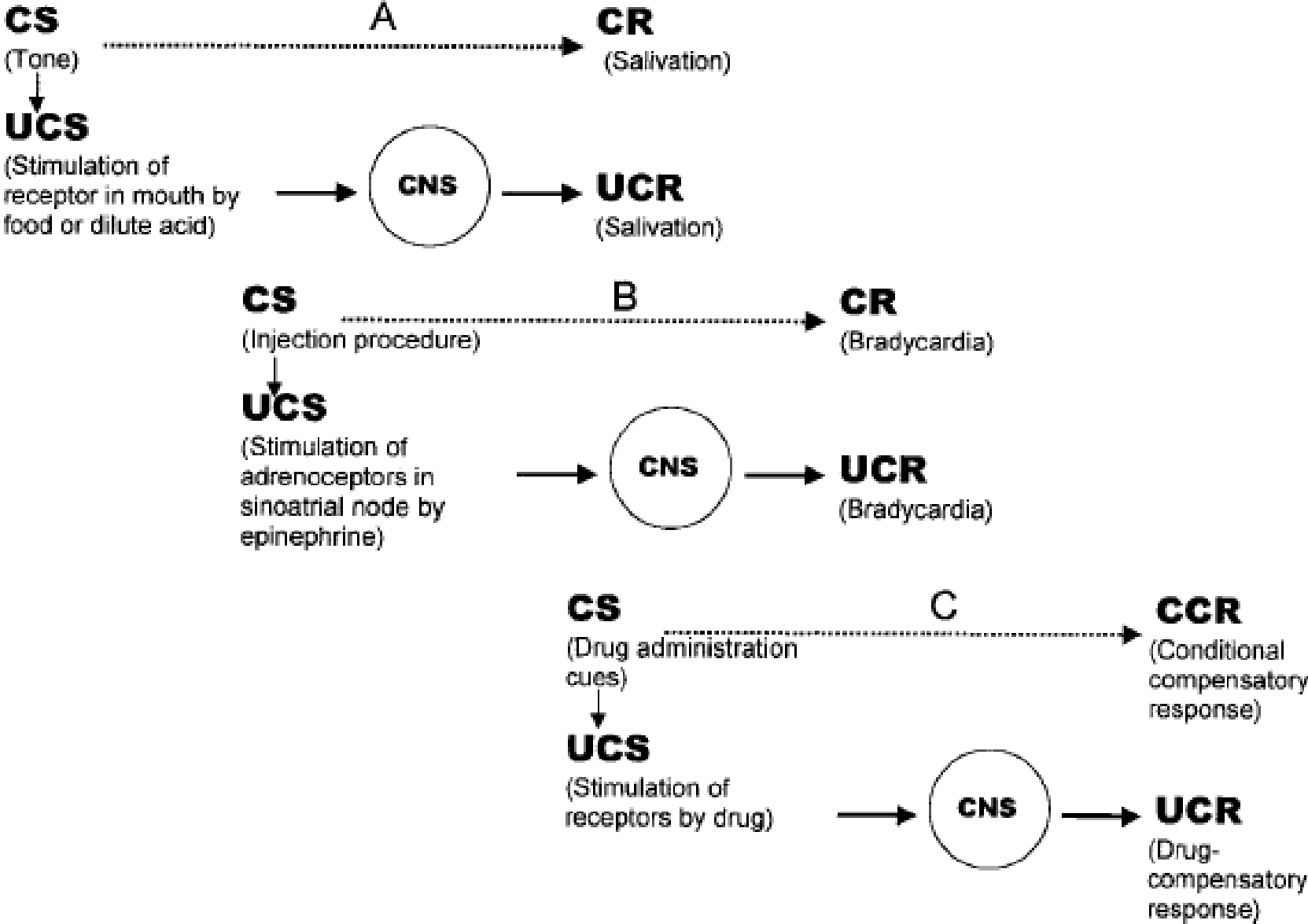
## Conditioned hypoalgesia (rats)



## Morphine tolerance (rats)

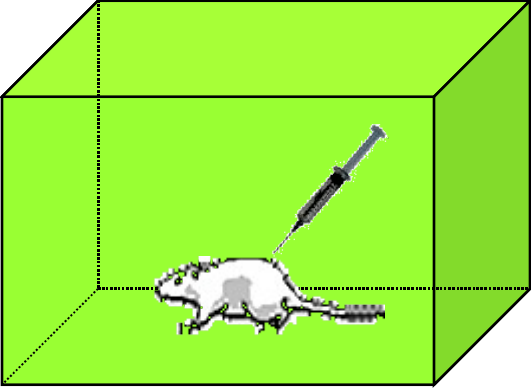


# Conditioned and unconditioned compensatory responses

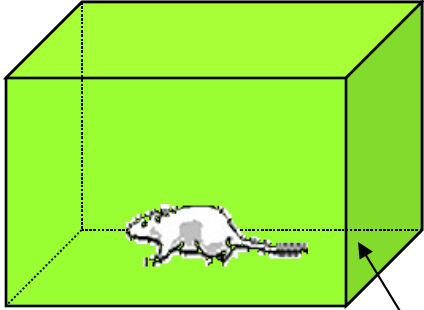


Morphine tolerance

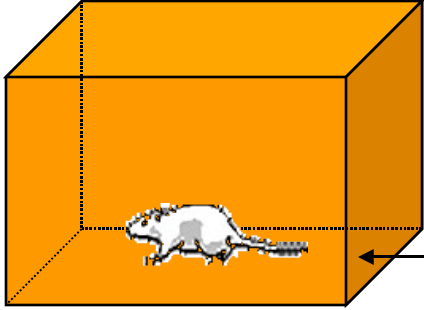
Morphine trial



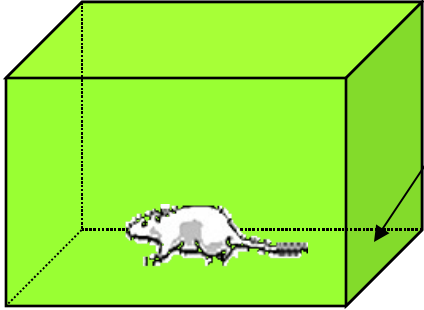
Same



Different



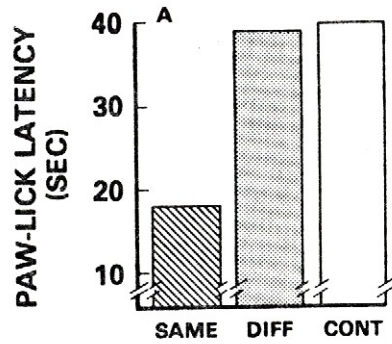
Novel morphine (at test)



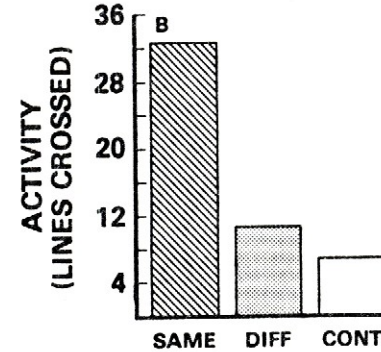
Testing

Hot plate

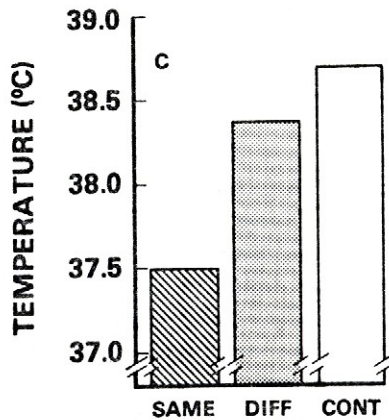
# Evidence for the Pavlovian conditioning of morphine tolerance



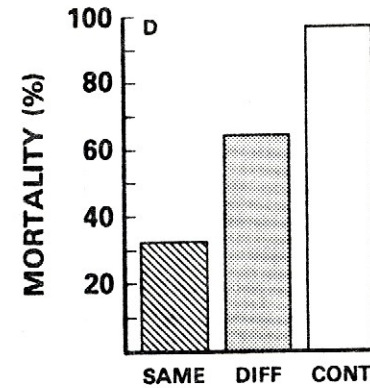
Pain sensitivity



Activity



Peripheral temperature



Death by overdose

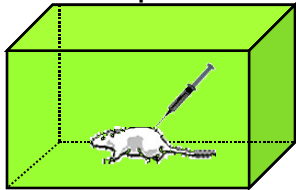
## Morphine tolerance: Predictions

If morphine tolerance is the product of Pavlovian conditioning, then what will be your prediction for the following situations?:

(3) Nonreinforced exposure to the context after morphine administration.

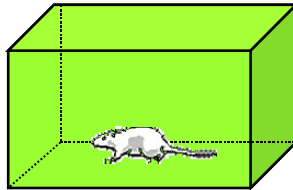
Phase 1

Morphine trial



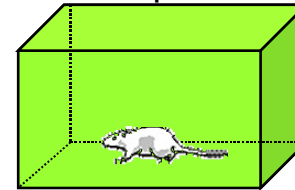
Phase 2

Context extinction



Test

Hot plate test



(2) Nonreinforced preexposure to the context before morphine administration.

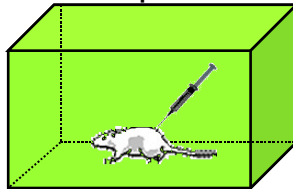
Phase 1

Context preexposure



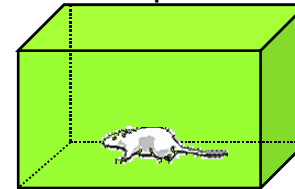
Phase 2

Morphine trial

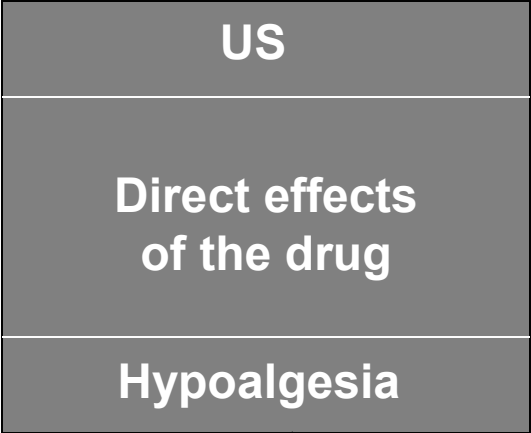
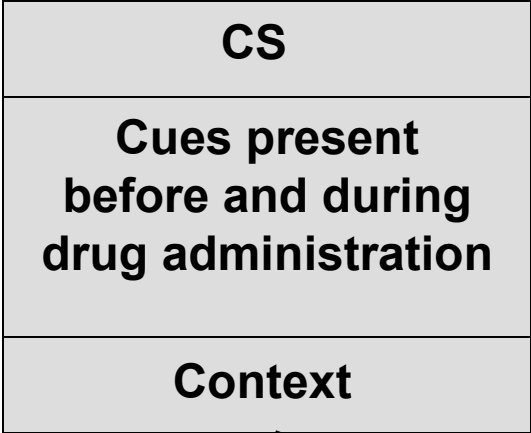
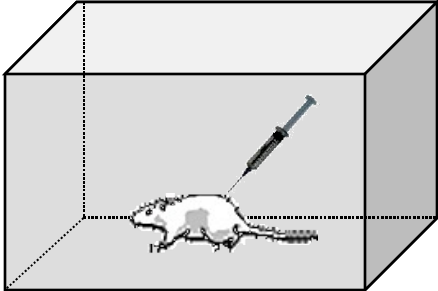


Test

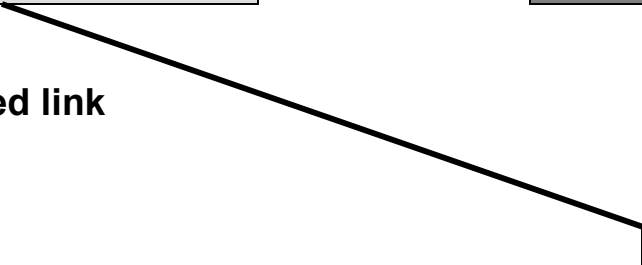
Hot plate test



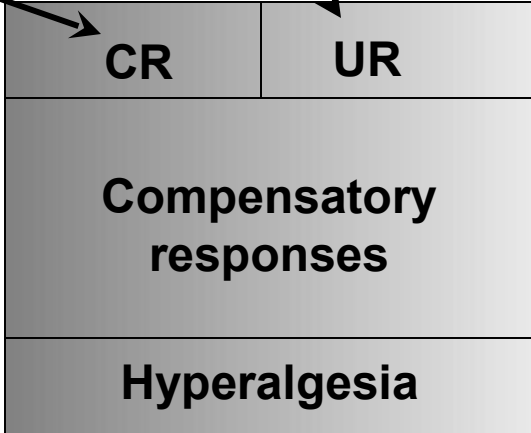
# Morphine tolerance and stimulus substitution



**Conditioned link**

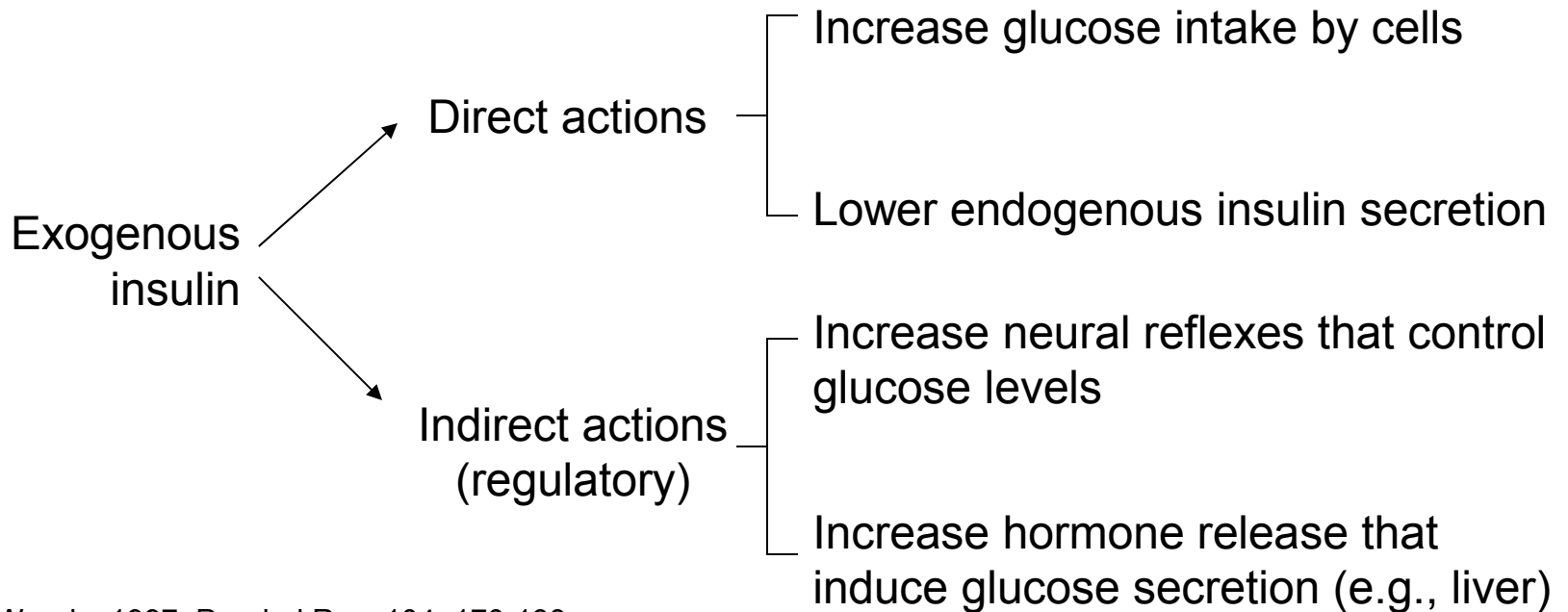


**Unconditioned link**

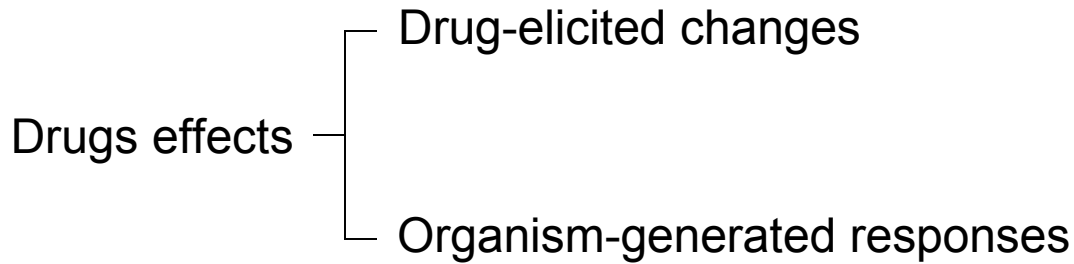


## Nature of the organism's response to a drug

- In a Pavlovian conditioning experiment, the key terms are CS, US, CR, and UR.
- What are the CR and UR when drugs are injected into an organism?
- Drugs have two types of effects:
  - Direct actions: drug effects on cell physiology that occur even in vitro.
  - Indirect actions: CNS-mediated actions

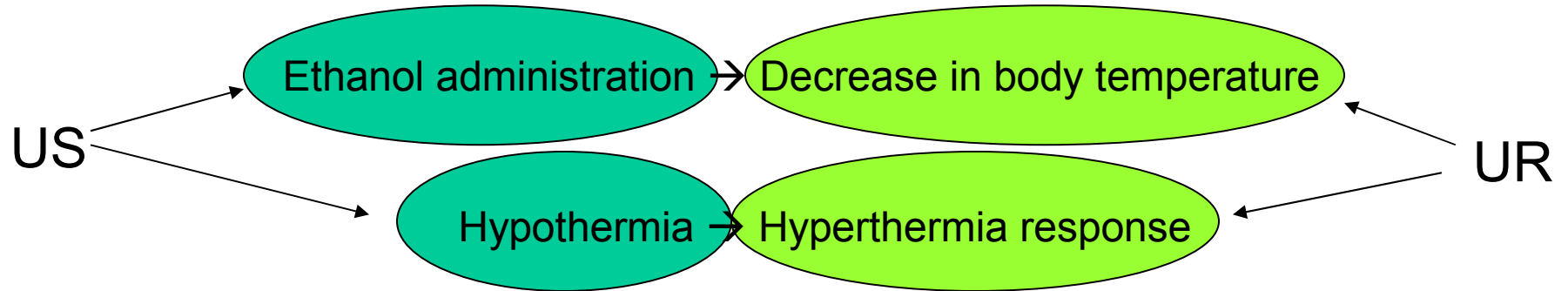


## Nature of the organism's response to a drug



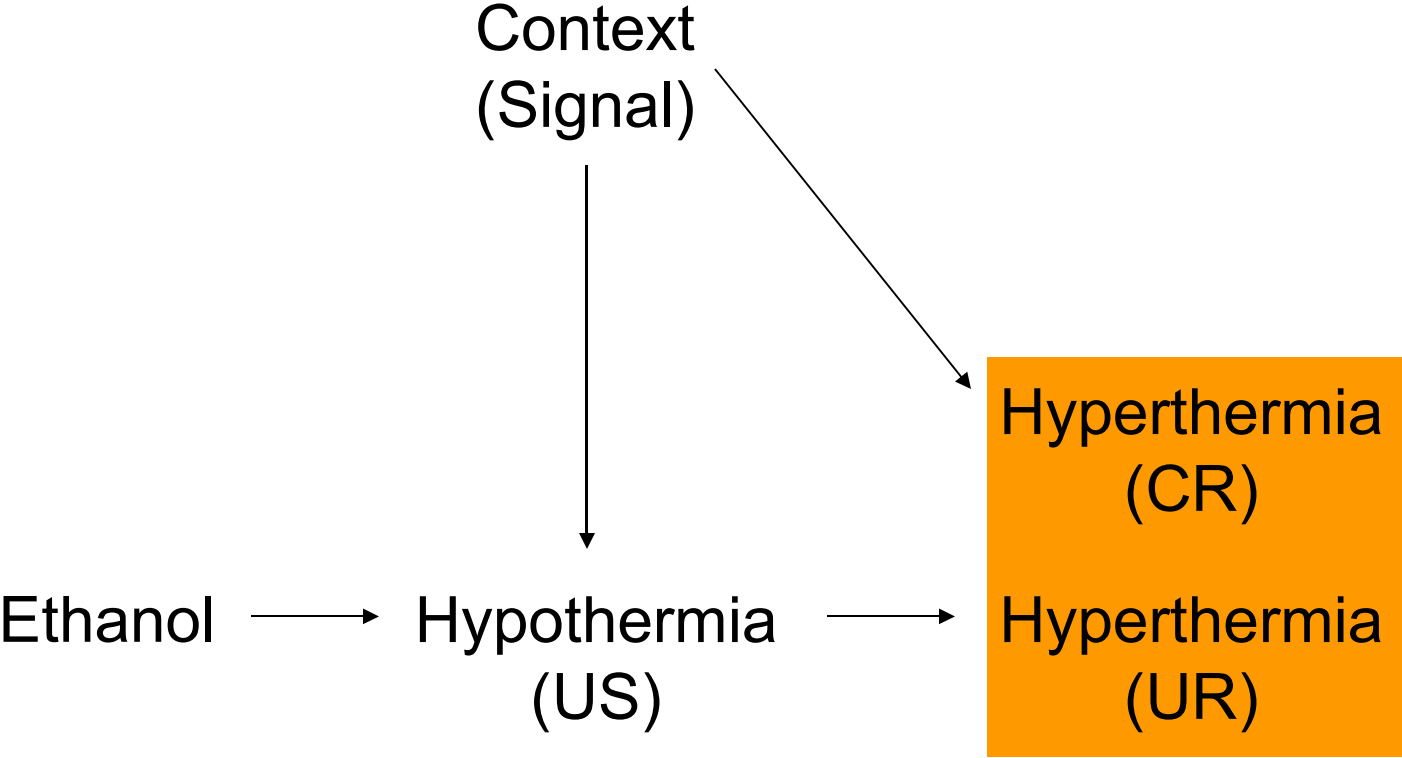
- The drug itself is not the US
- Drug → physiological perturbations
- Perturbations detected by the CNS → US
- In Pavlov's experiment with acid as the US: the real US is the centrally detected perturbation in the oral cavity caused by the acid
- Detected acid-induced oral perturbation (US) → Increased salivary response (UR)

# Ethanol



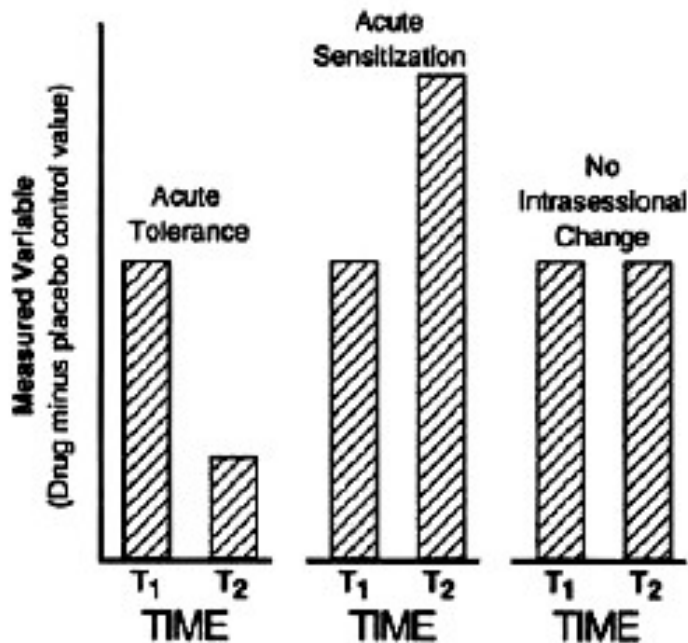
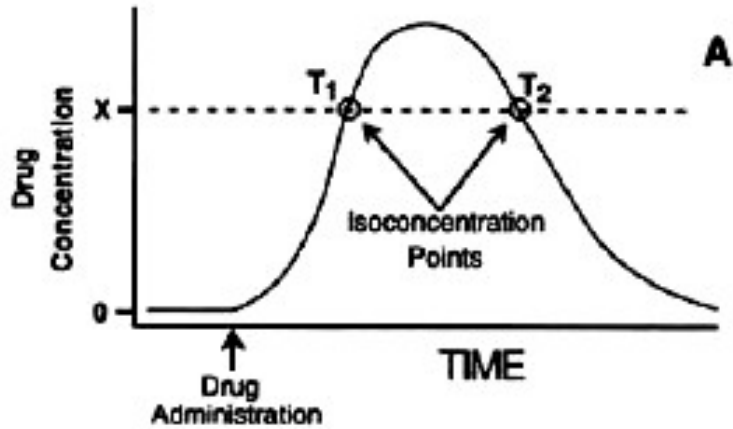
- The traditional view is that drug = US and the direct drug response = UR.
- Thus, ethanol = US and hypothermia = UR
- Because the Pavlovian procedure results in hyperthermia (CR) to the CS, then the CR is (incorrectly) viewed as being compensatory.
- However, ethanol  $\neq$  US
- And hypothermia  $\neq$  UR
- Hypothermia induced by a cold environment also leads to a hyperthermia CR

# Pavlovian conditioning with ethanol

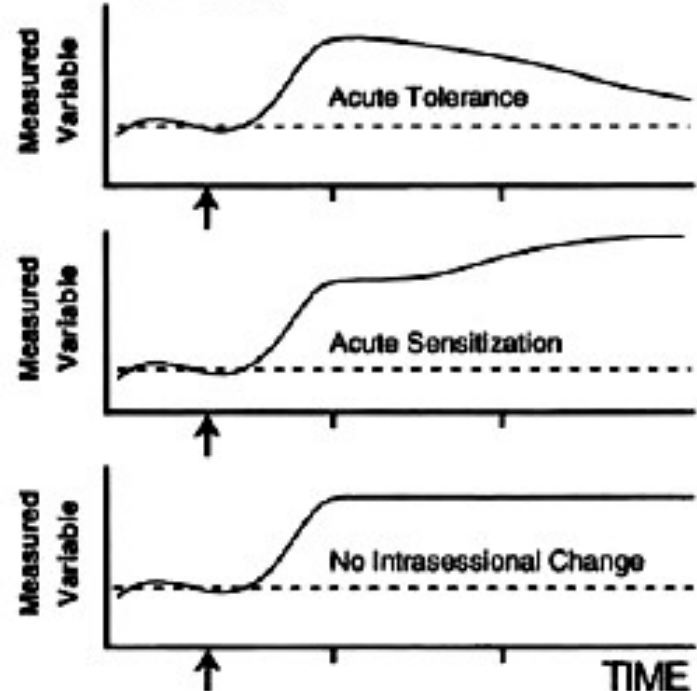
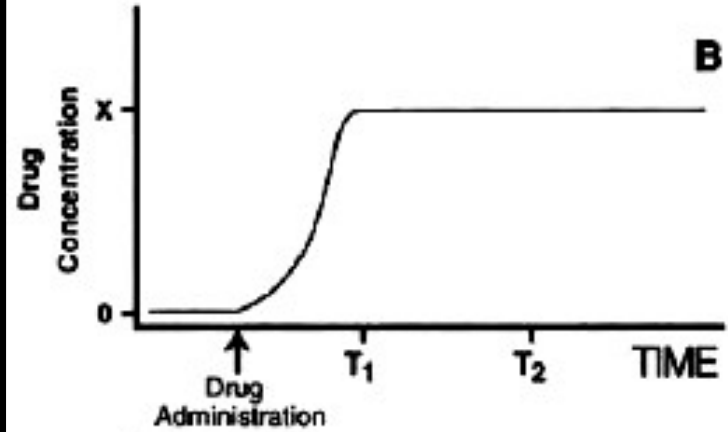


# Measuring acute (unconditioned) tolerance

## Bolus method



## Steady-level method



# Summary

URs recruited at three levels of drug action

