

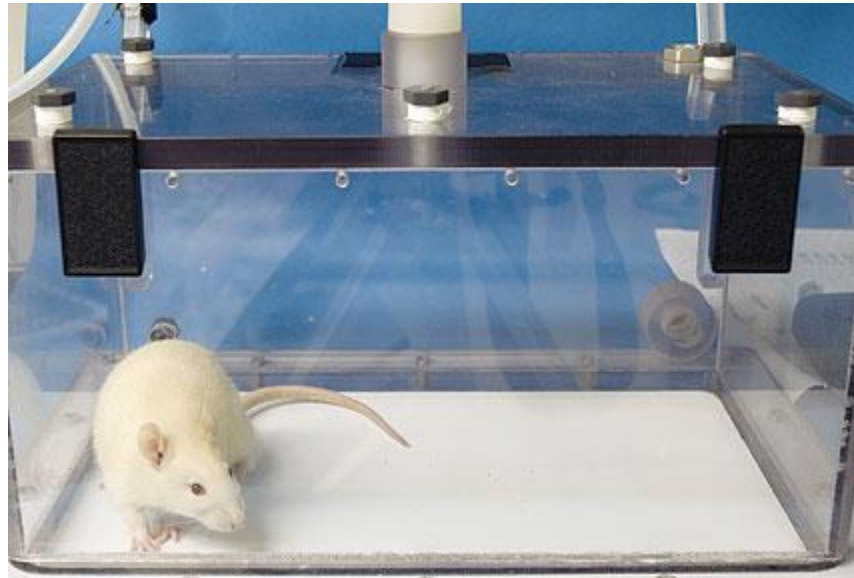


animal welfare
program

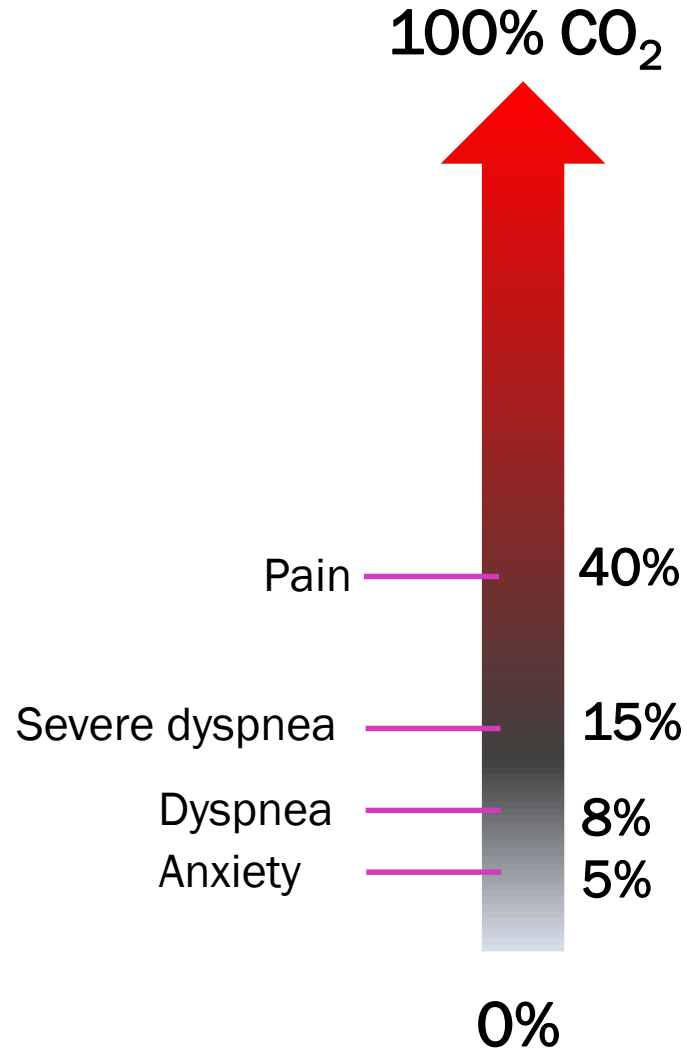
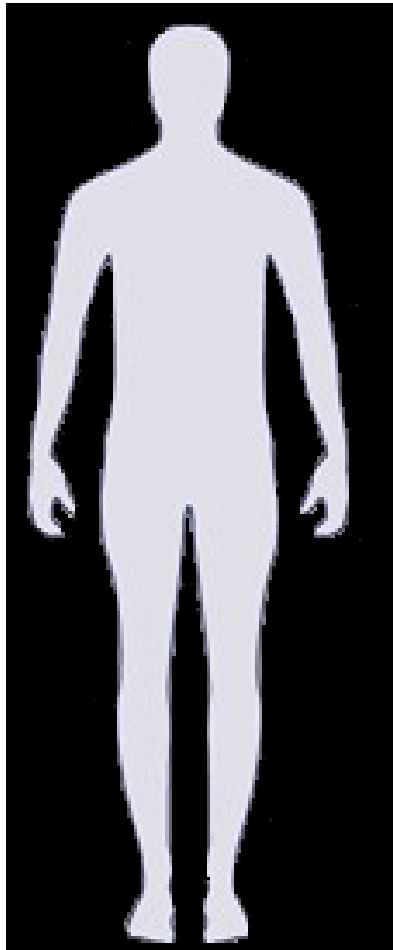
Workshop – CO₂

Daniel M. Weary & Joanna Makowska

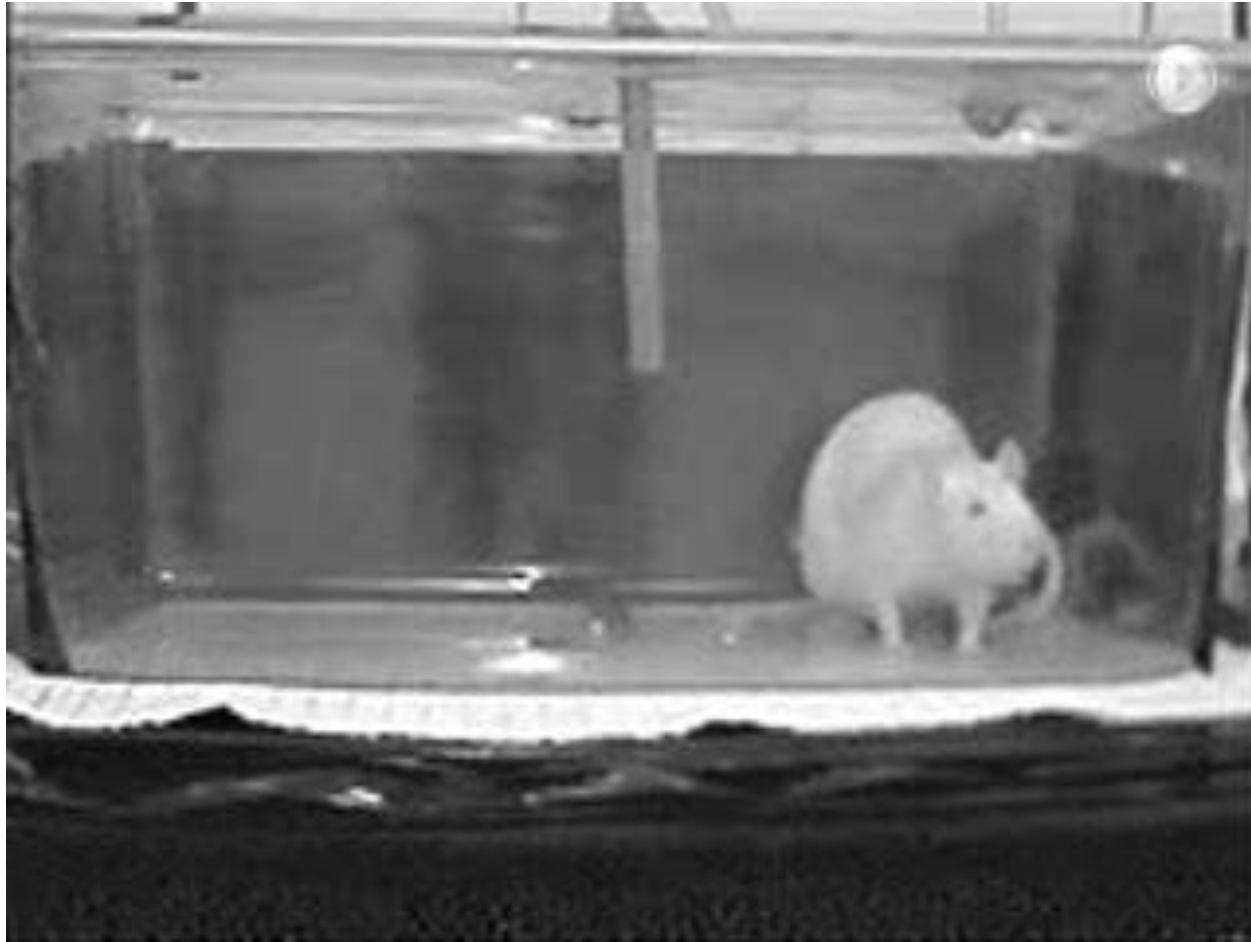
Is exposure to CO₂ humane?

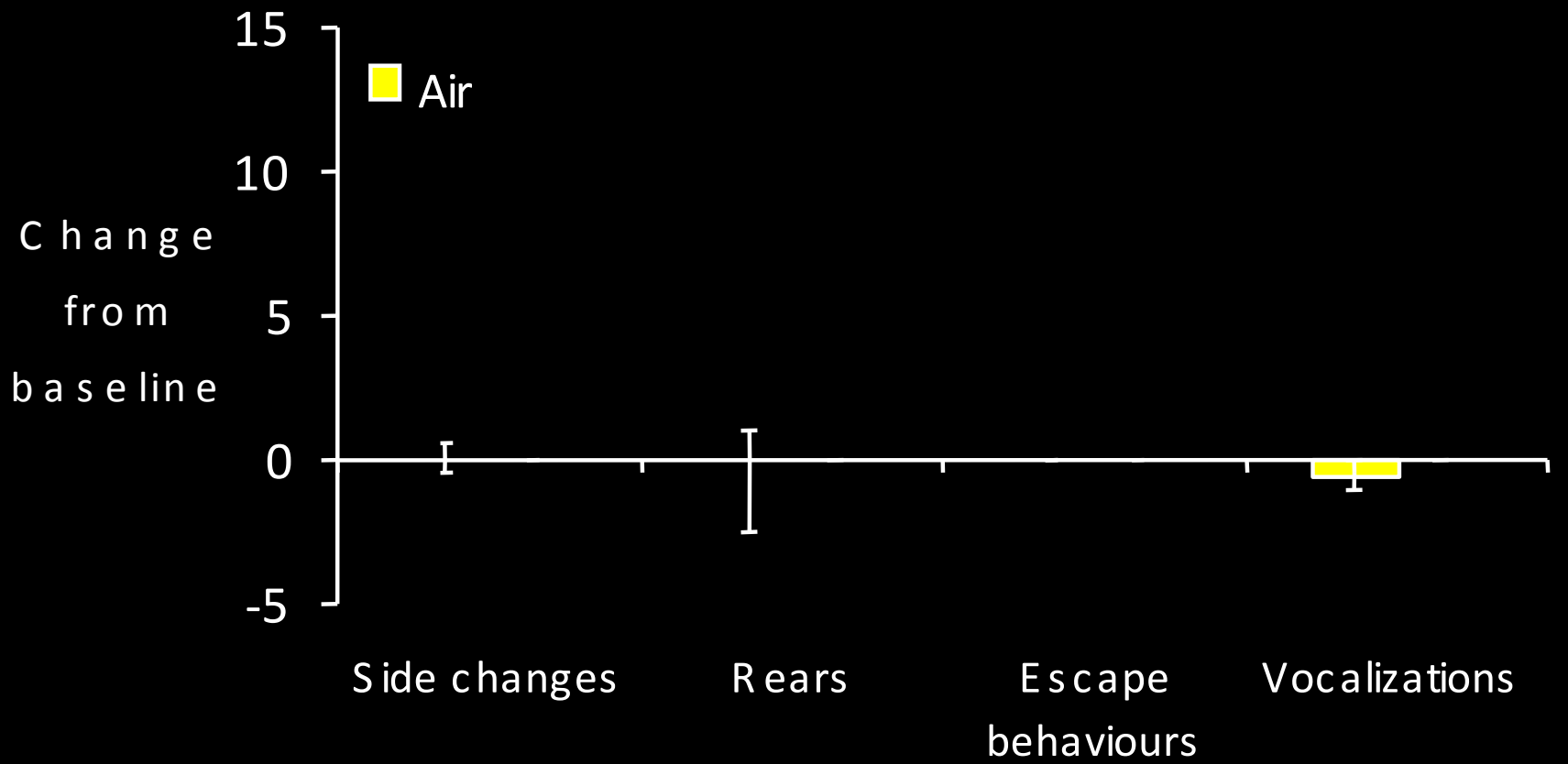


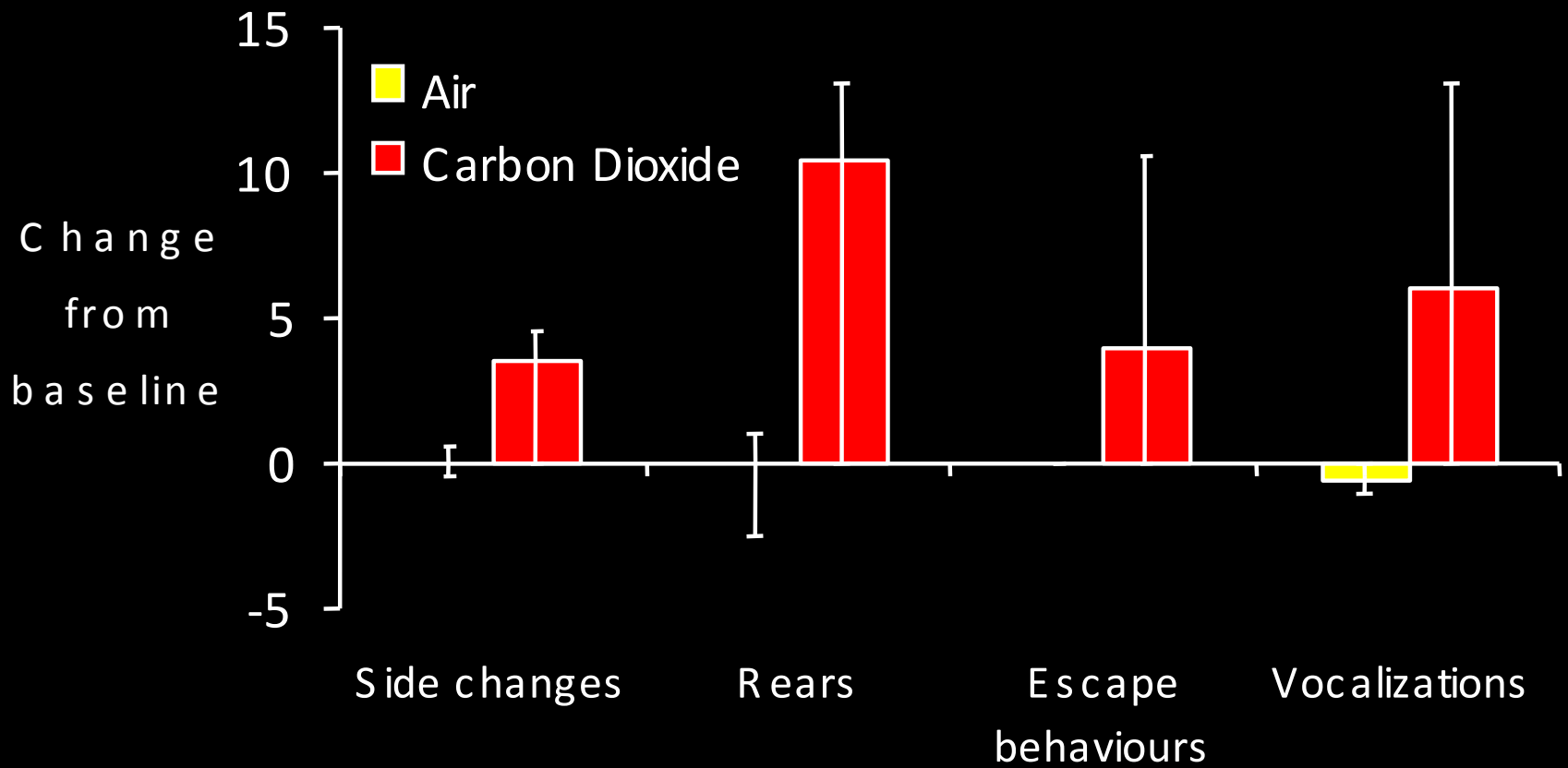
Pain and distress associated with CO₂ exposure



Acute responses to forced exposure







Acute responses to forced exposure

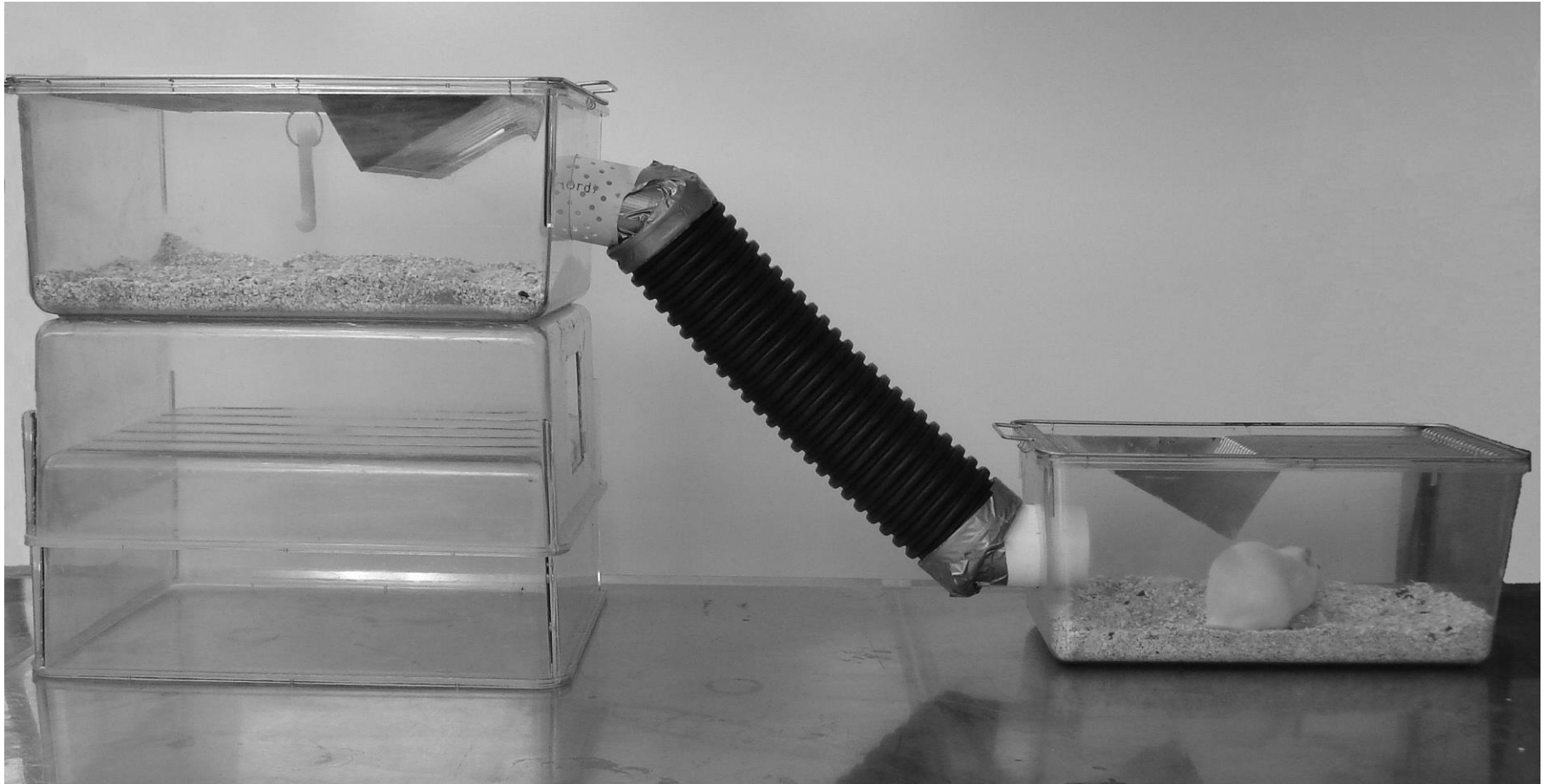
Pros:

- Intuitive, cheap and easy

Cons:

- Highly variable responses
- Responses and lack of response are difficult to interpret

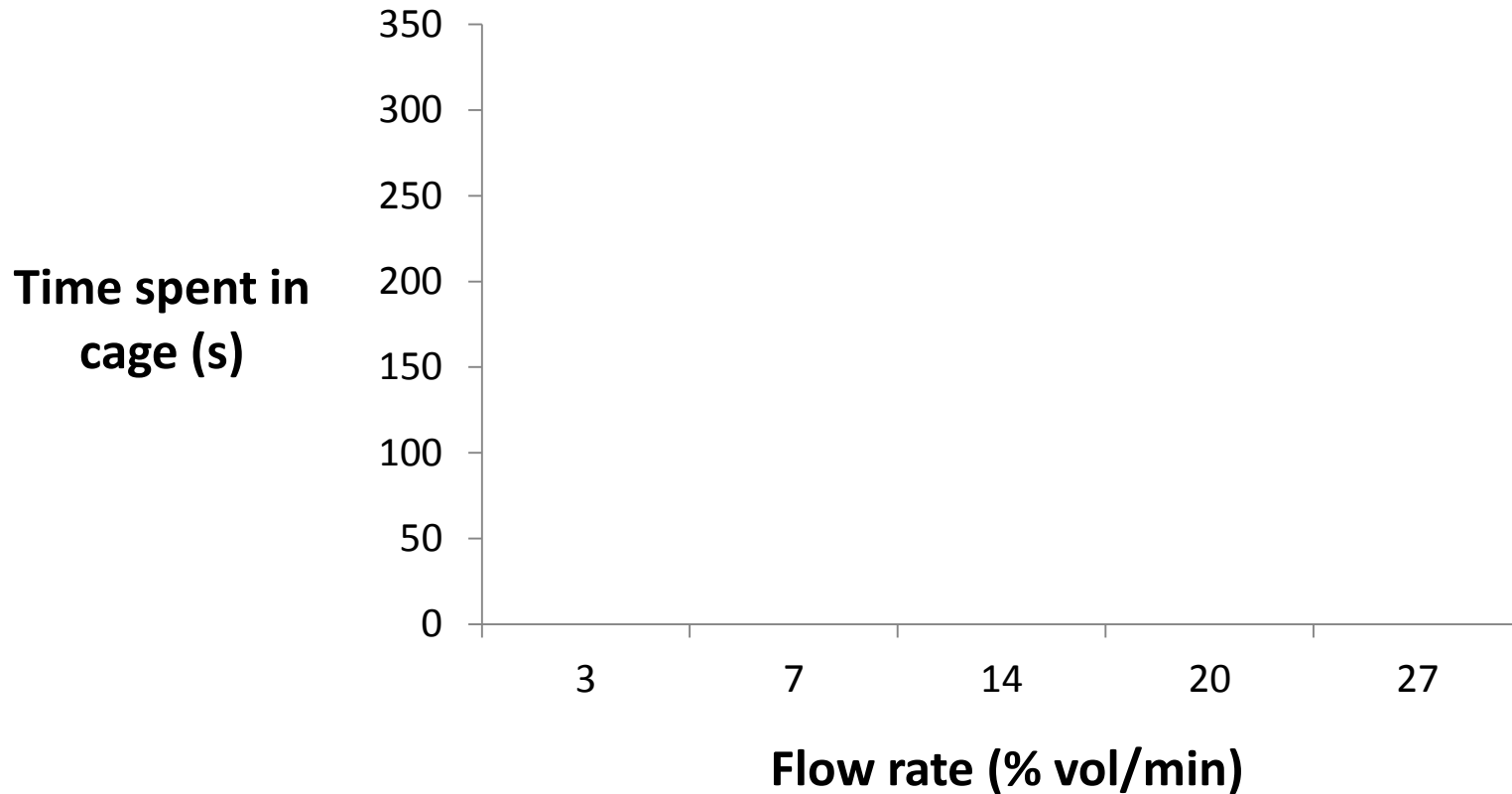
Approach-avoidance



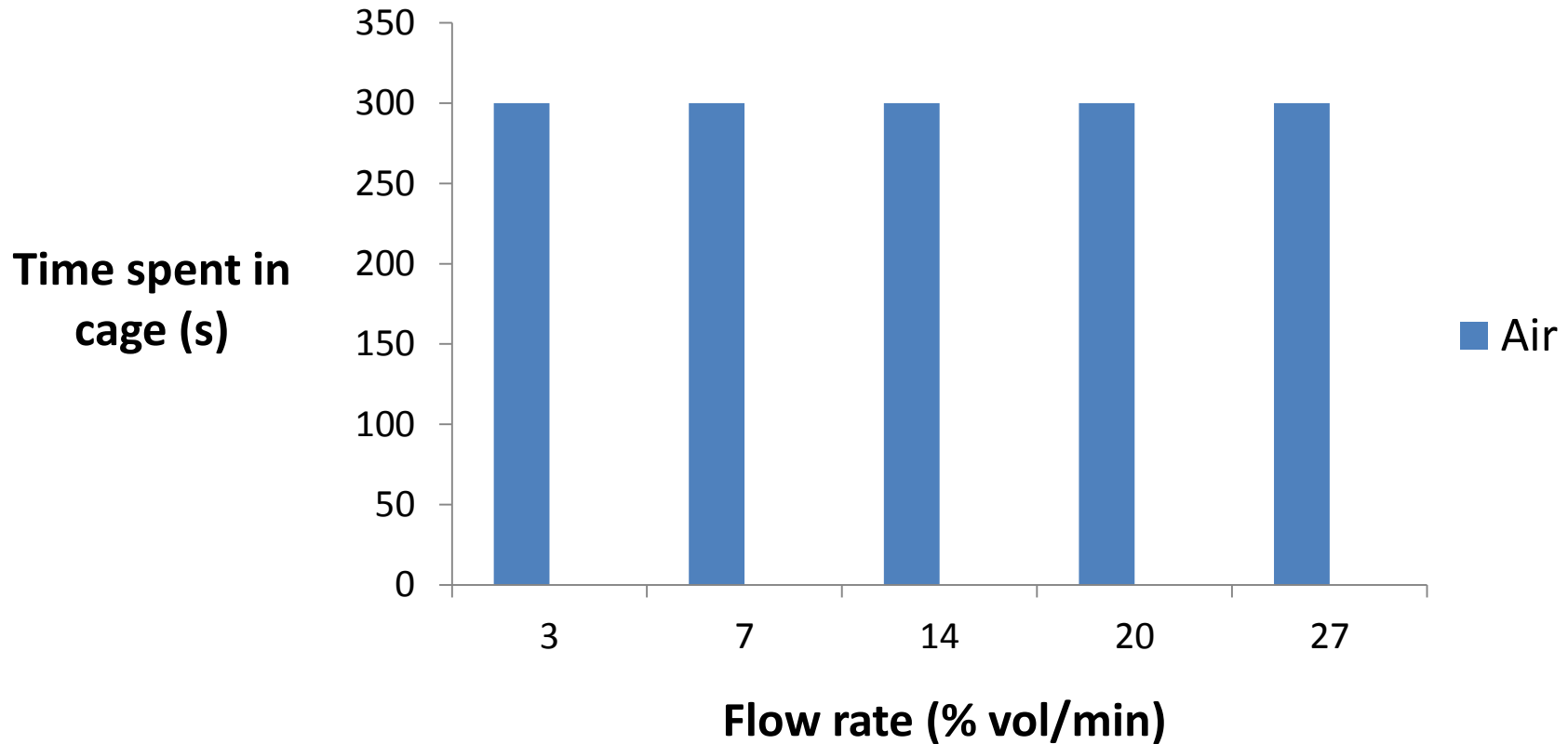
Approach-avoidance



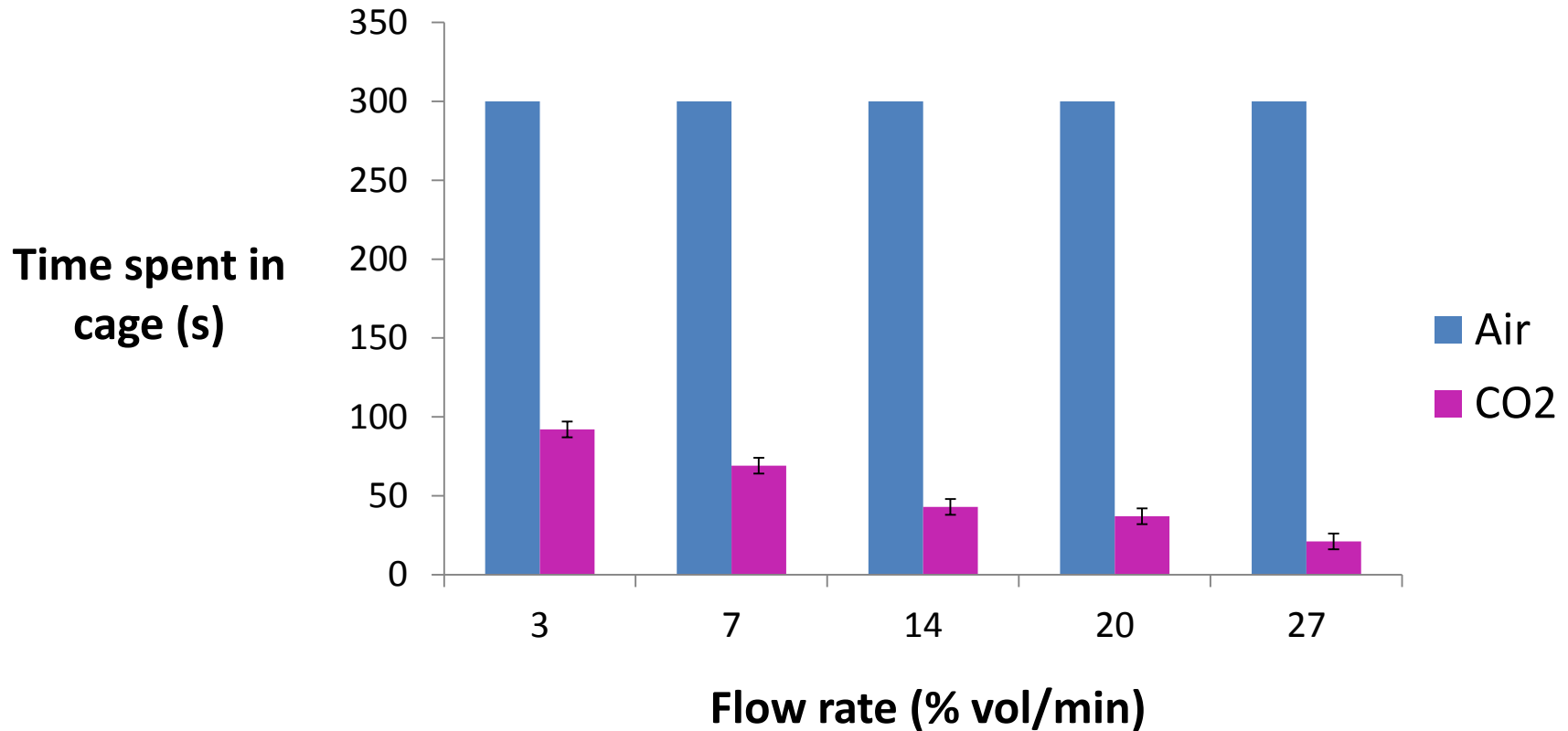
Approach-avoidance with CO₂



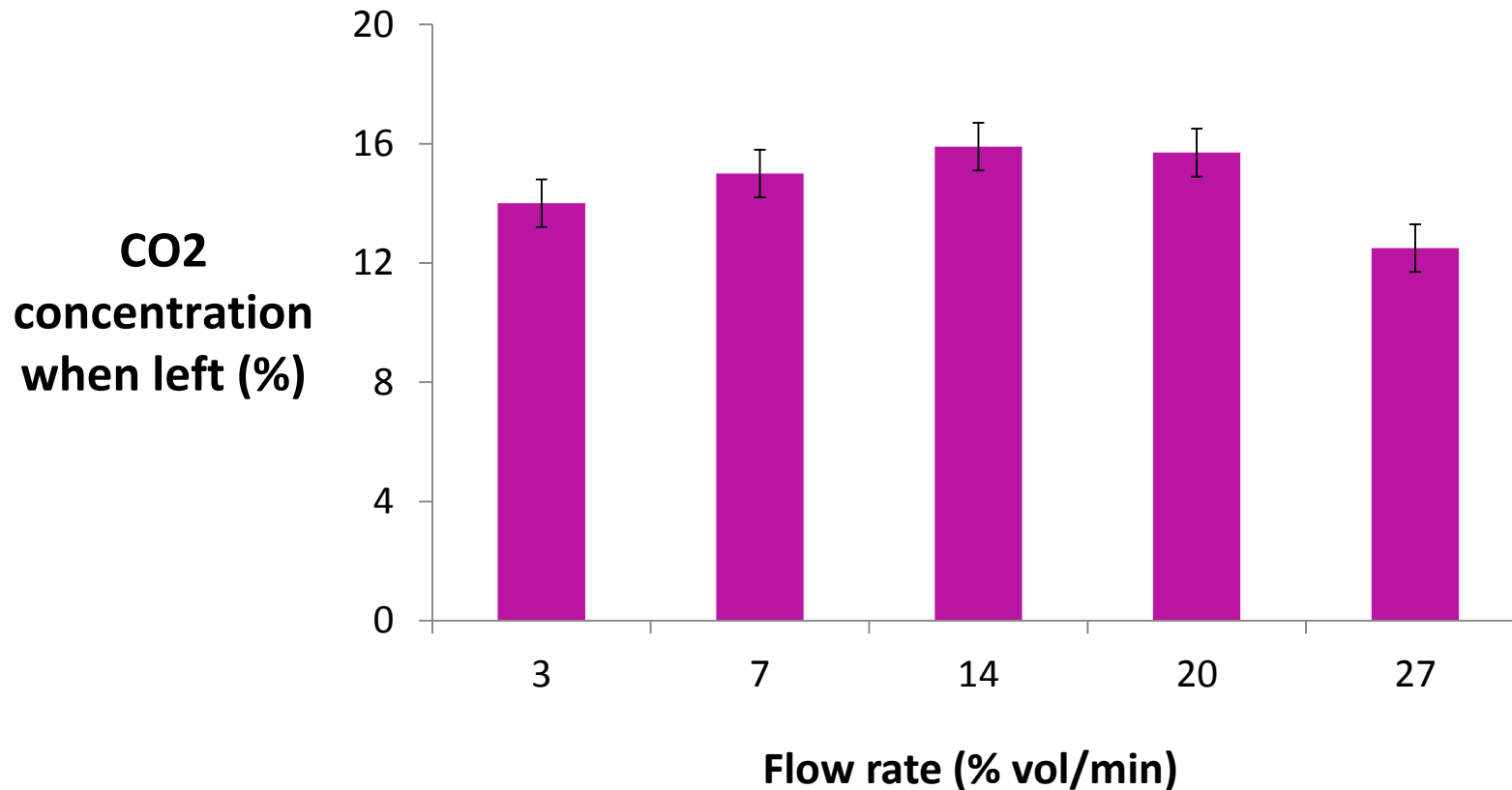
Approach-avoidance with CO₂



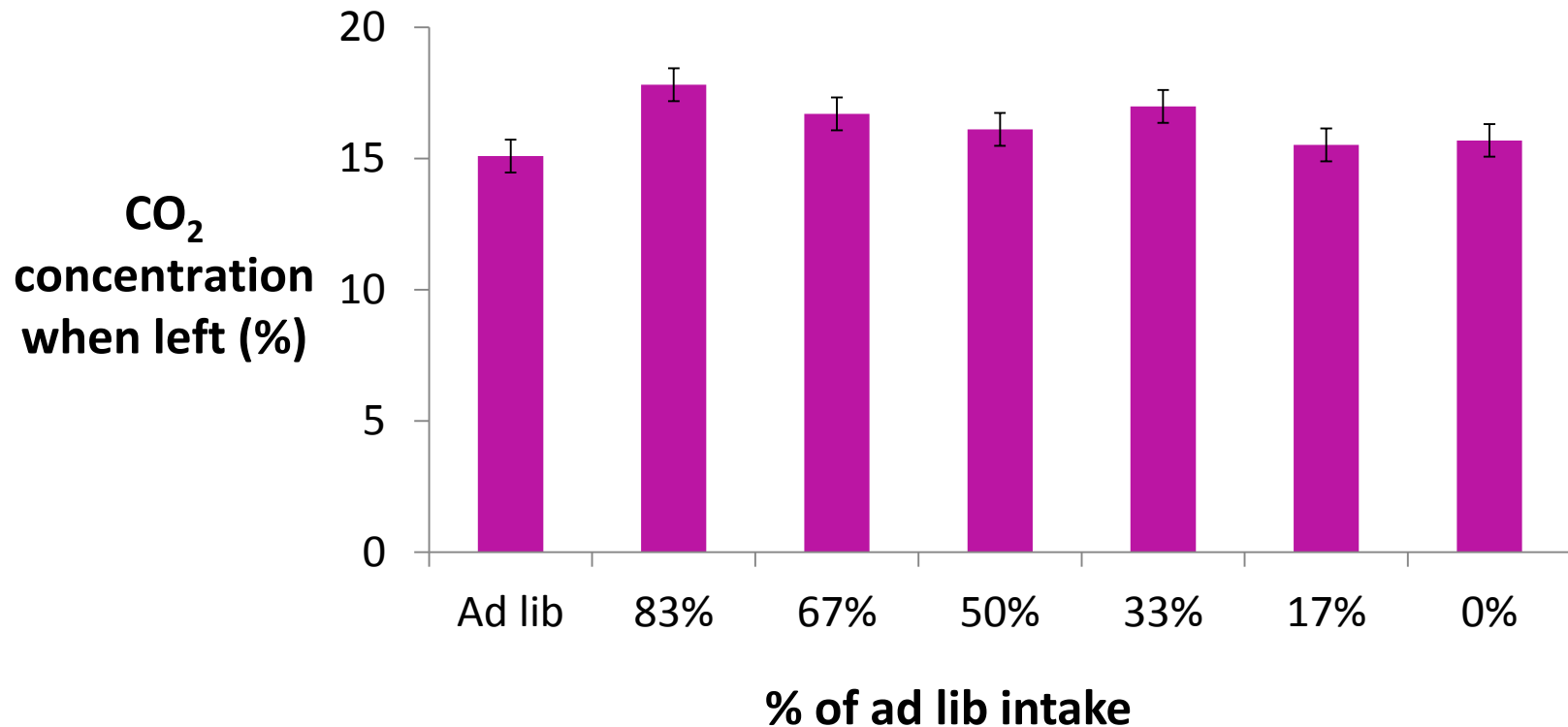
Approach-avoidance with CO₂



Approach-avoidance with CO₂



Rats leave chamber at $\approx 15\%$ CO₂ ever after 24 h of food deprivation



Approach-avoidance testing

Pros:

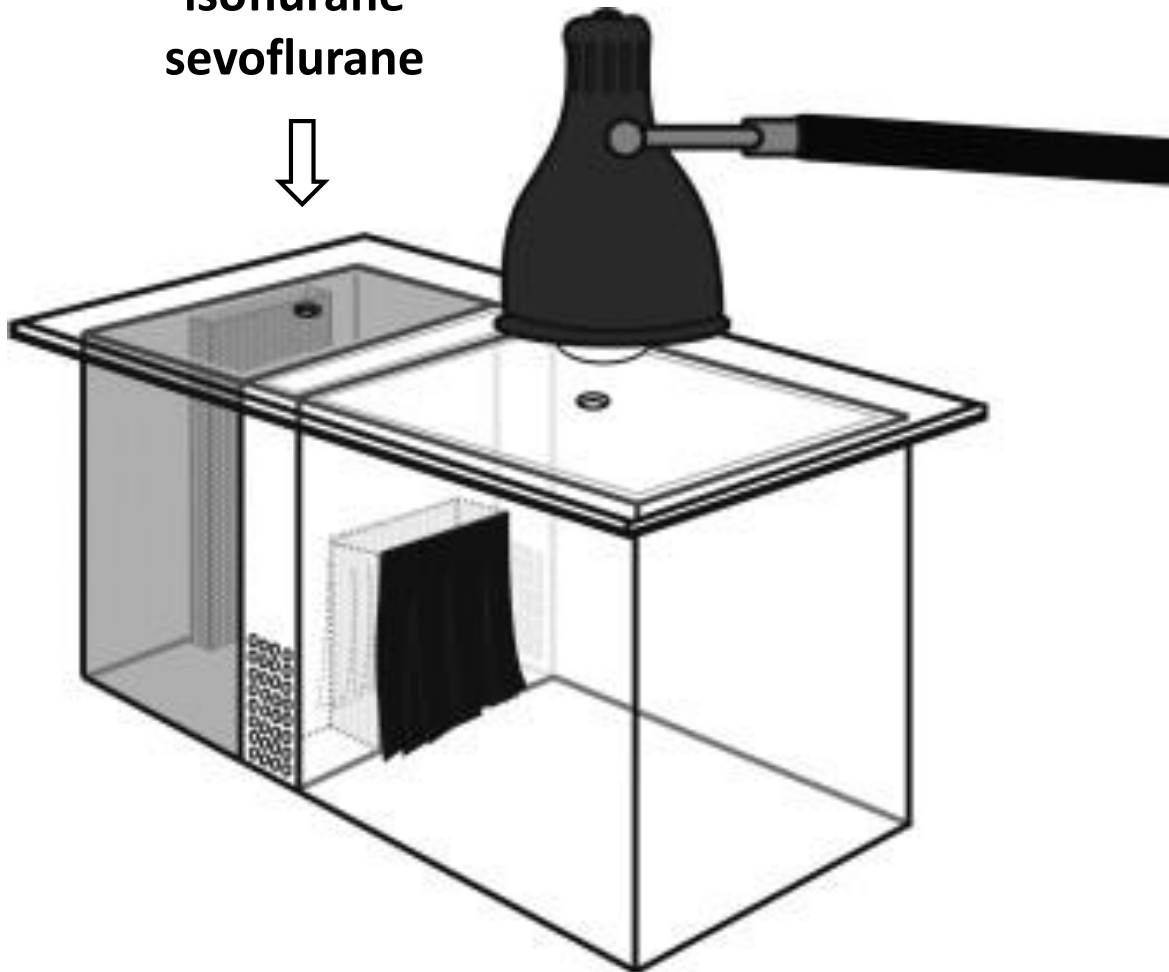
- Pre-defined response measures
- High consistency

Cons:

- Requires training
- Requires inferences about motivation to access reward
- Assumes that motivation does not vary with treatment

Aversion-avoidance

CO₂
isoflurane
sevoflurane



Percent rats that stayed in the dark/euthanasia compartment

Experiment 1	
CO ₂	isoflurane
0%	56%

Percent rats that stayed in the dark/euthanasia compartment

Experiment 1		Experiment 2	
CO ₂	isoflurane	isoflurane	sevoflurane
0%	56%	65%	71%

Exp. 1: Wong et al. 2013

Exp 2: Boulanger Bertolus et al., in press

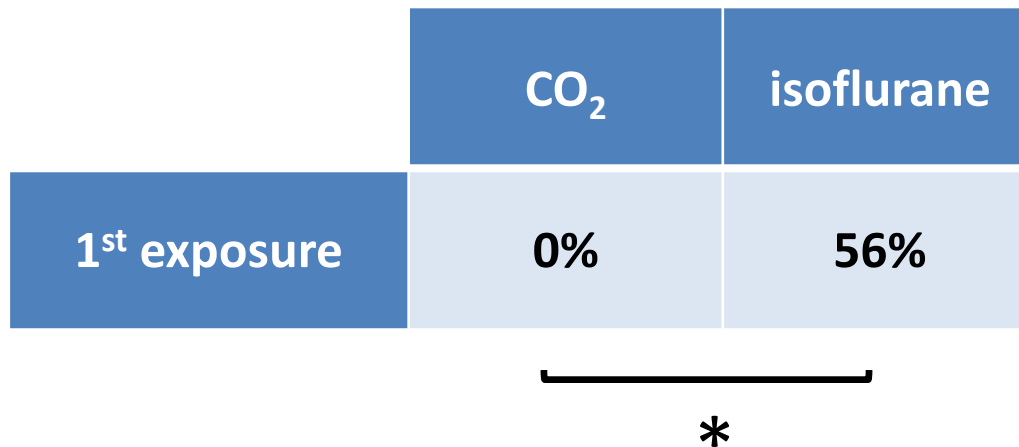
Percent rats that stayed in the dark/euthanasia compartment

	Experiment 1		Experiment 2	
	CO ₂	isoflurane	isoflurane	sevoflurane
1 st exposure	0%	* [56% ↓	* [65% ↓	* [71% ↓
2 nd exposure	0%	* [6% ↓	* [39% ↓	* [56% ↓

Exp. 1: Wong et al. 2013


Exp 2: Boulanger Bertolus et al., submitted

Percent mice that stayed in the dark/euthanasia compartment



Percent mice that stayed in the dark/euthanasia compartment

	CO ₂	isoflurane
1 st exposure	0%	56%
2 nd exposure	-	22%



Aversion-avoidance testing

Pros:

- Pre-defined response measures
- High consistency

Cons:

- Requires habituation
- Requires inferences about motivation to avoid light
- Assumes that motivation does not vary with treatment

Indicators of insensibility
*(when is it 'safe' to switch from
isoflurane to CO₂?)*

Indicators of insensibility

Conscious



← *Recumbency*

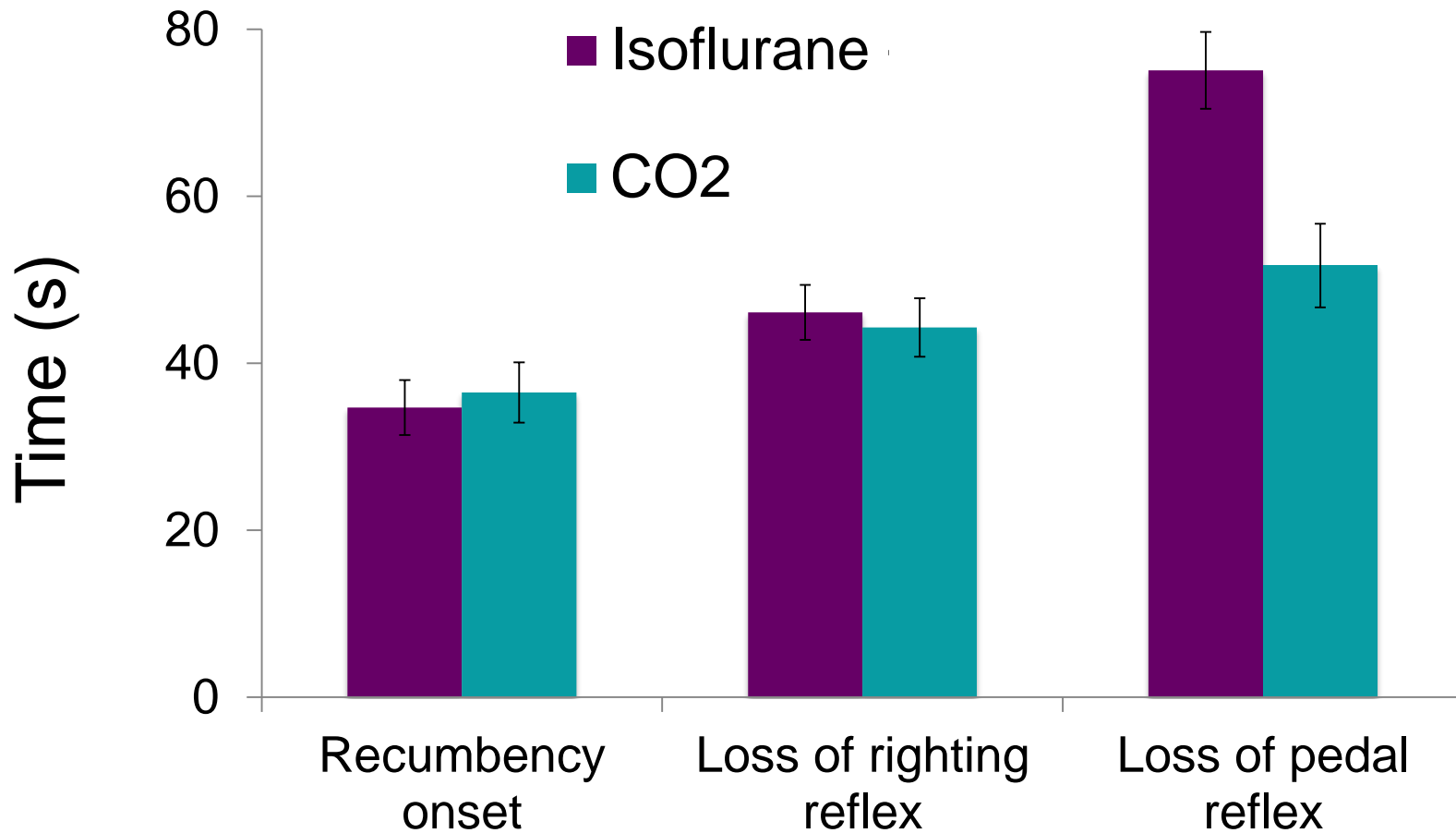
← *Loss of righting reflex*

← *Loss of the pedal withdrawal reflex*

Unconscious



Indicators of insensibility



Summary of findings

- Rats and mice avoid CO₂ > 15%
- Exposure to gas anaesthetic is a refinement, but:
 - re-exposure to anaesthetic is aversive
 - wait 80 s after recumbency before switching to CO₂

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Thank you!



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