

Comparison of aversiveness of 8 different inert gas (mixtures) to CO₂ for stunning pigs at slaughter

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Testing Inert Gases in order to Establish Replacements for high concentration CO₂ stunning for pigs at the time of slaughter

With support from



Project manager



by decision of the German Bundestag

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Project partners:



FRIEDRICH-LOEFFLER-INSTITUT

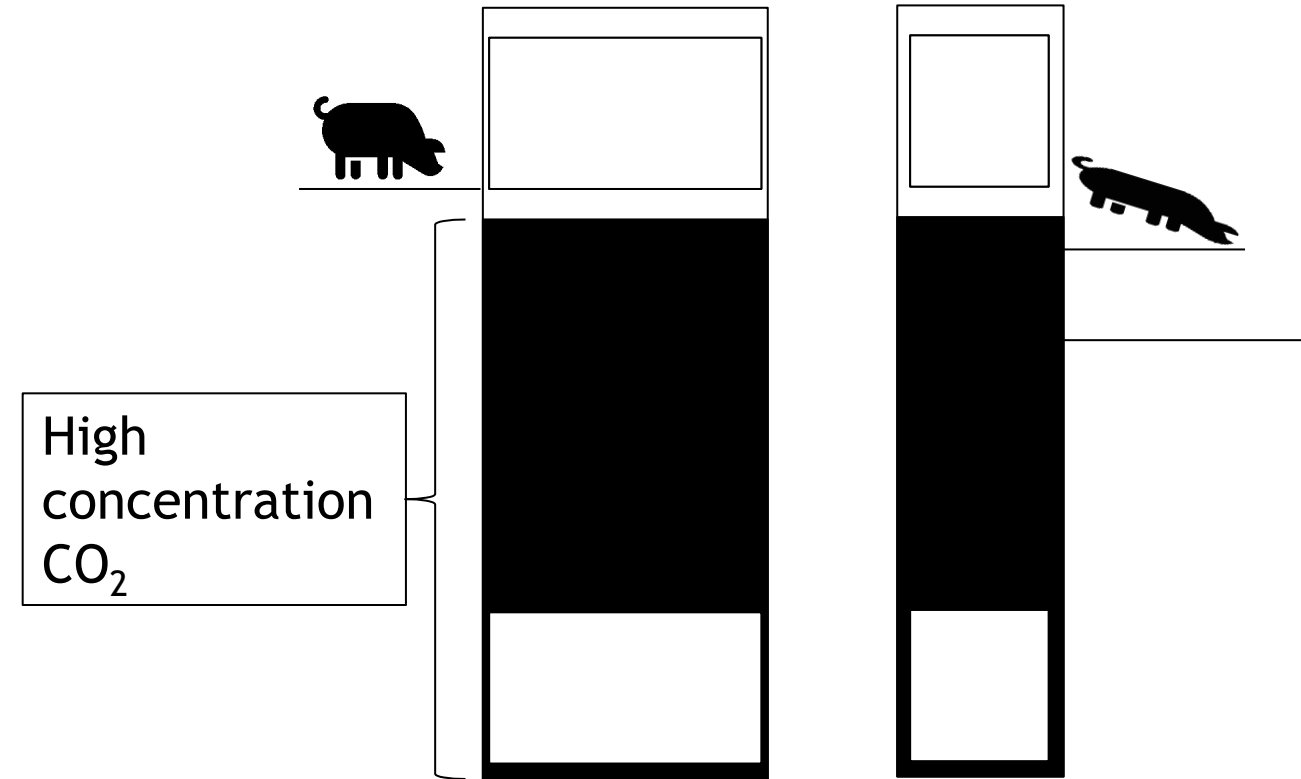
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Federal Research Institute for Animal Health

Dip-Lift System

- A small group of pigs (2-6) entering mobile crate (gondola)
- Pit filled with high concentration CO₂
- Gondola moves down, exposing pigs to gas atmosphere
- **Dwell time:** time at bottom position
- Gondola moves back up and ejects the animals



Benefits

- ✓ **Deep and long lasting unconsciousness and insensibility**
(Forslid, 1987)
- ✓ **Good meat quality**

Drawback

- **Pigs can detect CO₂** at concentrations of about **30%** (EFSA, 2004)
- **Hyperventilation and breathlessness** before loss of consciousness
(Troeger, 2008; Gregory et al., 1990)
- **Irritations of mucus membranes** through creation of carbonic acid
(Peppel und Anton, 1993)
- **Aversive reactions** of animals exposed to CO₂ (e.g. escape attempts)
(Llonch et al., 2012a,b; Dalmau et al., 2010; Rodriguez et al., 2008; EFSA, 2004; Machold et al., 2003b; Raj und Gregory, 1996)



Inert gas mixtures proposed as an alternative to high concentration CO₂ stunning:

Benefits - pros

- ✓ **Less aversive**

Drawback - cons

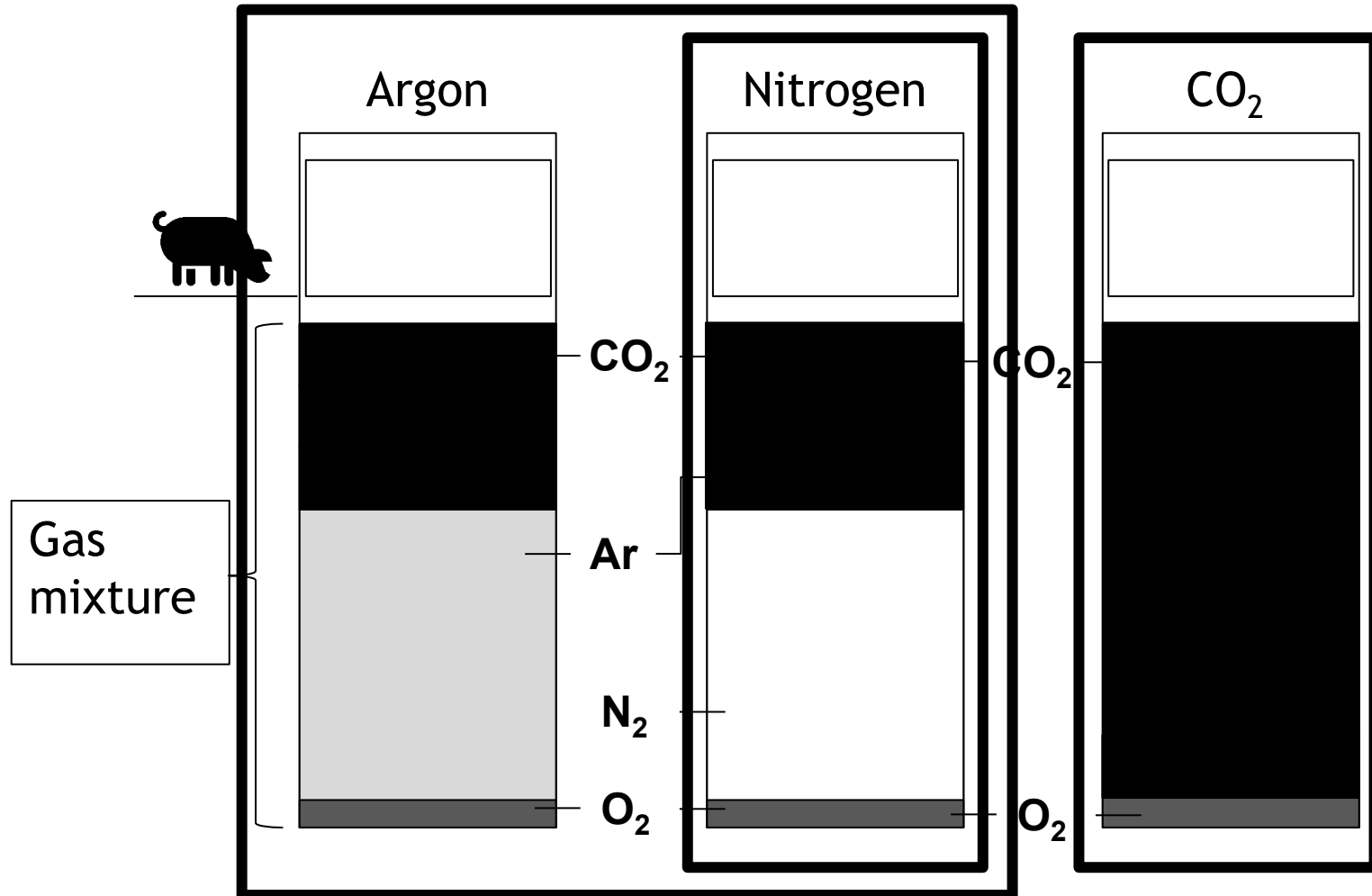
- N₂ gas mixtures **less stable** (Dalmau et al., 2010)
- **reduced meat quality** (Llonch et al., 2012 b , Atkinson et al., 2020)
- **Longer exposure times** — more inadequate stuns
(Machold et al., 2003a; Machold et al., 2003b; Llonch et al., 2012 b, Atkinson et al., 2020)

Importance of residual oxygen:

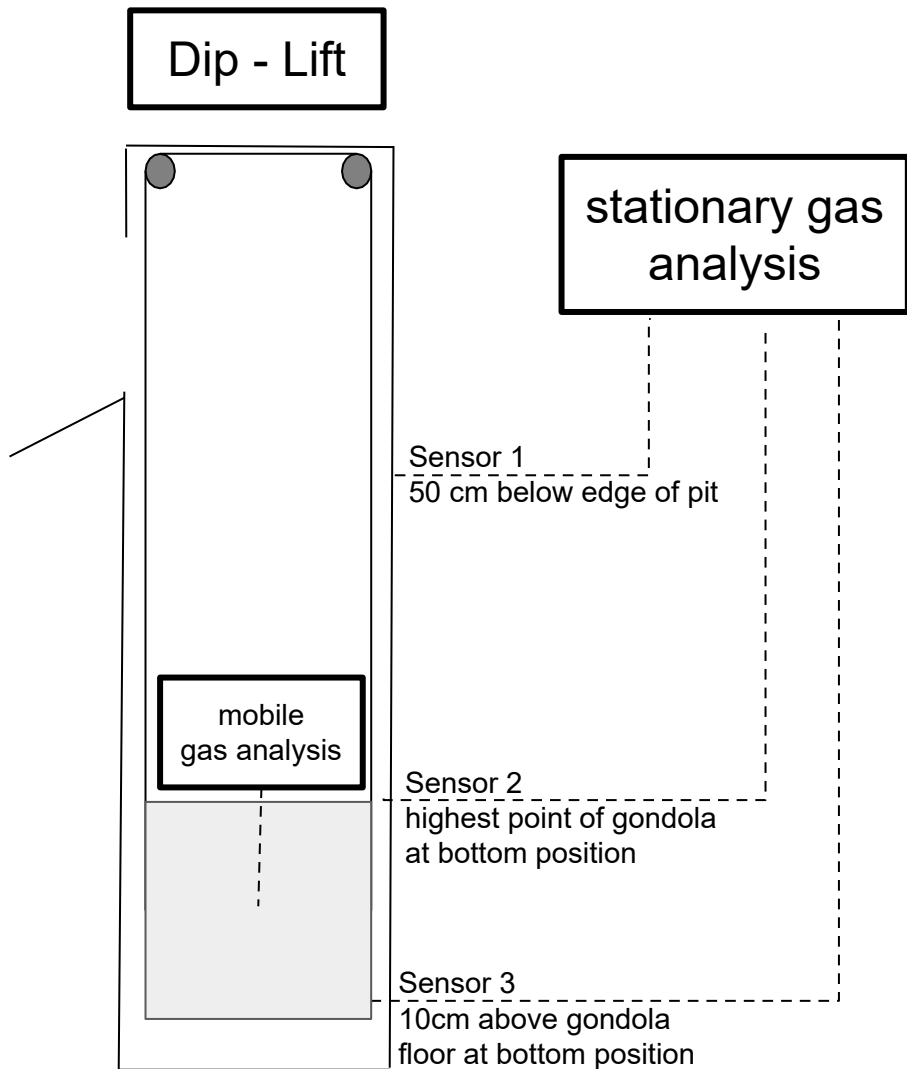
Atkinson et al., 2020		
Residual O ₂	< 2 %	> 2 %
Inadequately stunned	5 %	19 %



- Find gas mixture best suited to replace high concentration CO₂ stunning
 - Argon or nitrogen as primary gas
 - residual oxygen level: < 1 %
 - CO₂ from 0 to 30 %
- 90 and 95% CO₂ control conditions



Project goal II



- New (patented) gassing system installed into a commercial Dip-Lift-System
- Gas analyzer to measure (CO_2 and O_2) and control the gas atmosphere

✓ Stable gas atmospheres

✓ Residual O_2 well below 1 %



(MDE 3300, htk Hamburg)



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- Compare each to high concentration CO₂ based on

- aversiveness

This presentation!

- meat quality

Presented by Julia Gelhausen in Monday.

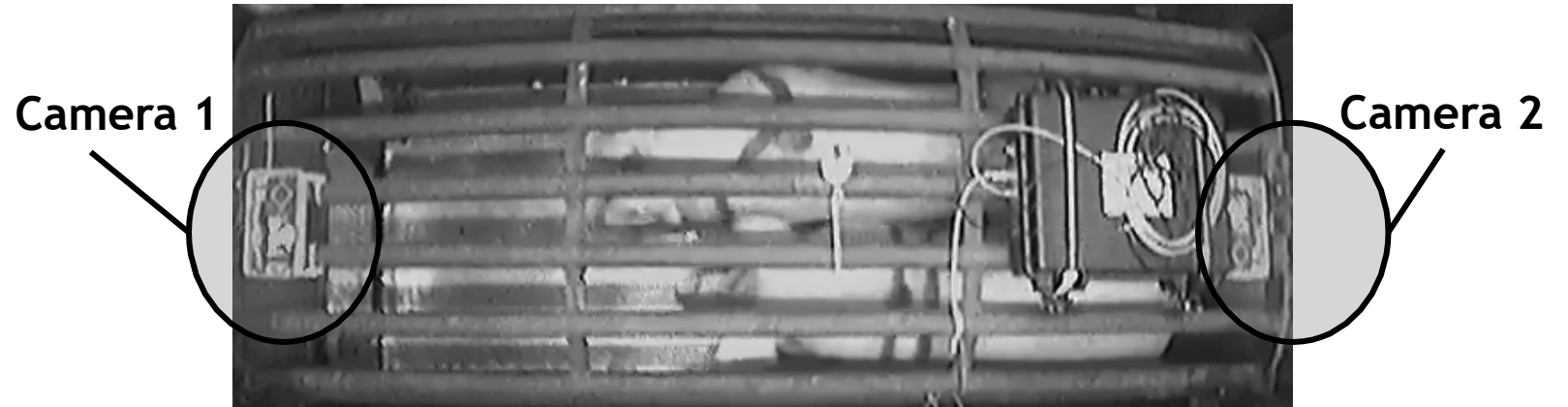
- Determine necessary dwell times

Presented on Monday.

to accomplish < 0.5 % inadequate stuns



- Video recordings:
- Two cameras on gondola
- 1300 pigs, 650 gondolas



- Preparing videos for each measurement day
 - New video with all segments in **randomized order**
- Behavior analysis by two observers
 - **One observer for each pig**
 - **Using BORIS (Behavioral Observation Research Interactive Software)**
<https://www.boris.unito.it>

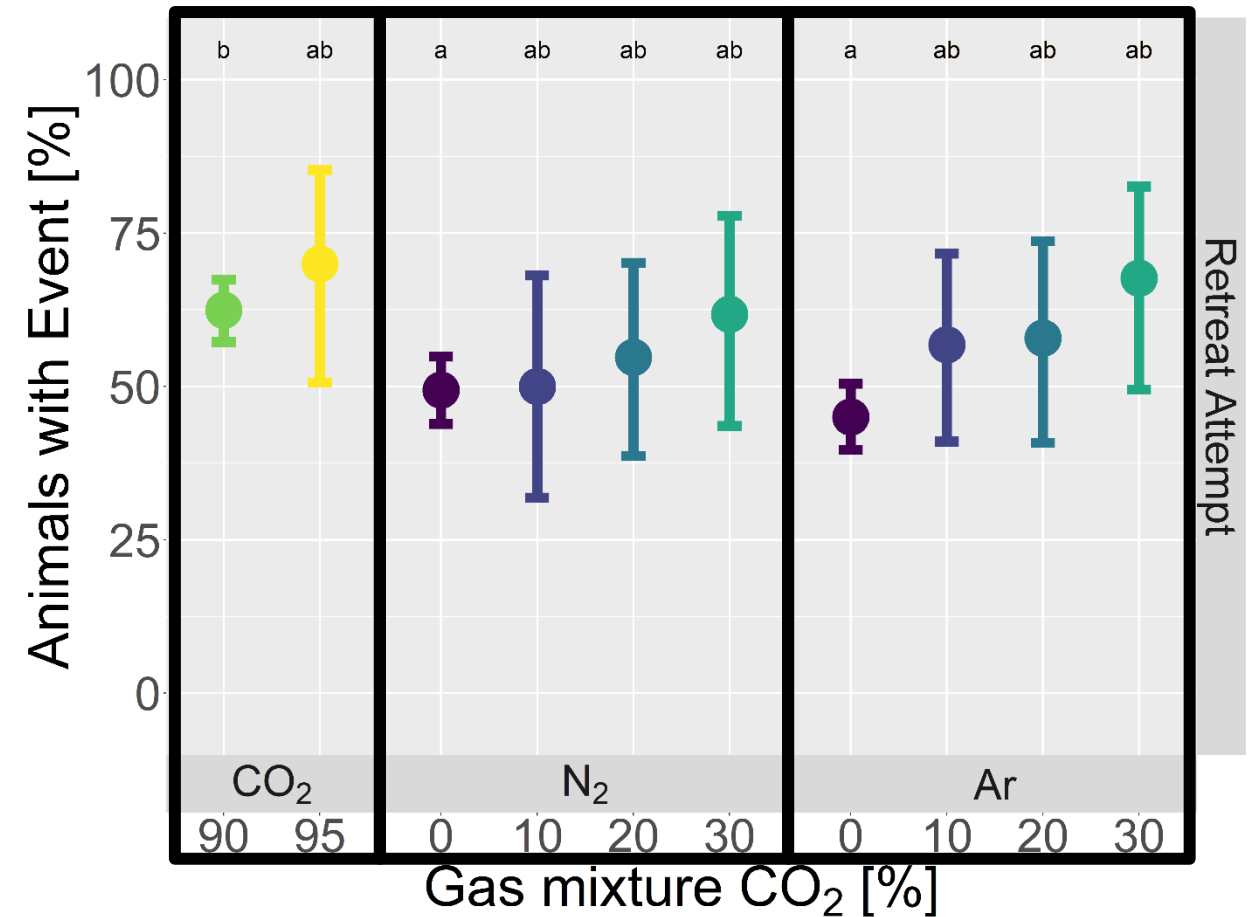


Ethogram: Initial reactions and breathing

Category	Indicator	
Process	Start driving to stunner	
	Start of gondola	
Initial Reactions	Exploration	
	Retreat attempt	Dig retreats backwards
	Escape attempt	
	Other (aversive)	„Aversion excl. vocalizations“
Breathing & Vocalizations	Reactions	„Aversion incl. vocalizations“
	Hyperventilation	frequency
	Vocalizations	Calls and noises from the
	Gasping	
	Gagging	
Stunning	Loss of posture	Moment in which the animal falls to the ground. The animal is incapable of remaining in a standing position ...
Progress		

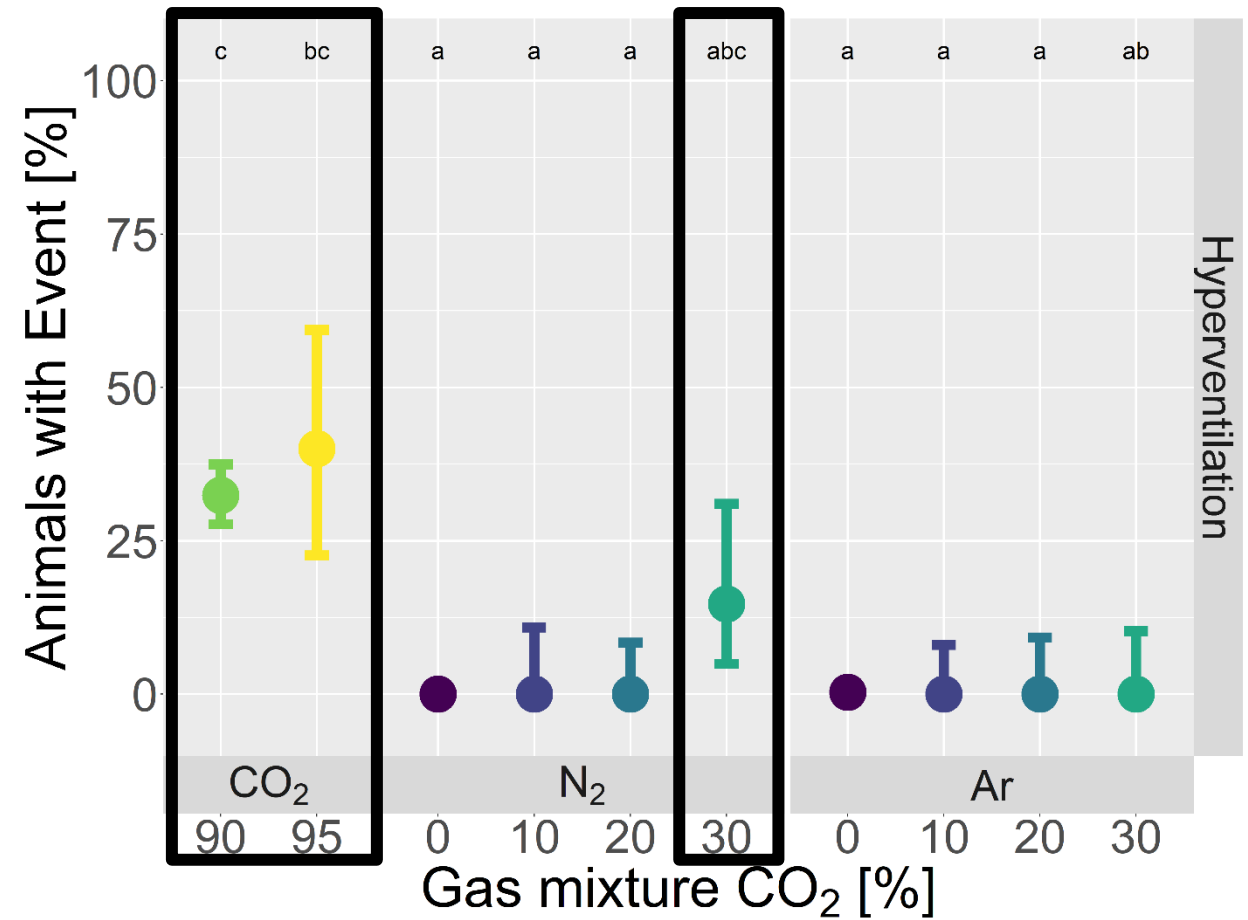
- Majority of animals making retreat attempt within the first few second after gondola movement

Proportion making retreat attempt



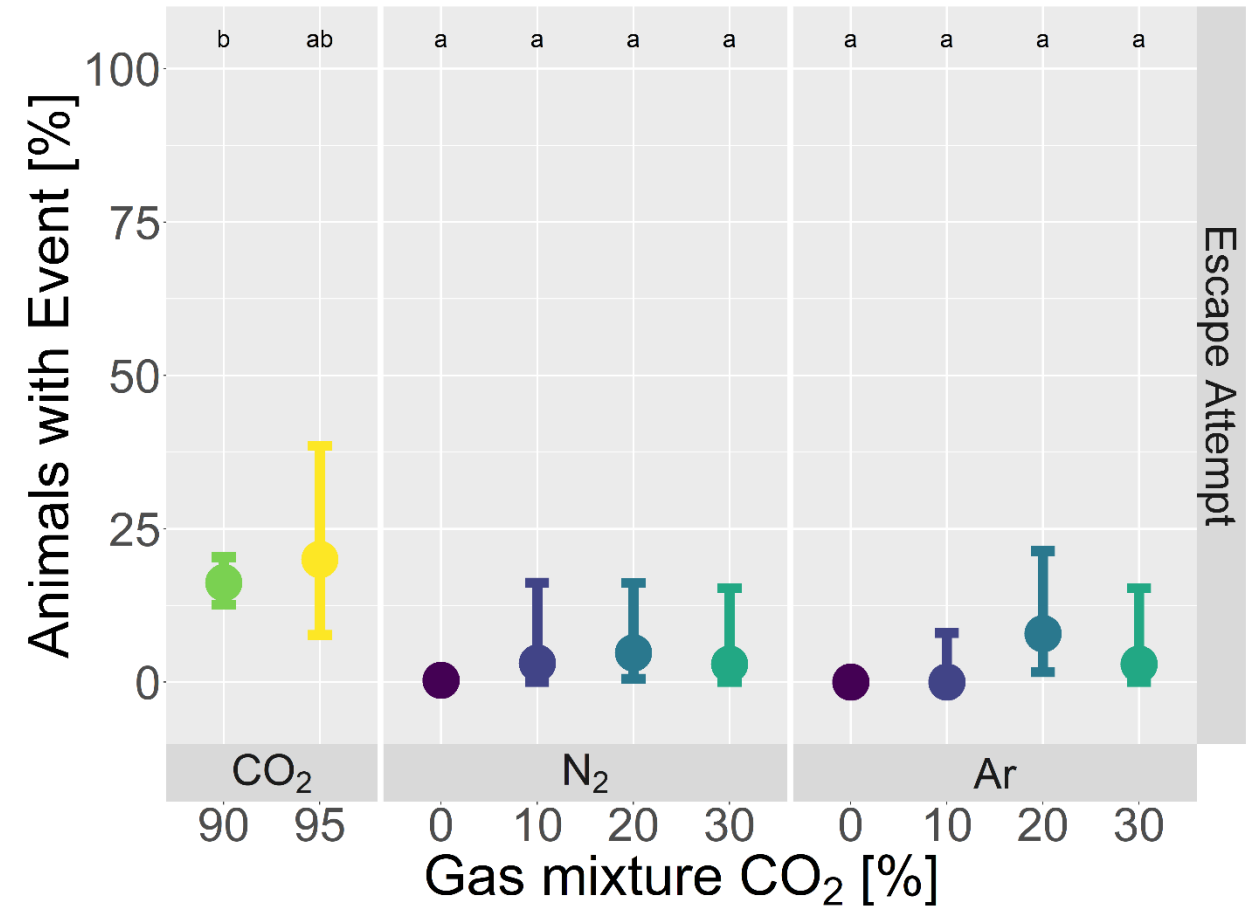
- Hyperventilating occurred almost exclusively in conditions with at least 30 % CO₂

Proportion Hyperventilating



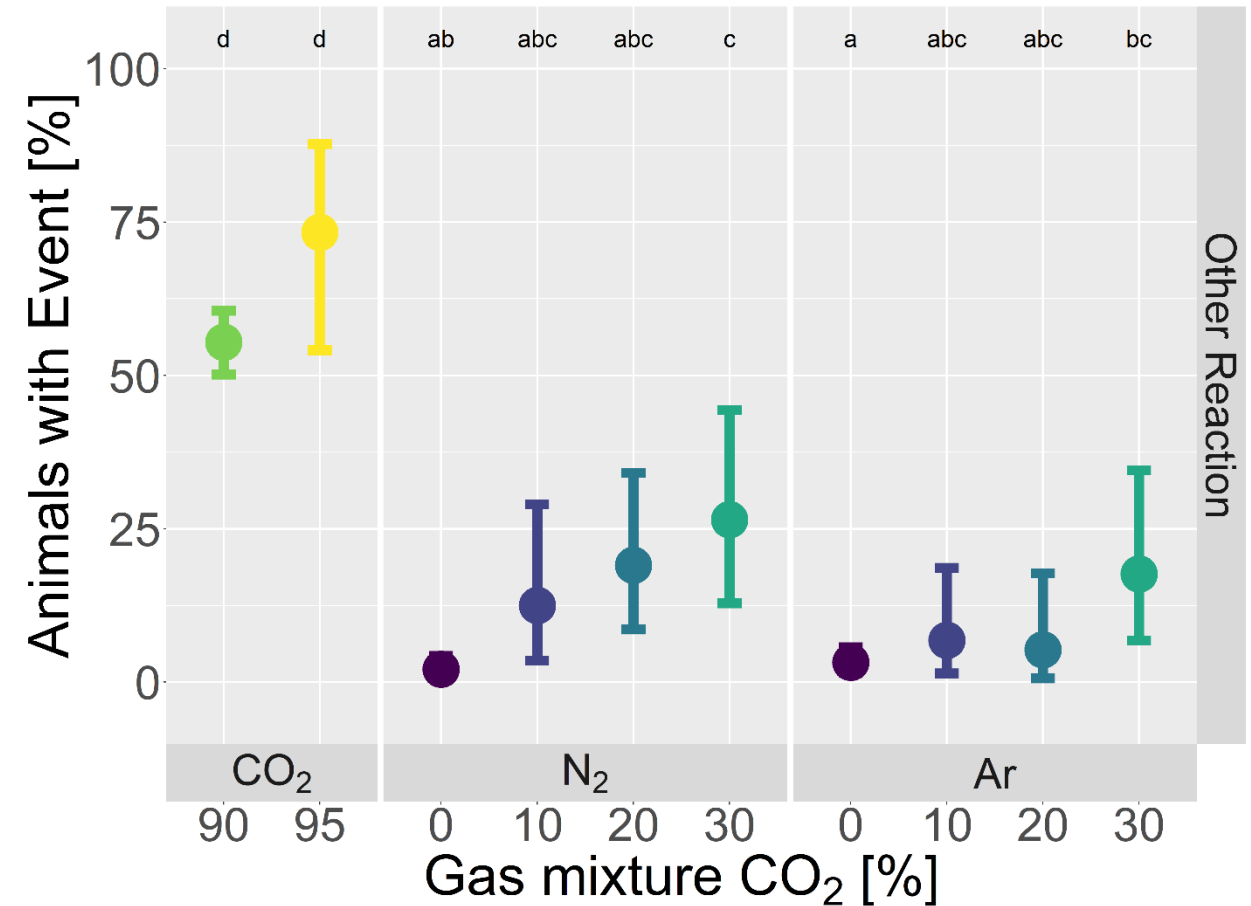
- Rare for inter gas mixtures with CO₂
- Almost no escape attempts with pure inert gases
- Approximately 16 % of animals make escape attempt during high concentration CO₂ stunning

Proportion making escape attempts



- Other (aversive) reactions: like kicking, throwing the body against walls, somersaults or fast shaking of the head
- Other (aversive) reactions increase with increasing CO₂ concentration

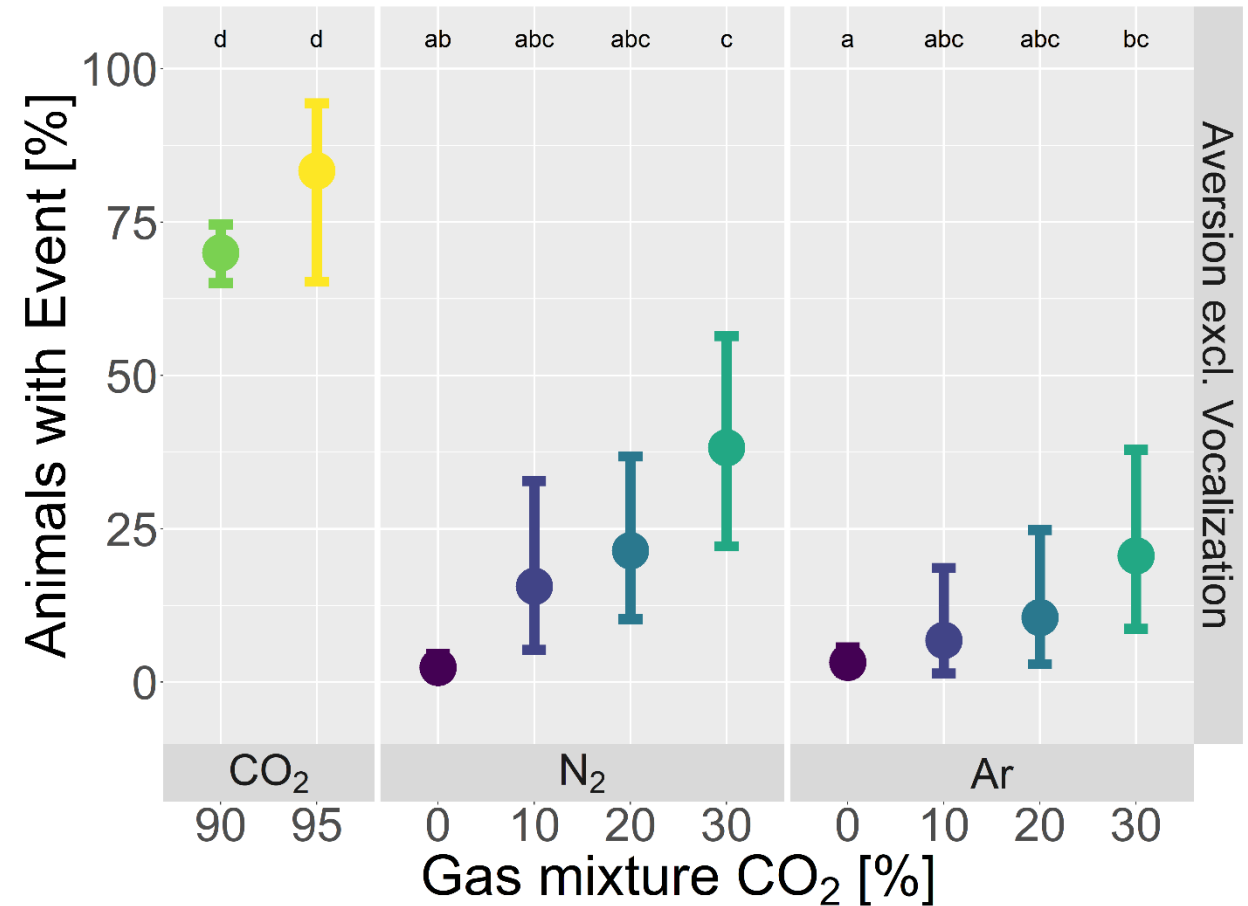
Proportion showing other reactions



Aversive behaviors excl. vocalizations

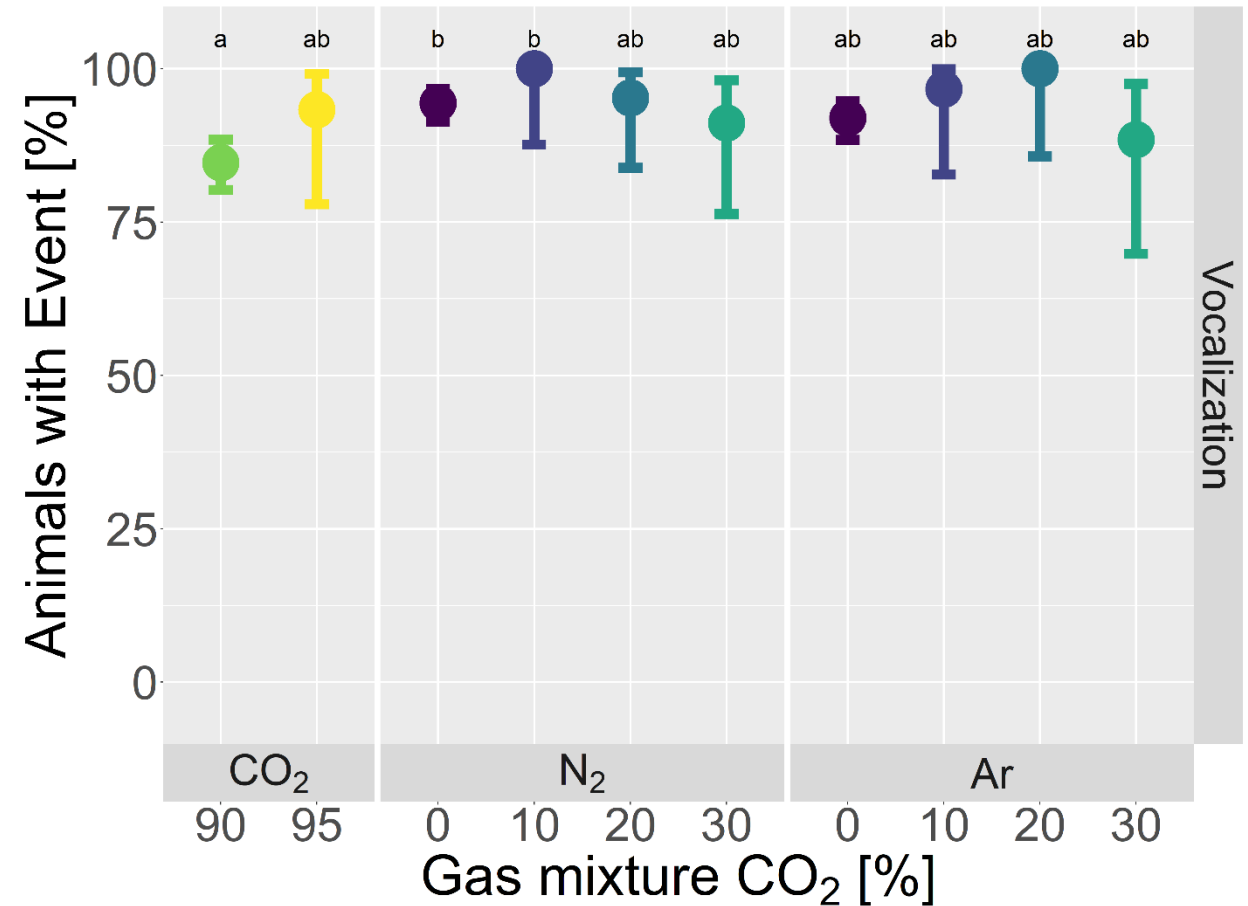
- more often for high concentration CO₂ stunning compared to inert gasses
- Increases with increasing CO₂ concentration

Proportion with aversive behavior



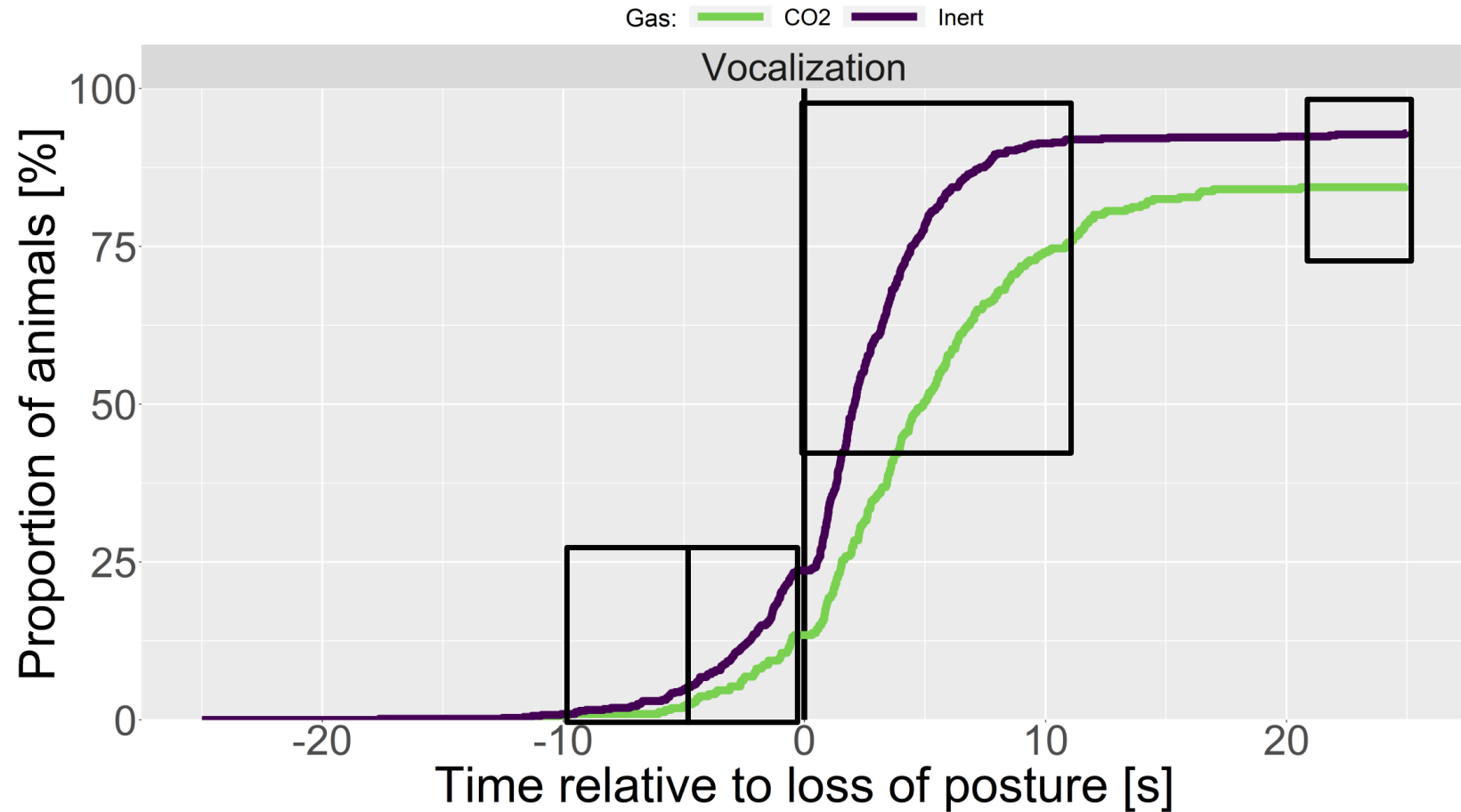
- **Most animals vocalize** at some point during the stunning process, typically shortly after loss of posture
- Slightly more vocalizations for inert gases compared to high concentration CO₂

Proportion vocalizing



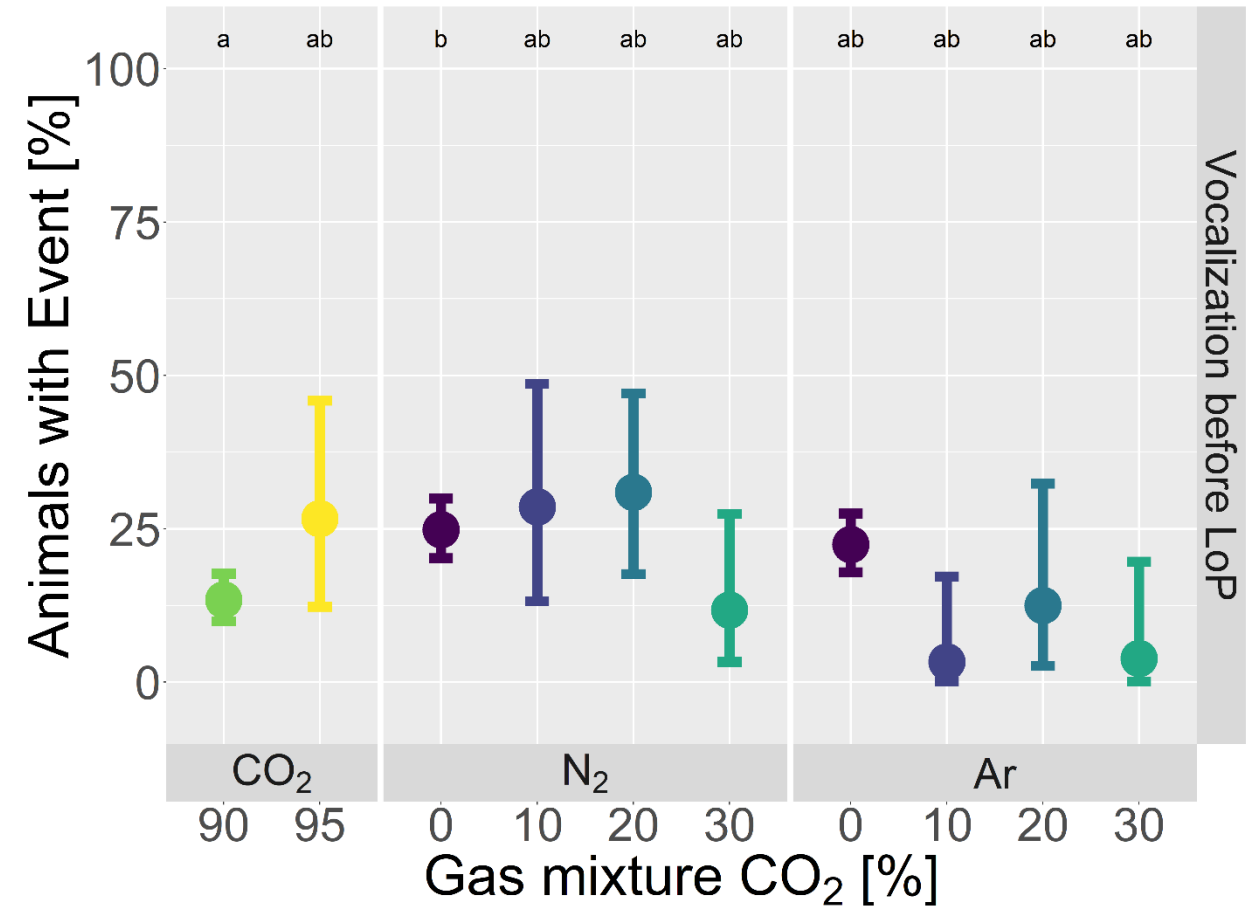
Results: Time course of vocalization

- Increased vocalizations just before loss of posture for inert gases
- Most vocalize at some point, typically shortly after loss of posture



- Vocalizations just before loss of posture increased for pure inert gases (~25 %) compared to high concentration CO₂
- These extra vocalizations occur in a 5 s window before loss of posture

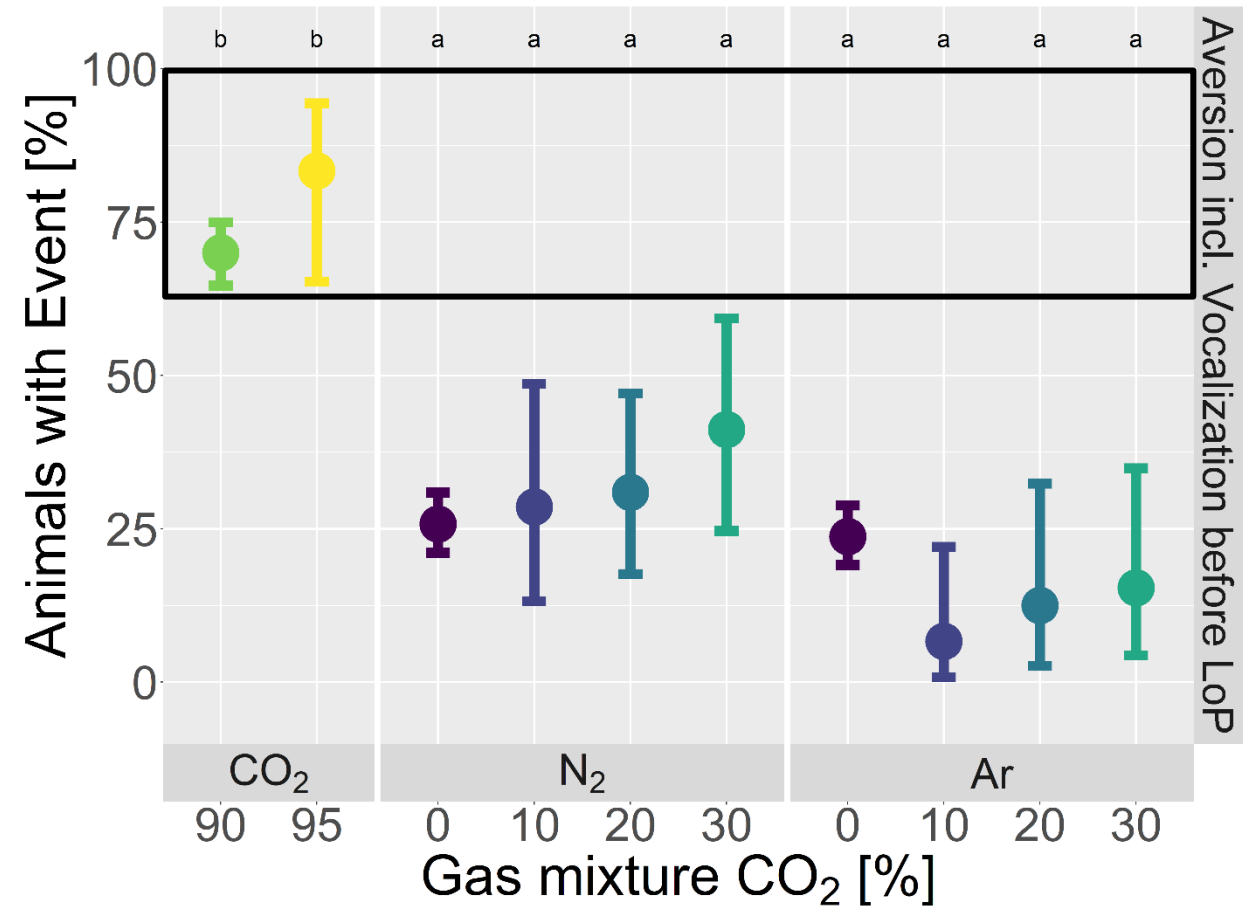
Proportion vocalizing before LoP



Aversive behaviors incl. vocalizations before loss of postures combined

- more often for high concentration CO₂ stunning compared to inert gasses

Proportion with aversive incl. vocalization



- All tested inert gas mixtures reduced aversiveness compared to high concentration CO₂
- Gas mixtures with less CO₂ showed less aversions
- Increase of vocalizations just before loss of posture requires investigation

Thank you!

Next Steps:

- Verifying results in a commercial Paternoster System
- Is there an influence of number of animals per Gondola?

