

# Haven't I heard your Voice before?

## Same-Different-Categorisation of the Calls of Conspecifics in Pigeons

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### Goals

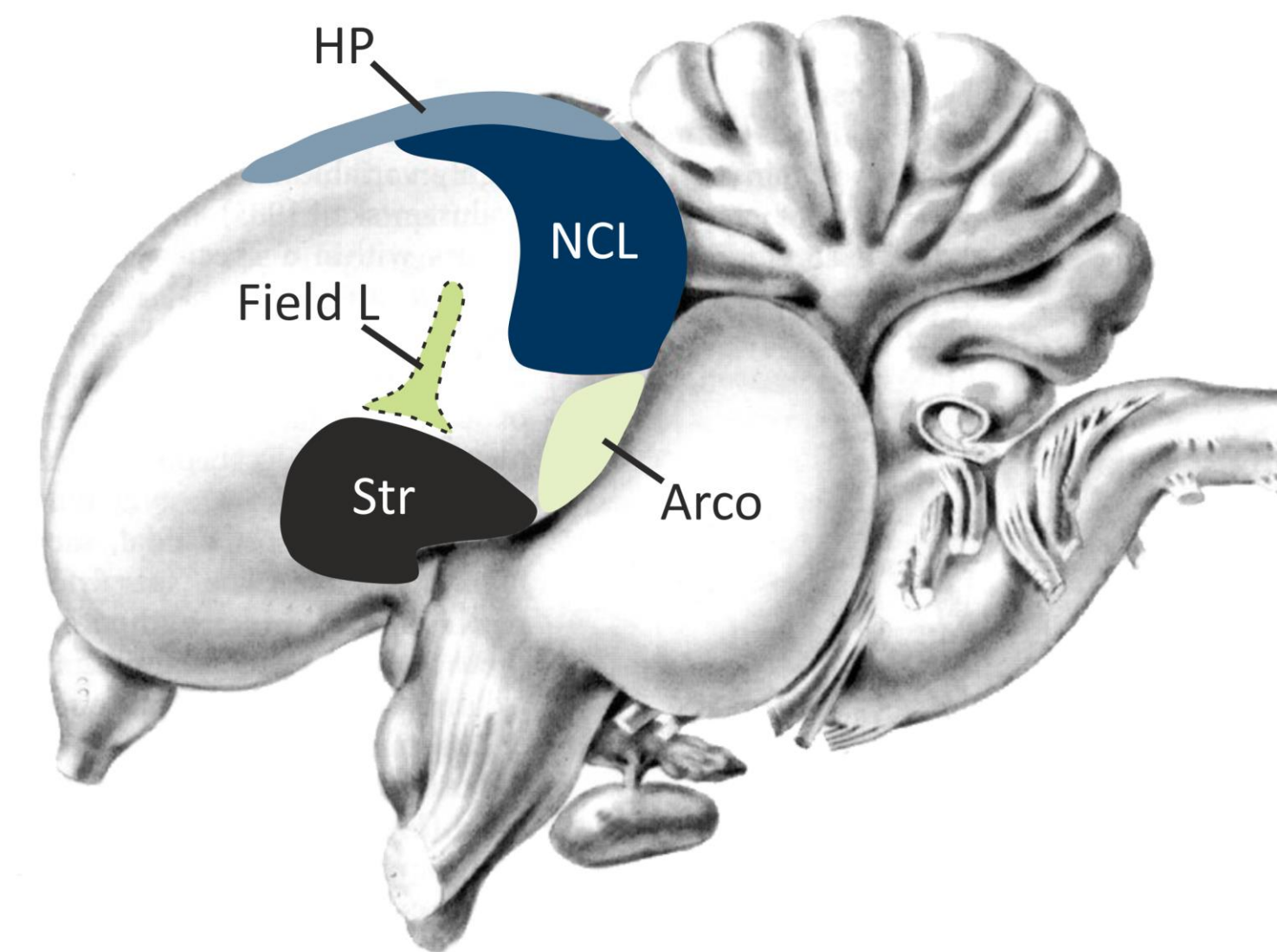
1. Can Pigeons discriminate the quality of social calls of conspecifics?
2. Can Pigeons discriminate the identity of a conspecific by its social call?
3. How does the activation in the pigeon's brain look like when the bird considers conspecific's social calls of different emotional valence?

### Theory

- Pigeons have difficulties identifying conspecifics visually (Watanabe & Ito, 1990)
- Pigeons can discriminate sequences up to 12 sounds (natural or man-made; Cook et al., 2016)
- Same/different tasks can be solved by pigeons, however the results in this field are inconsistent (Diaz et al., 2021)
- MRI has not been used often in same-different-categorisation tasks in pigeons so far
- Head fixed pigeons in the MRI can still move their beaks (Behroozi, 2019)
- How could all of this look like in a same-different categorisation using pigeons' social calls?

### Expectations

- Activation in the frontal brain, especially in the Nidopallium caudolaterale (NCL) → **Working memory, Decision making** (Atoji & Wild, 2009; Rose et al., 2009))
- Hippocampus (HP) + dopaminergic system (including striatal regions; Str) → **Reward-System** (Atoji & Wild, 2009)
- Trigeminal System, including Arcopallium (Arco), Striatum (Str), principal sensory tigrminal nucleus, nidpallium frontotrigeminale → **Beak movement** (Behroozi, 2019)
- Auditory field L, among other regions → **Auditory processing** (Rose et al., 2009)

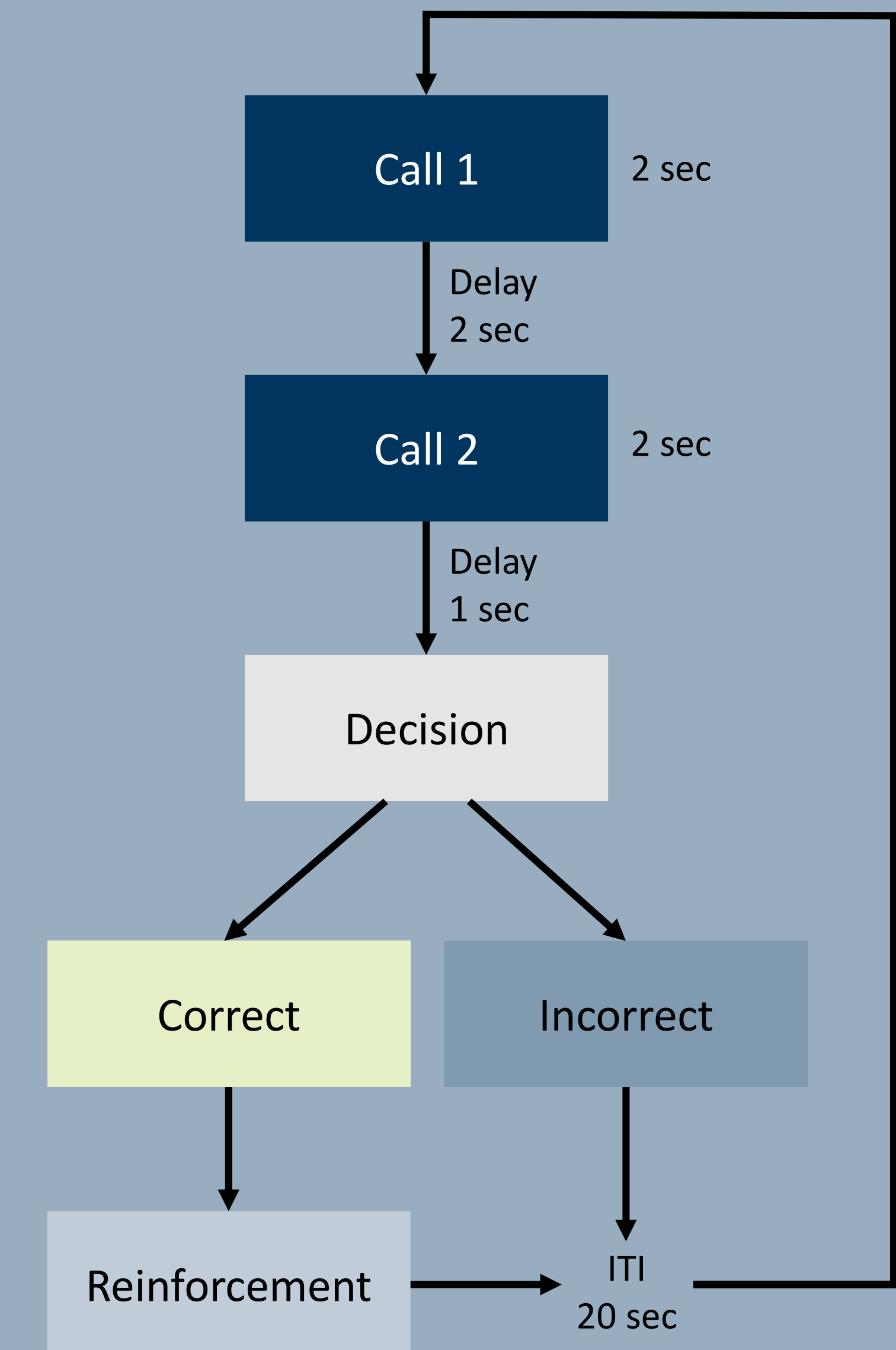


Regions in which activations during the experiments are anticipated. Depiction shows only the biggest regions. Figure is adapted from Kalenscher (2005).  
HP Hippocampus, NCL Nidopallium caudolaterale, Arco Arcopallium, Str Striatum

### Methods

- Preparations:**
  - Pigeons need to be operated on to allow for head fixation during MRI
  - In order for the conditioning to work, pigeons need to be water deprived
- Quality of stimuli:** courtship, aggression, identical individuals, different individuals
- Conditioning Trial:** The pigeon hears the call of a conspecific; after a short delay, the bird will hear a second call and needs to either open or close its beak (Diagram to the left)
  - The table below shows, how each of the four groups must react to each stimulus combination to be rewarded with a bit of water
  - Occurrence of stimulus combinations are randomised
- Beak movements are tracked with one camera, positioned on one side of the subject's head using **DeepLabCut-Live!** (DLC; Kane et al., 2020)
  - Used to track the pigeon moving its beak during initial conditioning to train a neuronal model
  - Camera runs during scanning; the live-feed is analysed in real time by the DLC-Model
  - Analysis of movement is done to reward the pigeon inside the scanner automatically through a tube with water, when the analysis is combined with MatLab where the script with the design will run
  - The model can also be used to compare whether the way a pigeon mandibulates differs from the stimulus combination it must react to
  - Video will be used to mark the exact times where the pigeon opens the beak

### Conditioning Procedure



### Combination of Stimuli and Groups

Stimulus compounds		Call 1	Aggression	Courtship	Aggression	Courtship	Aggression	Courtship	Aggression	Courtship
		Call 2	Aggression	Courtship	Courtship	Aggression	Aggression	Courtship	Courtship	Aggression
		Identity	Identical	Identical	Identical	Identical	Different	Different	Different	Different
Group	Follow Quality	Concordant	Correct	Correct	Incorrect	Incorrect	Correct	Correct	Incorrect	Incorrect
		Discordant	Incorrect	Incorrect	Correct	Correct	Incorrect	Incorrect	Correct	Correct
	Follow Identity	Concordant	Correct	Correct	Correct	Correct	Incorrect	Incorrect	Incorrect	Incorrect
		Discordant	Incorrect	Incorrect	Incorrect	Incorrect	Correct	Correct	Correct	Correct

### Data Processing using FSL

1. Brain Extraction
2. Distortion Correction (depends on the scanner!)
3. Slice Timing/ Acquisition Correction
4. Motion Correction
5. Spatial Normalisation
6. Spatial smoothing

7. Level-1-Analysis
8. Level-2-Analysis using Double-Gamma HRF
9. Group Analysis

### Statistical analysis using Nilearn

- Comparison of the four groups in a general linear model (GLM)



### Pitfalls and Limitations

- Length and volume of the stimuli (Humans are better at identifying voices the longer they can listen to them; Yarmey et al., 2001)
- Gender of the conspecific
- Negative results are extremely hard to interpret (can they not discriminate auditory stimuli or can the not discriminate individual voices)
- Opening the beak could also be a natural reaction of the pigeon to any conspecific call
- Thresholds during the fMRI-data processing

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# Same-Different-Categorisation of the voices of conspecifics pigeons in fMRI

## Goals:

- Can Pigeons discriminate the quality of calls of conspecifics?
- Can Pigeons discriminate the identity of a conspecific by its call?
- How does the activation in the pigeon’s brain differ from the judgements of the auditory stimulus constellations?

## Expectation:

- Activation in the Nidopallium caudolaterale (NCL) -> Working memory

## Theory:

- Ca

## Pitfalls:

- Can

## Methods:

- Trial: The pigeon hears the call of a conspecific; after a short delay, the bird will hear a second call
  - If it is the same conspecific than before: open the beak
  - If it is a different conspecific: keep the beak closed
    - The bird receives a bit of water for every correct reaction
- Quality of calls: courtship, aggression
- Beak movements are tracked with one camera, positioned on one side of the subject’s head in real time using DeepLabCut-live!
  - Used to track, weather the pigeon is discriminating the voices; the information from this needs to be combined with the information from the current trial, which then decides if the pigeon receives water or not
  - The tracking data will be correlated with the BOLD-data to figure out exactly when the movement occurred and therefore, which activation brought this forward
  - To speed the process up, the computer shall figure out the points in time for each trial as well

Call 1			Aggression	Courtship	Aggression	Courtship	Aggression	Courtship	Aggression	Courtship
Call 2			Aggression	Courtship	Courtship	Aggression	Aggression	Courtship	Courtship	Aggression
Identity			Same	Same	Same	Same	Different	Different	Different	Different
Group	Follow	Concordant	Correct	Correct	Incorrect	Incorrect	Correct	Correct	Incorrect	Incorrect
	Quality	Discordant	Incorrect	Incorrect	Correct	Correct	Incorrect	Incorrect	Correct	Correct
	Follow	Concordant	Correct	Correct	Correct	Correct	Incorrect	Incorrect	Incorrect	Incorrect
	Identity	Discordant	Incorrect	Incorrect	Incorrect	Incorrect	Correct	Correct	Correct	Correct

# Conditioning Procedure

