Impairment of Figure-Ground and Shape Discrimination After Lesion of Nucleus Subpretectalis in Pigeons

Erin Scully, Katie Goodwin, Olga Lazareva, & Martin Acerbo
Department of Psychology, College of Arts and Sciences, Drake University

Background

- Collothalamic visual pathway is a major source of visual information (90%; Shimizu & Watanabe, 2012)
- Retina → Optic tectum → Nucleus rotundus → Entopallium
- N. rotundus (Rt) is the largest midbrain nucleus in birds
- Change from retinotopic organization to functional organization
- Several functional subdivisions
- Receives inhibitory input from nucleus subpretectalis/interstitial-pretecto-subpretectalis (SP/IPS)
- Earlier study (Acerbo et al., submitted) demonstrated higher activity of Rt and SP/IPS only after figure-ground discrimination.

Hypothesis

Effect of lesion of SP/IPS will depend on the type of visual discrimination
1) Color discrimination – no effect
2) Figure-ground discrimination – impairment
3) Shape discrimination – no effect

Method (modified from Lazareva et al., 2006)

Stimuli

- Target presented in one of four locations, equally often on figure or ground region (see left)

Subjects

- 10 homing pigeons, kept at 85% of free-feeding weight (8 lesioned so far)

Procedure

- Three trial types: shape, color, and figure-ground presented in blocks of 40 trials (total 120 trials)
- Additional shape training (128 trials) as needed after first 10 days of training
- Once criterion is reached, lesion n. subpretectalis

Surgery

- Anesthetize with Nembutal
- Experimental group: Bilateral ibotenic acid injection to lesion SP/IPS
- Sham group: Injection of artificial cerebrospinal fluid

Recovery

- Five-day recovery
- Retraining until 5 completed training sessions are collected
- Sacrifice bird with overdose of Nembutal
- Extract brain and analyze region of interest for volume and location of lesion (in process)

Results

Training

- Different speed of acquisition during first 10 days of training
  - Color discrimination is the easiest task
  - Figure-ground discrimination is next
  - Shape discrimination does not differ from chance after 10 days of training

Implemented additional shape training

- Three sessions of shape trials followed by a session with 3 trial types presented simultaneously
  - Repeated when shape discrimination accuracy is at 50% or below
  - By the end of training, shape is as accurate as figure-ground

Effect of lesion of n. subpretectalis

- No effect in sham group
- No effect on color discrimination in experimental group
- Equal impairment in figure-ground discrimination and shape discrimination

Histology

- Currently measuring the volume of lesion in experimental group to correlate with discriminative performance

Summary and future research

- Bilateral lesion of SP/IPS differentially impairs three discriminations
  - Color discrimination is unimpaired
    - Even though Rt contains neurons sensitive to color (Wang, Jiang, & Frost, 1993)
  - Both shape discrimination and figure-ground discrimination are equally impaired
  - Our earlier study (Acerbo et al., submitted) demonstrated that figure-ground discrimination is associated with a high activity of SP/IPS and Rt but shape discrimination is not
  - Together, these results suggest that Rt and SP/IPS are key structures involved in figure-ground assignment
    - Thalamic nuclei instead of cortical structures (striate cortex) as in mammals
  - The impairment of shape discrimination is likely due to distortion of visual information transmitted through Rt to higher-level areas

Next, we will explore the effect of pharmacological blockade of specific receptors in SP/IPS on figure-ground discrimination
  - Glutamate (projections to SP/IPS from optic tectum) and GABA (projections from SP/IPS to Rt)
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References


