# Master Thesis - Zebra finches

Paul Ecoffet

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**Abstract**

The Zebra Finches are songbirds which learn the song of their tutor. They learn it from 25 days post hatch (DPH) to 90 DPH (Liu, Gardner, & Nottebohm, 2004). Zebra finches are commonly used as a model of speech acquisition.

Derégnaucourt, Mitra, Fehér, Pytte, and Tchernichovski (2005) showed that sleep plays an important role in the learning of tutor songs. Indeed, they showed that sleeping has a negative impact on song restitution by zebra finches in the short term but a positive impact on the long run. Song restitution is less complex and less similar to the tutor song from one morning to the previous day evening, but the greater this loss in performance was overall for one bird, the better this bird was able to reproduce the tutor song at the end of its learning.

In addition to that, Dave and Margoliash (2000) have found neurons in the motor cortex which fires sequences during sleep that correspond to their activity pattern when the birds sing in adult zebra finches. This shows that motor neurons that are highly correlated with bird's own song (BOS) are activated during the night. These identified replays suggest that some learning may occur during sleep that use past experiences.

Our hypothesis is that during its sleep, the zebra finch restructures the knowledge it has acquired so far thanks to replay mechanisms. We hypothesize that this restructuring can account for the loss of performance in the short term and an improvement of performance in the long term.

The goal of this internship is to offer a model of the zebra finch song learning which can explain different behavioral data observed such as the correlation between the loss of performance every night and the overall performance at the end of learning.

# Contents

# 1. Introduction

## 1.1 Zebra finch song learning

The Zebra Finches are songbirds which learn the song of their tutor. They learn it from 25 days post hatch (DPH) to 90 DPH (Liu, Gardner, & Nottebohm, 2004). Zebra finches are commonly used as a model of speech acquisition.

Why model of speech acquisition: * fast learning (90 days) * Learning during development Margoliash, 2003 * Very reproductible result with a tutor song that the bird will mimic its whole life Margoliash and Schmidt, 2010 * Close ended learners vs open-ended learner Margoliash and Schmidt, 2010 * Many-to-many relationship between auditory feedback and muscle outputs Margoliash, 2003

* Can be easily raised domesticaly (Rosenfield) * More localised brain structure (Rosenfield) * Can study circuitries

The stages of learning * subsong, plastic, cristallization Margoliash and Schmidt, 2010

## 1.2 Neuroscience

## 1.3 Sleep

Derégnaucourt, Mitra, Fehér, Pytte, and Tchernichovski (2005) showed that sleep plays an important role in the learning of tutor songs. Indeed, they showed that sleeping has a negative impact on song restitution by zebra finches in the short term but a positive impact on the long run. Song restitution is less complex and less similar to the tutor song from one morning to the previous day evening, but the greater this loss in performance was overall for one bird, the better this bird was able to reproduce the tutor song at the end of its learning.

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* Replays can explain learning Margoliash, 2003 * Consolidate learning * Needed to reach new sounds Margoliash, 2003 * replays with weird burst inside Margoliash, 2002

## 1.4 Sum up

Our hypothesis is that during its sleep, the zebra finch restructures the knowledge it has acquired so far thanks to replay mechanisms. We hypothesize that this restructuring can account for the loss of performance in the short term and an improvement of performance in the long term.

The goal of this internship is to offer a model of the zebra finch song learning which can explain different behavioral data observed such as the correlation between the loss of performance every night and the overall performance at the end of learning.

# 2. Model

## 2.1 Previous models for birdsong learning with Zebra Finches

* Preference for same species songs Margoliash, 2002; Marler, 1997 * Marler, 1997 * Coen, 2007

## 2.2 Our proposed model

* Tutor song is known by the bird "by heart" Derégnaucourt, Mitra, Fehér, Pytte, and Tchernichovski, 2005; Margoliash and Schmidt, 2010 "Exposure to a song model, either from a live tutor (e.g. father or other male) or song playback, typically results in the production of a good imitation of the tutor song. For learning to occur, birds only need to hear the song template during a short critical period in their life suggesting that auditory encoding of the song template and the process of vocal imitation are two separate events" source?

# 3. Results

# 4.  Discussion

# 5. Conclusion

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