Summary

This dissertation explores the influence of environmental variability, specifically temperature fluctuations, on the cognitive abilities and physiological responses of zebra finches across different life stages. The research stems from the need to understand how unpredictable environmental conditions, which are becoming more prevalent due to climate change, affect the cognitive functions of birds.

Chapter 1 of the dissertation aims to systematically map the literature and identify any bias toward certain areas of research, particularly in the field of the cognitive studies of zebra finches, extending beyond their well-documented song-learning capabilities. Following the literature search, I categorized existing studies into five main learning domains including associative, spatial, social, motoric learning, and inhibitory control. This review identified significant research gaps, particularly in studies on motor learning, inhibitory control, and the overlooked critical period of juvenile development. I also point out that the heterogeneity in cognitive research methodologies complicates the comparisons between results across studies. To address these gaps, I propose a high-throughput method for testing associative learning ability in both juveniles and adults. My empirical data reveals that zebra finches are capable of effective learning regardless of age. I advocate that researchers consider a more comprehensive approach to cognitive studies while communicating and standardizing methodologies to facilitate collaboration and comparisons across studies.

In Chapter 2, I examined the impact of temperature fluctuations on the associative learning ability of juvenile zebra finches at around 55 to 65 days of age. I hypothesized that birds exposed to variable temperatures during early development would show reduced learning abilities compared to those reared in stable environmental conditions. Furthermore, I considered the potential role of prehatching maternal effects in preparing offspring to cope with unpredictable environmental conditions later in life. I used a 2x2 experimental design to create matched and mismatched temperature conditions. Half of the hatchlings from each family were cross-fostered from either stable or variable temperature to opposite conditions, creating four treatment groups: Stable-Stable, Stable-Variable, Variable-Stable, and Variable-Variable. I found that juveniles from the Stable-Variable group, subjected to the greatest change in temperature conditions showed the highest participation rate and shortest latency to choice in the learning tests. Contrary to my prediction, the groups had no differences in learning performance. Although I did not observe the anticipated pre-hatching maternal effects on learning, I observed them in varying activity levels of the offspring, which could potentially influence their learning opportunities during foraging. As the natural environment of zebra finches is highly variable and unpredictable, the increase in activity level suggests that temperature variability might serve as an environmental enrichment rather than a stressor. This work not only sheds light on how zebra finches cope with changing environments, but also raises intriguing questions about the interplay between environmental conditions and cognitive development across species.

Chapter 3 examines the direct and indirect effects of temperature variability on zebra finches from juvenile stages to adulthood, focusing on the relationship between fluctuating environments, physiological responses, learning, and memory. I utilized a similar experimental design as in

Chapter 2, but the change of conditions happened later in life, shortly after the zebra finches reached independence. This setup also creates matched and mismatched temperature conditions but at a different life stage. I hypothesized that juveniles subjected to fluctuating temperatures would exhibit elevated corticosterone (CORT) levels than those developed in stable temperature conditions. I anticipated that increased CORT levels would be associated with decreased activity levels and impaired learning performance in the associative learning tests. Additionally, I expected that the mismatched condition between life stages would have an impact on learning behaviours. My findings reveal that juvenile finches exposed to variable temperatures show increased CORT. Contrary to predictions, the variable temperature group exhibited shorter latency to choice, and increased CORT levels predicted lower participation rates. Despite these physiological responses, learning and memory performance remained unaffected across all temperature conditions for up to ten months. Nevertheless, adults from variable conditions demonstrated quicker decision-making, highlighting the lasting influence of early-life exposure to temperature fluctuations on activity levels. This research highlights the cognitive resilience of zebra finches, suggesting that while temperature fluctuations both directly and indirectly (through physiological changes) influence activity levels, they do not directly affect cognitive performance and long-term memory.

I conclude that zebra finches exhibit remarkable resilience to environmental variability, as demonstrated by their stable cognitive performance across different life stages, despite changes in activity levels and physiological responses. This research contributes significantly to the field of avian cognition, suggesting that while temperature fluctuations impact physiological responses and activity levels, they do not necessarily impair cognitive functions. The findings emphasize the importance of the timing of exposure of animals to particular environmental conditions and advocate for interdisciplinary research to understand the ecological and evolutionary implications of cognitive abilities in the face of climate change.