

# Temperature effects on cutaneous healing in rough-skinned newts (*Taricha granulosa*)

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## INTRODUCTION

- Immune function in ectotherms is highly temperature dependent (Wright & Cooper 1981).
- Temperature deviations outside the optimal range have been shown to alter innate immunity in some ectotherms (Dittmar et al 2013).
- We analyzed how temperature stress might affect immunity in juvenile newts.
- We also analyzed how housing newts at three different temperatures spanning the range of preferred body temperatures affected their immune response.
- For both studies, we hypothesized that temperature and healing rate would exhibit a positive relationship.
- Alternatively, newts may have an optimal temperature at which they perform best.

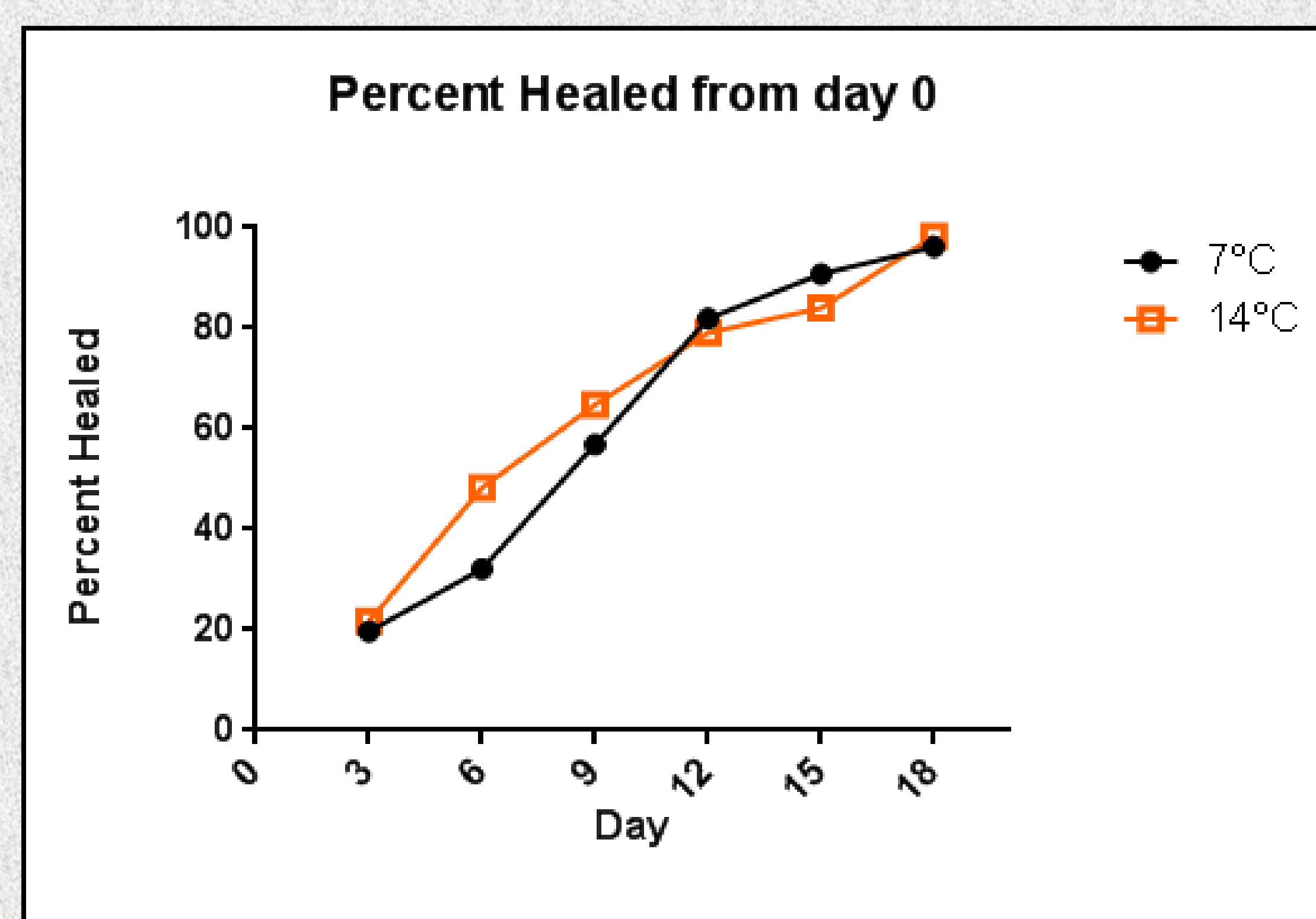
## METHODS

- Biopsy punches were used to create small uniform cutaneous wounds on each of the newts which were then measured over a period of 15 or 18 days for adults and juveniles, respectively.
- Juveniles were either transferred to a different temperature (7°C) or remained at the same temperature (14°C).
- Adult rough-skinned newts (*Taricha granulosa*) were divided into three temperature groups, 21°C, 14°C, and 7°C.
- Size of the wounds over time was used to indirectly evaluate immune response.



## RESULTS

Figure 1. Juvenile newts that underwent the temperature change showed a suppressed healing response early during the primary innate immune response period (day 6), relative to those that remained at a stable temperature throughout the study.



• Adult newts housed at 7°C mounted a greater initial immune response, followed by 21°C, and finally 14°C. (Figure 2).

## Healing in an Adult Newt

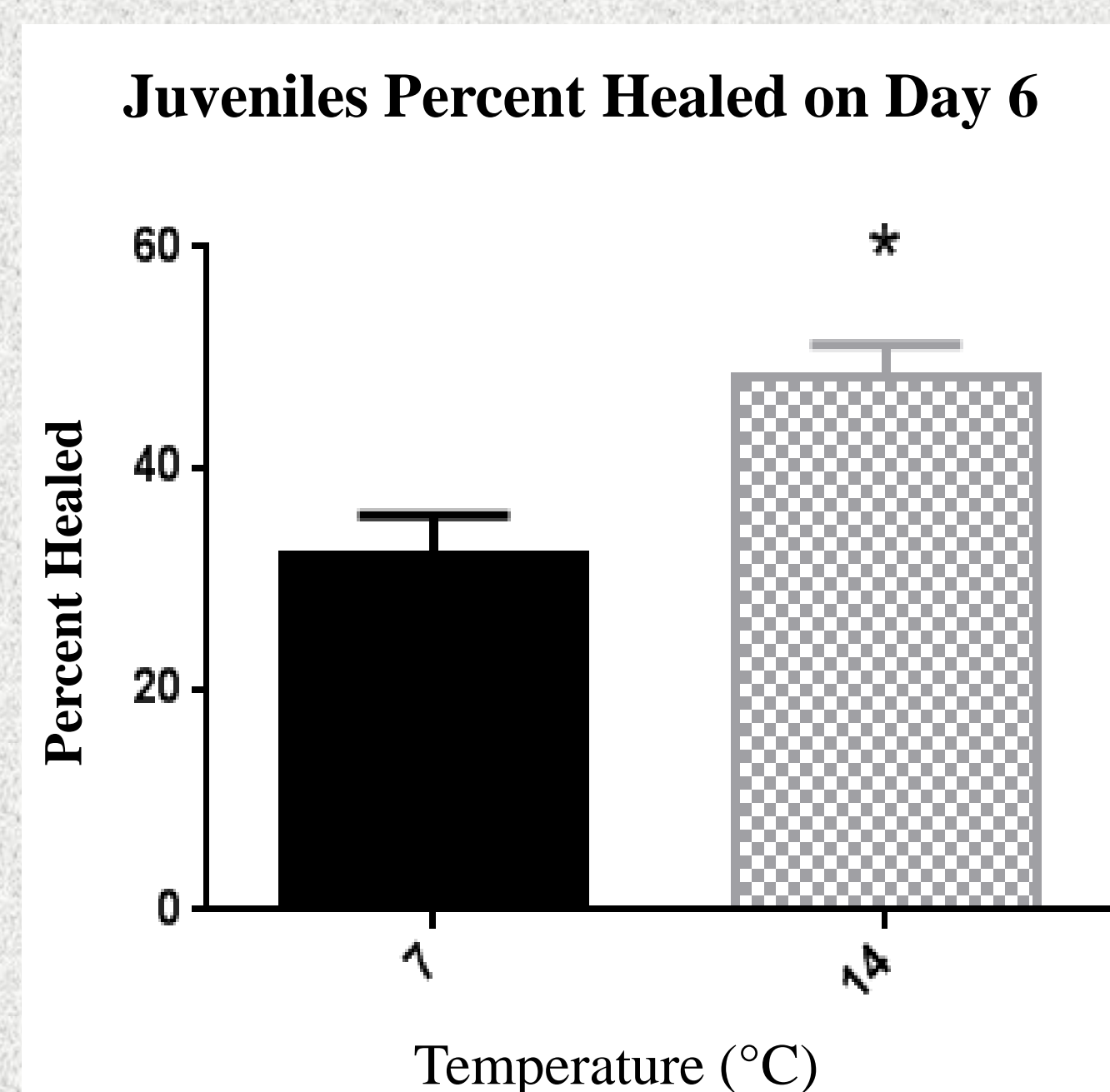


Figure 2. Juvenile newts that remained at 14°C had the greatest immune response

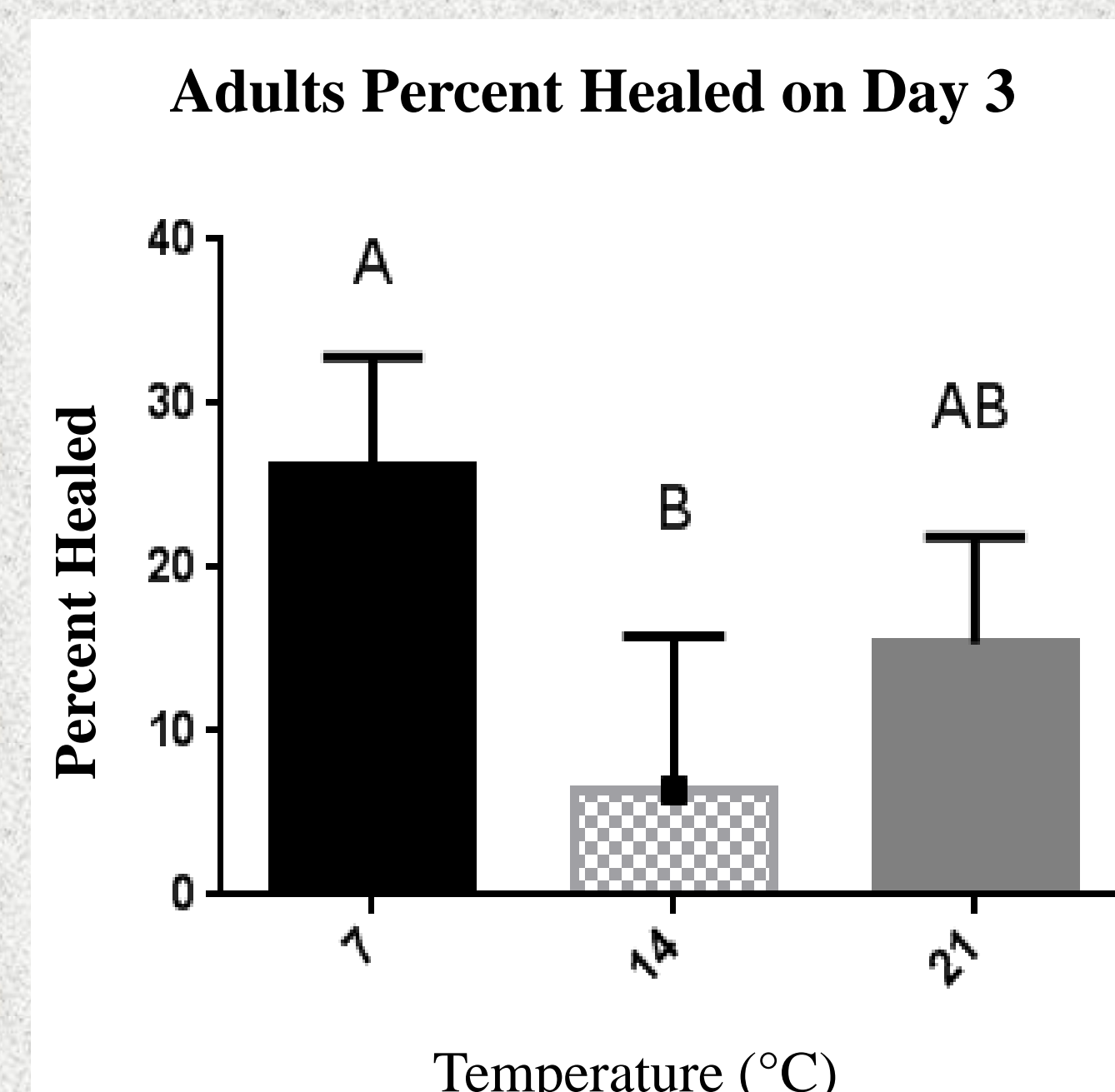


Figure 3. Adult newts had greatest immune response at 7°C. Levels not connected by the same letter are significantly different

## DISCUSSION

- There is good evidence that the immune system is temperature sensitive (Butler et al 2013).
- Interestingly, juvenile newts that were acclimated to 14°C and then underwent a temperature stress via switch to 7°C, showed reduced healing during the initial, stress-sensitive (French et al 2006), immune phases of wound healing.
- Results from the adult newts suggest that early during the innate immune response animals from 7°C healed faster relative to the other temperatures.
- In either case, these results suggest immune function is heavily impacted by environmental temperature.
- Our results for adult newts are similar to those of the study on temperature stress on immunity in three-spined sticklebacks, where animals at lower temperatures resulted in greater immune response (Dittmar et al 2013).
- Finally, increased immune response at lower temperatures could be a result of varying bacterial growth in the aquatic environment, which is also temperature-dependent. It is possible that at colder temperatures, while immune response may be suppressed, bacterial growth is suppressed even further.
- These two experiments taken together indicate that other variables, abiotic and biotic, work alongside temperature to affect the overall healing profile of a wounded animal.

## REFERENCES

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## ACKNOWLEDGEMENTS

We would like to thank Dr. Edmund D. Brodie, Jr., Gareth Hopkins, and Jory Johnson for their assistance and support.