Zombies vs. Plants: The Effects of Context on Student Explanations of Natural Selection

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Natural selection can be a difficult process for students to describe

- Research suggests item context may impact student reasoning about natural selection[1]
- Plants may seem unfamiliar to students because they are less pervasive in the curriculum, leading to student difficulties[2]

We looked for 7 key principles of natural selection in the student responses

Principle	Phenotypic Reasoning	Genotypic Reasoning
Variation [V]	Phenotypic variation exists in a population at the same time. (V_P)	Variation in a population has genetic origins. (V_G)
Inheritance [I]	Phenotypes are inherited by offspring. (I_P)	Inheritance of phenotypes is due to genetics. (I_G)
Fitness [F]	Differential reproduction or fitness based on phenotypes. (F)	-------
Evolution [E]	Phenotypes of a population change over time. (E_P)	Genetics of a population change over time. (E_G)

Data were collected from two courses

- Introductory Biology II (two sections, same semester, $n = 431$)
- Evolution (two sections, different semesters, $n = 222$)
- Pre- and Post-instructional assessments
- All student responses were coded by two independent coders
  - Disagreements were discussed and resolved
  - Cohen's Kappa to establish IRR

Code	Cohen's Kappa
VP	0.77
VG	0.92
IP	0.80
IG	0.90
F	0.89
EP	0.62
EG	0.80

Sensitive plants (*Mimosa pudica*) are able to fold their leaves in about one second to escape predation. How would a biologist explain how the ability to rapidly fold leaves evolved in sensitive plants, assuming their ancestors could fold leaves in five seconds on average?

"At one time all plants most likely closed in five seconds, then there was a mutation among the population that allowed the leaves to close quicker. This made them more fit and more quick closing leaves passed on their genetics. Over time as more quick closing leaves survived and slow died the population shifted. It would have taken many generations but if one traits benefits the species more it will have higher fitness."

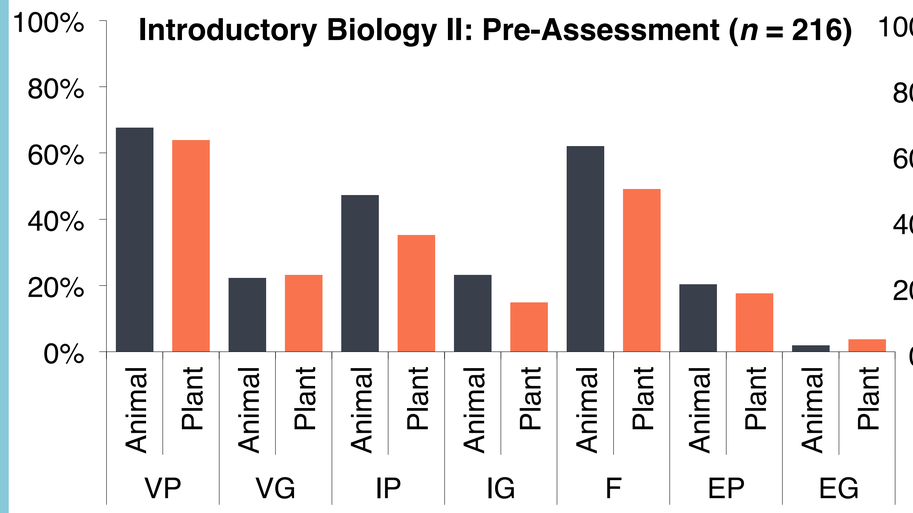
The Prompts

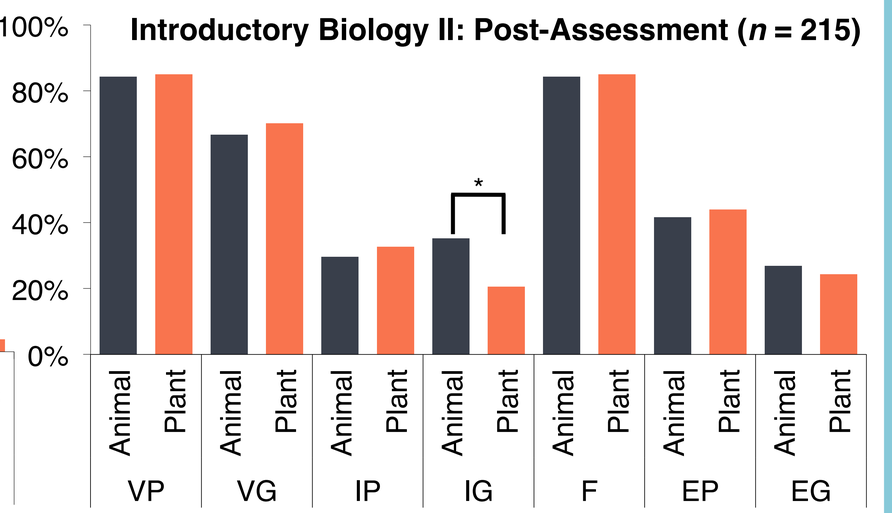
V_P	V_G
I_P	I_G
F	---
E_P	E_G

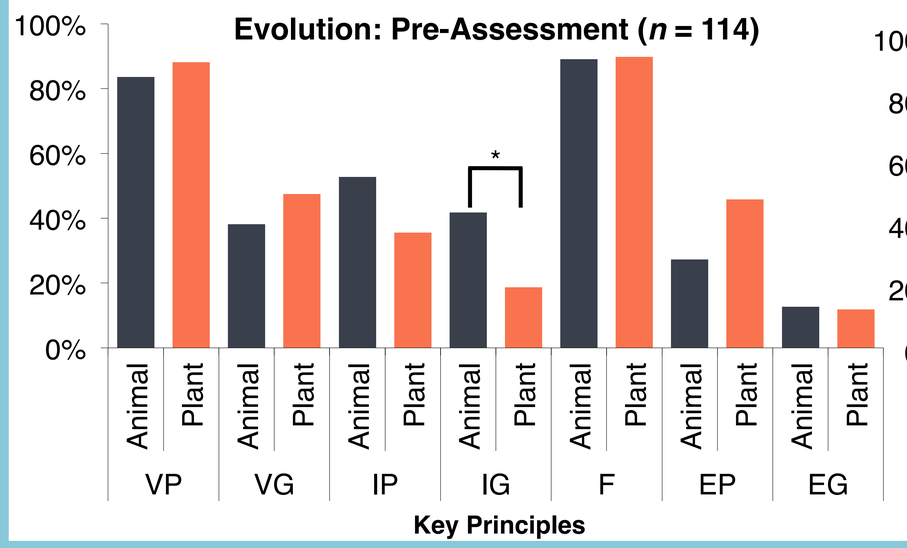
Springboks (*Antidorcas marsupialis*) are able to run about 60 miles per hour to escape predation. How would a biologist explain how the ability to run fast evolved in springboks, assuming their ancestors could run 30 miles per hour on average?

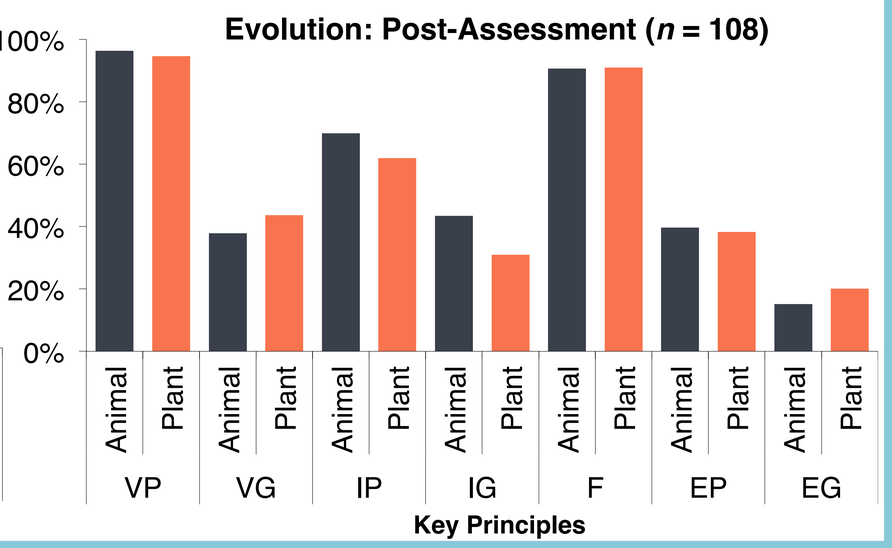
"At some point in the history of the Springboks, some sort of variation occurred in the population. One possible source could be a mutation in a gene that controls speed. This mutation resulted in a Springbok that was much faster than the others. The fast Springbok was able to escape predators easier, and as a result was able to survive reproduce successfully. This speed gene was also heritable, and the speedy springbok had fast offspring. Over time this fast trait was favored and as a result became more prevalent in the population. As a result the allele for fast be came more common, while the allele for slow became less common."

Student reasoning about natural selection was *NOT* impacted by context in either course









References
[1] Nehm et al. 2012. Reasoning about natural selection: Diagnosing contextual competency using the ACORNS instrument. ABT 74:92-98.
[2] Balas & Momsen. 2014. Attention "blinks" differently for plants and animals. CBE-LSE 13: 437-443.

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