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DATA Nugget

David vs. Goliath

Featured scientists: Andrew Bubak, Nathan Rieger, and John Swallow from the University of Colorado, Denver; Michael Watt and Kenneth Renner from the University of South Dakota. Written by: Gabrielle Welsh

Research Background:

Stalk-eyed flies have their eyes at the end of long stalks on the sides of their head. These stalks are used by males when fighting for resources.

Animals in nature often compete for limited resources, like food, territory, and mates. To compete for these resources, they use aggressive behaviors to battle with others of the same species. **Aggressive behaviors** are meant to overpower and defeat an opponent. The outcome of a battle depends on many different factors. In insects, one important factor is body size. Larger individuals are usually more aggressive and often win more battles. Chemicals in the brain can also influence who wins a fight. One chemical, called **serotonin**, can cause insects to have more aggressive behaviors. It is found in the brains of all animals, including humans.

Andrew had always been curious about what makes an animal decide to use aggressive behaviors in battle, or when to end one. He worked with researchers Nathan, Michael, Ken, and John to study the role that chemicals in the brain have on behaviors. The team was interested in how brain chemicals, like serotonin, affect aggression. They have been studying an insect species called stalk-eyed flies. These flies have eyes on the ends of long eyestalks that protrude from their heads. Male stalk-eyed flies use these eyestalks when battling each other. In a previous experiment, they found that serotonin can cause these flies to have more aggressive behaviors. They also knew that flies with shorter eyestalks usually lose fights to larger flies.

This made them curious about whether extra serotonin could make flies with shorter eyestalks act more aggressive and help them win fights against flies with longer eyestalks. The team of researchers discussed what they knew from past research and predicted that if they gave serotonin to short eyestalk flies, it might help them win fights against long eyestalk flies. They thought this made sense because they already knew that serotonin make flies more aggressive, and more aggressive behaviors could help the shorter flies win more fights.

The fighting arena where stalk-eyed flies battle. The camera is set up to help the scientists observe both the high intensity behaviors and retreats.

The team designed a lab study to look into this question about the importance of eyestalk length and serotonin for battles in stalk-eyed flies. First, the researchers raised male stalk-eyed flies in the lab. They made sure the flies were around the same age and were raised in a similar lab environment from the time they were born. Then, they measured the eyestalk length for each fly and divided them into two groups. One group had flies with longer eyestalks (Goliaths) and one group had flies with shorter eyestalks (Davids). They took the group of Davids with shorter eyestalks and fed half of them food with a dose of serotonin. This became the treatment group. They fed the other half of the Davids group food, but without serotonin. This was the control group. The treatment group and control group each had 20 flies.

To prepare the flies for battle, all flies were all starved for 12 hours before the competition to increase their motivation to fight over food. The researchers paired each David with a Goliath in a fighting arena. They observed the flies and recorded aggressive behaviors shown by each opponent. The researchers labeled any behavior where the fighting flies touch each other as a “high intensity behavior”. They labeled any behavior where the flies backed away as a “retreat”. Flies that retreated less than their opponent were declared the winners.

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A “Goliath” stalk-eyed fly demonstrating a high intensity behavior against its competitor.

Scientific Question: Does serotonin affect the chances of a short eyestalk fly winning a fight against a long eyestalk fly?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientific Data:

Use the data in Table 1 and Table 2 to answer the scientific question:

Table 1. Behaviors for Davids and Goliaths

	David		**Goliath**	
	Untreated	**Treated**	**Untreated David Opponent**	**Treated David Opponent**
Average # of High Intensity Behaviors	1.2	2.45	1.94	5.5
Average # of Retreats	1.5	1.45	0.35	0.5

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Table 2. Outcomes of Battles between Goliaths and untreated and treated Davids

Untreated David (control)		**Treated David (serotonin)**	
Battle Number	**David Won?**	**Battle Number**	**David Won?**
Battle 1	No	Battle 21	No
Battle 2	Tie	Battle 22	Tie
Battle 3	No	Battle 23	Yes
Battle 4	No	Battle 24	Yes
Battle 5	Tie	Battle 25	Tie
Battle 6	No	Battle 26	Tie
Battle 7	Tie	Battle 27	No
Battle 8	No	Battle 28	Tie
Battle 9	Yes	Battle 29	No
Battle 10	No	Battle 30	No
Battle 11	Yes	Battle 31	No
Battle 12	Tie	Battle 32	No
Battle 13	Tie	Battle 33	Tie
Battle 14	No	Battle 34	Tie
Battle 15	No	Battle 35	No
Battl1 16	No	Battle 36	No
Battle 17	Yes	Battle 37	Yes
Battle 18	Tie	Battle 38	No
Battle 19	No	Battle 39	No
Battle 20	No	Battle 40	Tie
# of battle wins	3	**# of battle wins**	3
Proportion of battle wins	0.15	**Proportion of battle wins**	0.15

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What data will you graph to answer the question?

Independent variable: ____

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Dependent variable: ____

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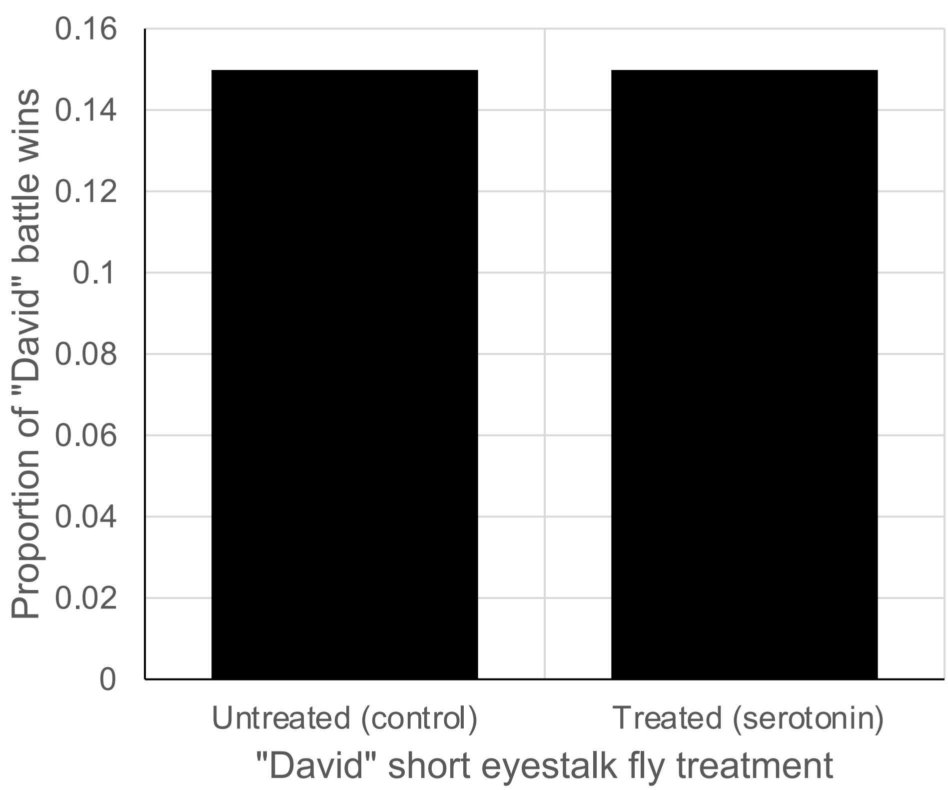
<u>Below is a graph of the data</u>: Identify any changes, trends, or differences you see in your graph(s). Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.



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Interpret the data:

Make a claim that answers the scientific question, does serotonin affect the chances of a short eyestalk fly winning a fight against a long eyestalk fly?

What evidence was used to write your claim? Reference specific parts of the table(s) or graph(s).

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how brain chemicals influence animal behavior.

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Did the data support the researchers' hypothesis? Use evidence to explain why or why not. If you feel the data are inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Andrew, Ken, and John's research? How do your questions build on the research that has already been done?