Fighting Cancer with raspberries: demonstrating the value of random assignment

A Flash applet at

www.causeweb.org/mouse_experiment

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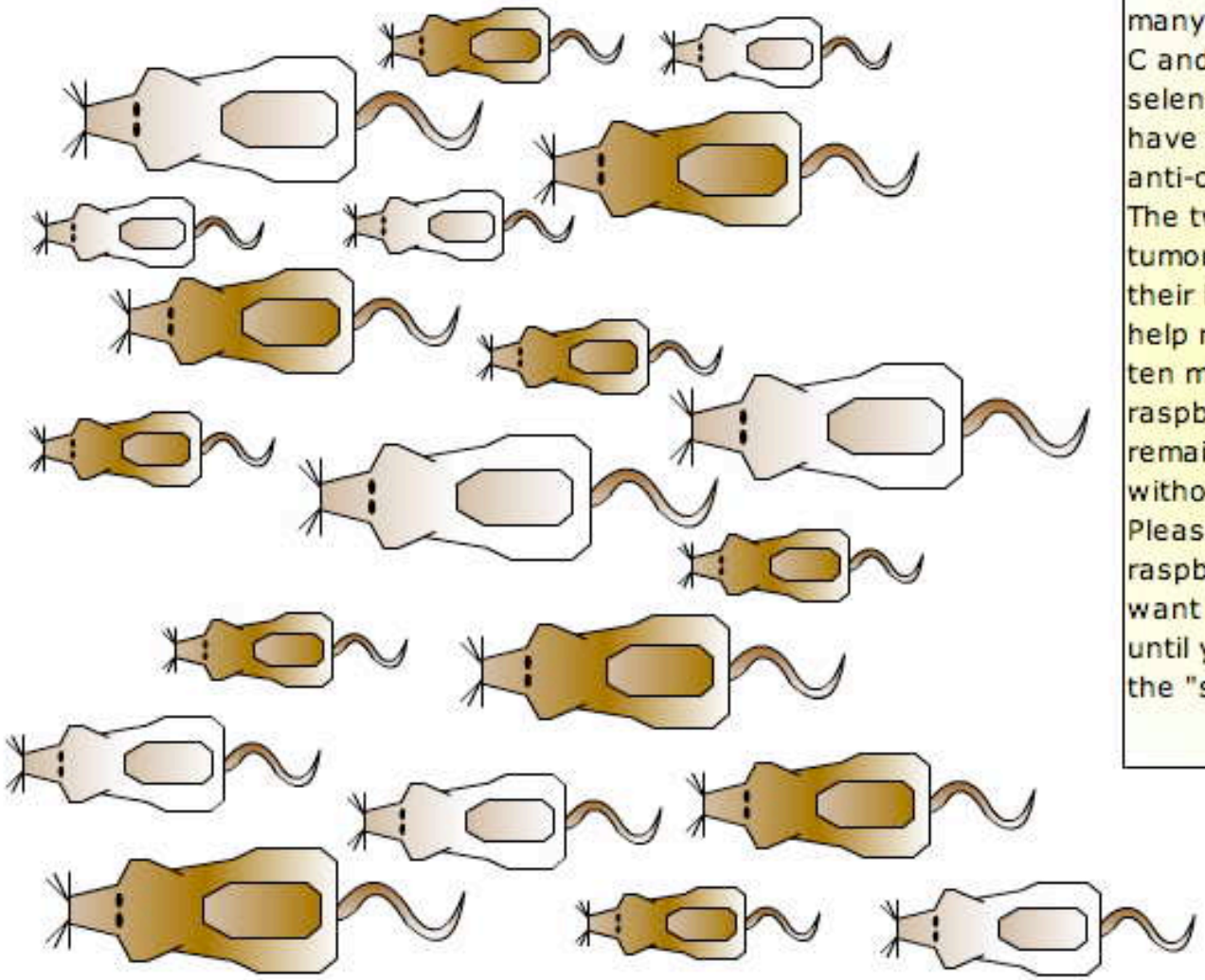
- Content by Dennis Pearl & Tom Santner
- Funded by Ohio Board of Regents

Learning Objectives

- Haphazard $\neq$ Random
- Random assignment eliminates bias
- It leads to a consistent pattern of results when repeated
- And thus makes the question of statistical significance interesting and easy to answer

Please Choose 10 Mice for the Raspberry Treatment



Raspberries have a high content of many beneficial compounds like vitamins C and E, folic and ellagic acid, calcium, selenium, etc. As a result, researchers have recently been investigating their anti-cancer properties.
The twenty mice in the picture all have a tumor growing just under the skin on their backs. To test if raspberries can help reduce the growth of these tumors, ten mice will be chosen to have raspberries added in their diet and the remaining ten will eat a normal diet without the raspberries.
Please pick the ten mice to receive the raspberry diet (just click on mice you want to include in the raspberry group until you have selected ten, then click the "submit selections" button).

submit selections

0 Number of Chosen Mice

Starting the activity

- Give background
- Give students 10 seconds to pick ten mice for raspberry group

Try it out!
Pick your ten mice but do not hit the submit button

…and be careful not to close the two windows associated with the webinar.

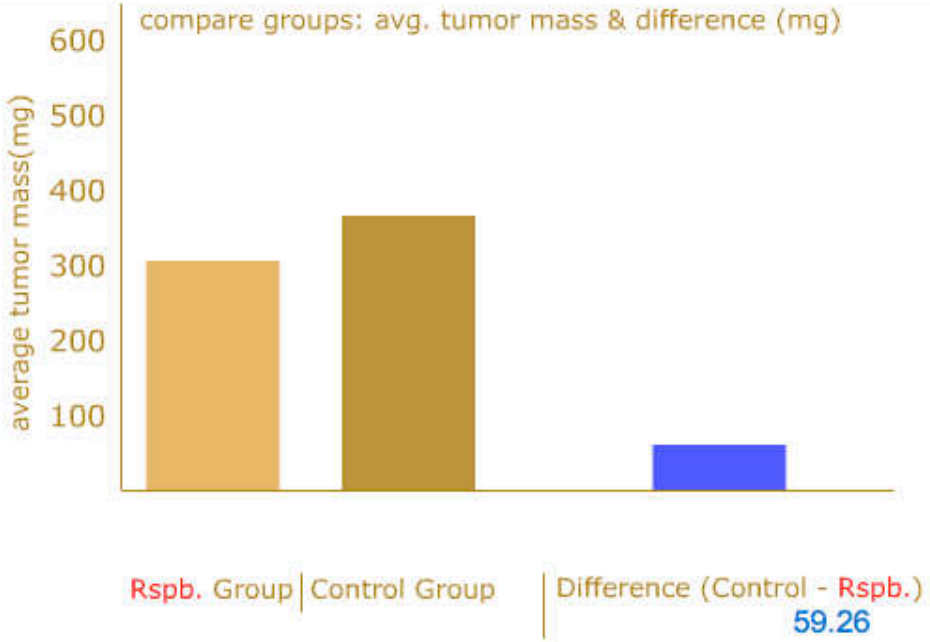
Make predictions

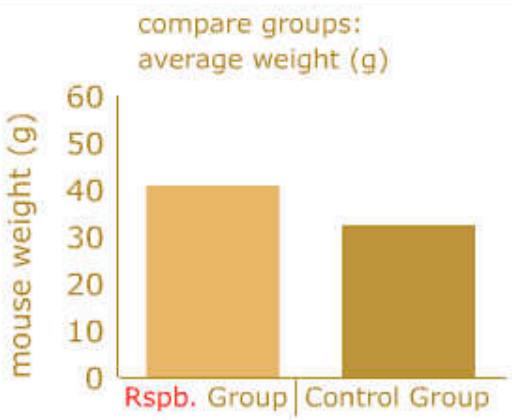
- Ask students if they showed any favoritism in their picks.
- Have students predict how a random sample will behave wrt variables besides treatment such as weight or age of mice.

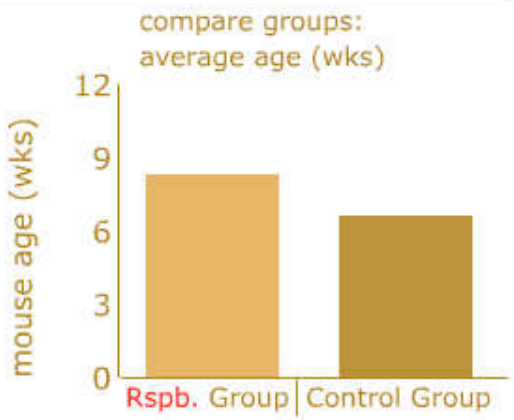
Summary of the Mice Hand-Selected for Comparison:

Summary of Data for Raspberry and Control Groups

	total selected	average wt. (g)	average age (wks.)	average tumor mass (mg)	proportion female	proportion brown
Rspb. Group	10	40.6	8.3	305.58	4 / 10	5 / 10
Control Group	10	32.5	6.6	364.84	6 / 10	6 / 10







random mouse selection

hand-selected mice summary

back to hand-selected mice

restart activity

use raw data

Compare Predictions to results from haphazard selection

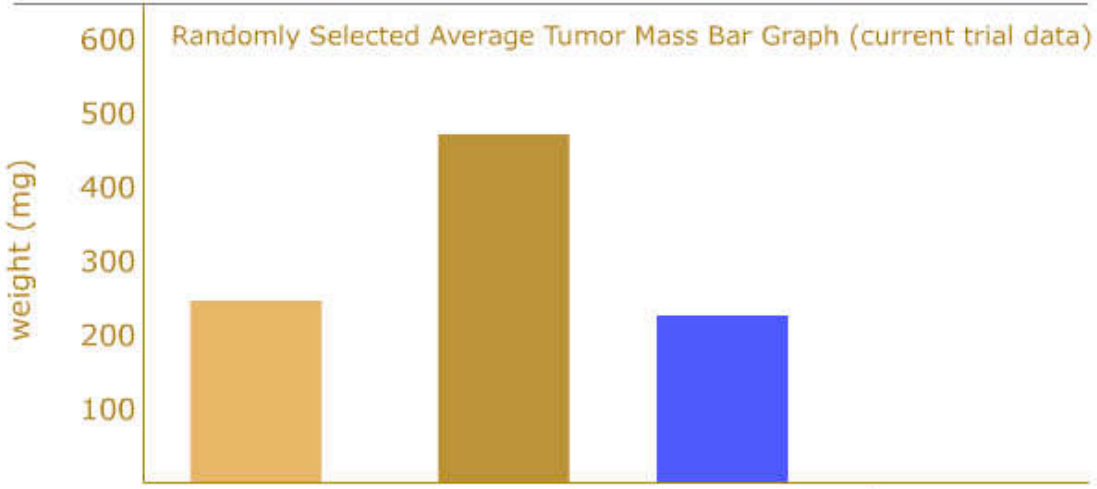
- Which group had larger weights?
- Which group had older mice?
- How did your results differ from your neighbor's?
- How did the class results differ from predicted?
  - (note your results for avg. difference in tumor size)
- Make a new prediction:

  Biology says that tumor growth will be faster in older (hence bigger) animals. How will this affect the results?

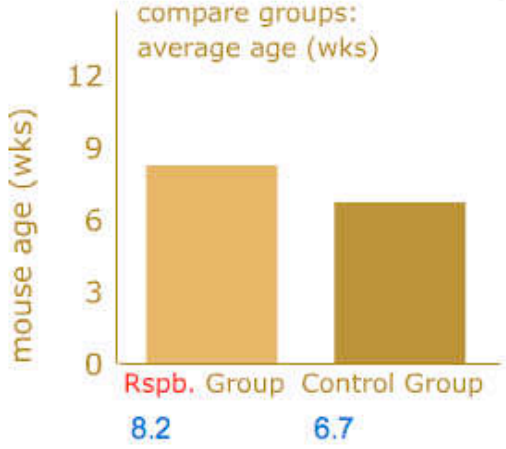
Let the applet pick the mice randomly and check the results

Summary of the Mice Randomly Selected for Comparison:

	total selected	average wt. (g)	average age (wks.)	tumor mass (mg)
Rspb. Group	10	35.7	8.2	245.4
Control Group	10	37.4	6.7	469.44



	rspb. average tumor mass(mg)	cont. average tumor mass(mg)	cont. - rspb. difference	number of trials	std. dev. of diff
current trial	245.4	469.44	224.04	1	
all trials	245.4	469.44	224.04		undefined



Instructions:

To generate random divisions of the 20 mice into control and treatment groups, click the generate random button to randomly select 10 mice for the raspberry treament. This can be done up to 10,000 times.

random mouse selection

generate random

Enter number to run multiple trials with one button press. 1

view histogram

clear random trials

back to summary, hand-selected mice

back to hand-selected mice

restart activity

use raw data

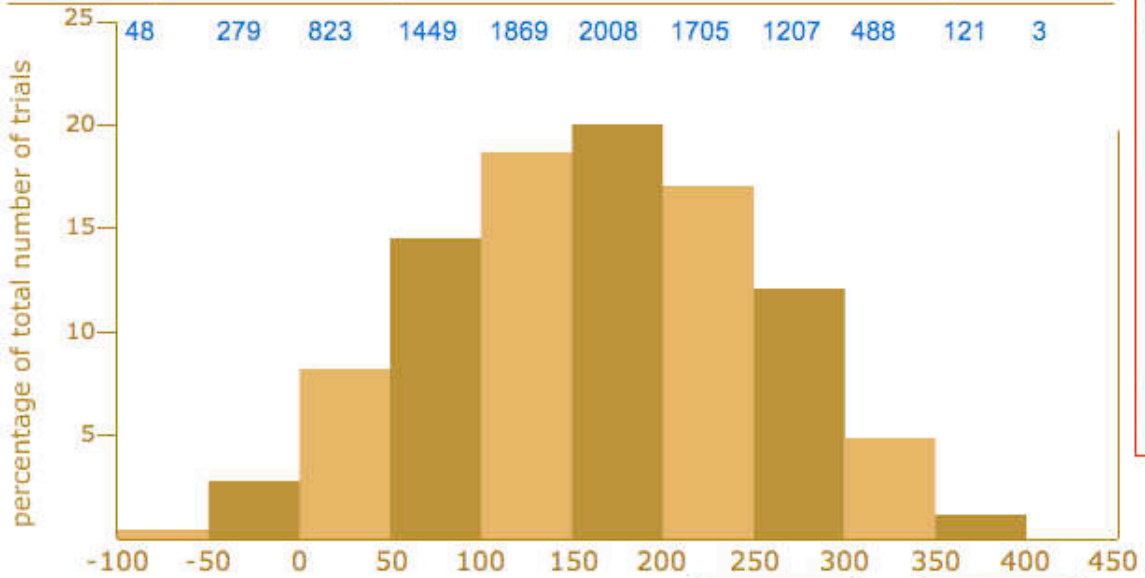
Let the applet pick the mice randomly and check the results

- Which group had larger weights?
- Which group had older mice?
- How did your results differ from your neighbor's?
- How did the class results differ from predicted?
- How did your results for tumor size change?

(Summarize results for individual students and for class as a whole)

Let the applet pick the mice randomly 10,000 times and check the results

Summary of Mouse Experiment Random Trials for Comparison:



Instructions:

To generate random divisions of the 20 mice into control and treatment groups, click the generate random button to randomly select 10 mice for the raspberry treament. This can be done up to 10,000 times.

no. of trials
10000

view age histogram | view weight histogram

random mouse selection

generate random | 10000 | Enter number to run multiple trials with one button press.

differences (mg): first 100 trials

trial numbers

1	129	12	113	23	202	36	125	49	82
2	382	13	186	24	165	37	191	50	82
3	27	14	330	25	158	38	250	51	13
4	216	15	187	26	8	39	271	52	141
5	143	16	228	27	146	40	231	53	230
6	33	17	179	28	20	41	205	54	141
7	-5	18	96	29	206	42	85	55	132
8	157	19	140	30	140	43	130	56	114
9	109	20	42	31	292	44	153	57	168
10	90	21	143	32	177	45	124	58	172
11	-7	22	187	33	215	46	47	59	23
				34	169	47	220	60	175
				35	252	48	129	61	236

62	316	75	367	88	161				
63	207	76	292	89	153				
64	227	77	267	90	151				
65	106	78	234	91	146				
66	162	79	162	92	247				
67	360	80	247	93	390				
68	199	81	110	94	43				
69	240	82	167	95	5				
70	37	83	335	96	220				
71	276	84	150	97	248				
72	94	85	206	98	288				
73	269	86	263	99	97				
74	229	87	231	100	133				

view bargraph

clear random trials

back to summary, hand-selected mice

back to hand-selected mice

restart activity

use raw data

Let the applet pick the mice randomly 10,000 times and check the results

- What kinds of differences in weights occurred?
- What kinds of differences in ages occurred?
- What kinds of differences in tumor size occurred?
  - Compare with graph for ages and weights.
- How did your results differ from your neighbor's?

(Summarize results for individual students and for class as a whole)

Summary Discussion

- Was it harder to see the Effect of Rasapberries when we selected the mice by hand? Why?
  - What "caused" difference in tumor sizes between groups when mice were hand selected?

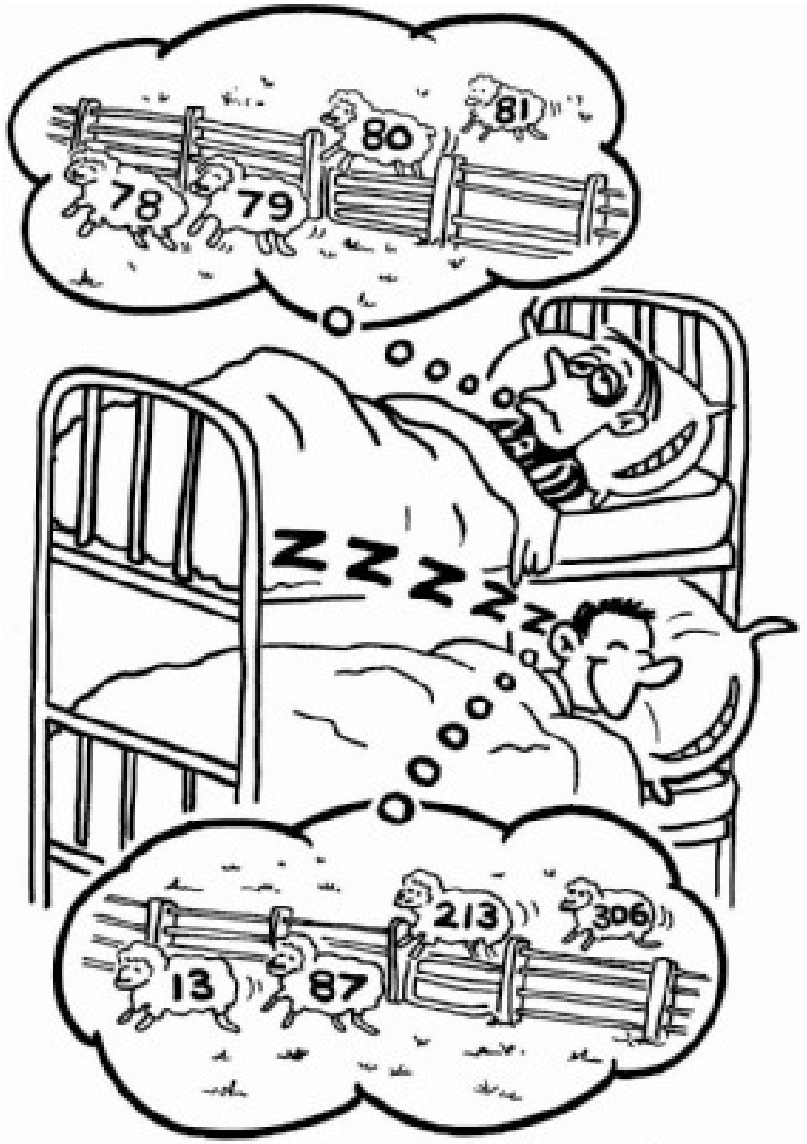
    (Bias toward older mice

    Luck of the draw

    Effect of raspberries)
  - What "caused" difference in tumor sizes between groups when mice were randomly selected?

    (Luck of the draw

    Effect of raspberries)



Statisticians fall asleep faster by taking a random sample of sheep.

Value of applet

- Time saving over classic activities
  - Stones
  - Driftwood
  - Two heads are better than one
- Requires little background
  - Useful for different audiences
  - Useful at different points in the syllabus

Value of applet

- Illustrates “subtle” points about bias
  - Bias can result without intentional favoritism
  - Bias reflects a tendency not a deterministic move
- Allowing individual student input challenges them to beat random allocation
- Comparison to random assignment is direct
- Can quickly compare distributions for both confounders and response variables

Supplemental Material

- Student handout
- Teacher’s lesson plan
- Assessment items