

Randomisation Lecture 1

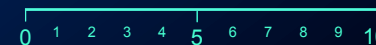
Statistics Department
Auckland University
New Zealand

Randomisation S1



- What are the chances of drawing a **RED** card? $p = 0.5$ (fair pack)
- In 10 draws, how many **RED** cards do we expect to get? **5**
- Can we be certain that we will get **5 RED** cards? **No!**
- If we repeated this experiment over and over *with a fair pack*, what would the pattern/*distribution* of results look like?
- Is this a fair pack?

Red	Black
✓	✓
	✓
	✓
	✓
	✓
	✓
	✓
	✓
	✓
	✓



Randomisation S2

Did Alice brush her teeth?

- Formulate statement to test. 1. She has brushed her teeth.
- Data (information at hand). 2. The toothbrush is dry.
- Consider 1. and the data:
If 1. is true, then what are the chances of getting data like that in 2.? 3. If she had brushed her teeth, then *the-toothbrush-is-dry* would be *highly unlikely*.
- Review the statement in 1. in light of 3. together with the data in 2. 4. Therefore, it's a fairly safe bet she has not brushed her teeth.

I have evidence that she has not brushed her teeth.

Randomisation S3

Did Alice brush her teeth (2)?

- Formulate statement to test. 1. She has brushed her teeth.
- Data (information at hand). 2. The toothbrush is wet.
- Consider 1. and the data:
If 1. is true, then what are the chances of getting data like that in 2.? 3. If she had brushed her teeth, then *the-toothbrush-is-wet* would *NOT* be surprising.
- Review the statement in 1. in light of 3. together with the data in 2. 4. Therefore, she could have brushed her teeth. *Or she could have just run the brush under the tap.*
I have no evidence that she has NOT brushed her teeth.

Randomisation S4

Was it a fair pack of cards?

1. Formulate statement to test. 1. The pack of cards is fair.
2. Data (information on hand). 2. 10 black cards out of 10 draws.
3. Consider 1. and the data: *If 1. is true, then what are the chances of getting data like that in 2.?* 3. If the pack of cards were fair, then 10-black-cards-out-of-10-draws would be *highly unlikely*
4. Review the statement in 1. in light of 3. together with the data in 2. 4. Therefore, it's a fairly safe bet that the pack of cards is not fair.
We have evidence that the pack of cards is not fair.

Randomisation S5

The Walking Babies Experiment

Does a special exercise programme lower walking age?

Phillip R. Zelazo, Nancy Ann Zelazo, & Sarah Kolb, "Walking in the Newborn" *Science*, Vol. 176 (1972), pp314-315

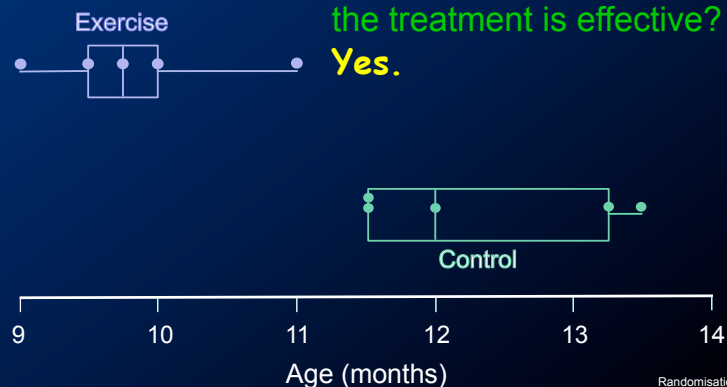
10 male infants (& parents) were *randomly assigned* to one of two treatment groups.

First walked without support:

Treatment	Age (months)				
Exercise	9	9.5	9.75	10	11
Control	13.25	11.5	12	13.5	11.5

Randomisation S6

The Walking Babies Experiment



Randomisation S7

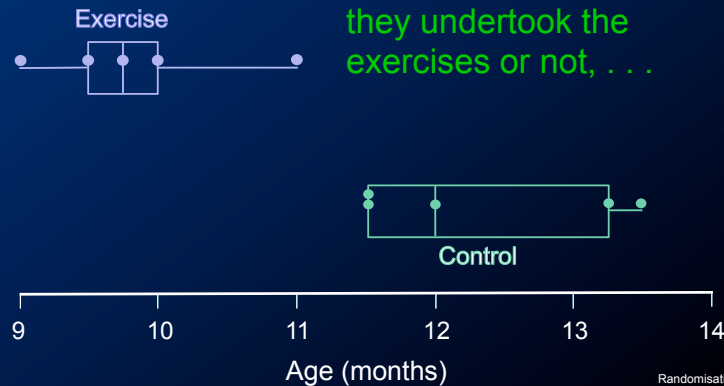
Looking at the world *using data* is like looking through a window with ripples in the glass

“What I see ...
is not quite the way it really is”



The Walking Babies Experiment

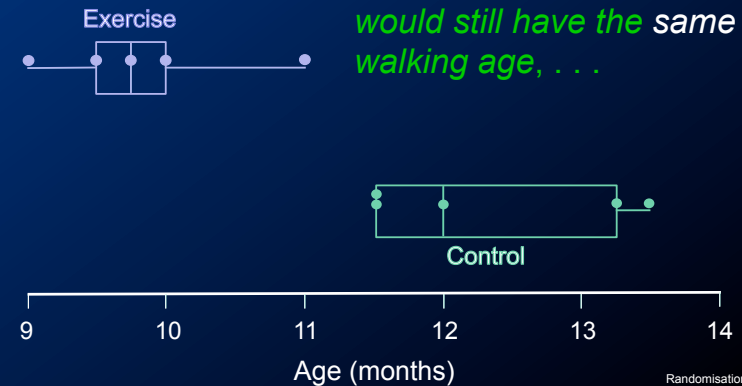
Is it *possible* that these babies' walking ages have nothing to do with whether they undertook the exercises or not, . . .



Randomisation S9

The Walking Babies Experiment

. . . i.e., it doesn't matter which group they were randomly assigned to, they would still have the same walking age, . . .

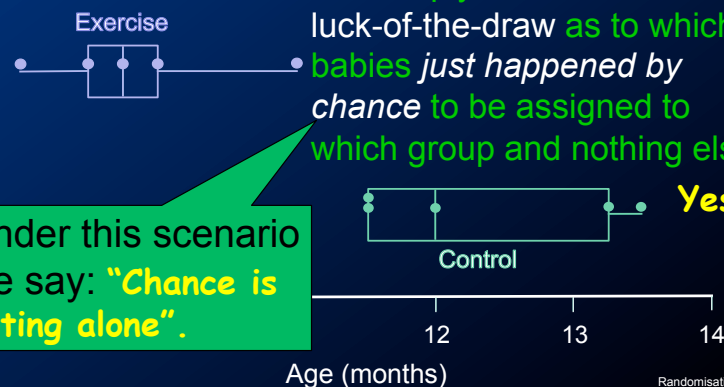


Randomisation S10

The Walking Babies Experiment

. . . and so the observed difference pattern is purely and simply the result of the luck-of-the-draw as to which babies just happened by chance to be assigned to which group and nothing else?

Under this scenario we say: "**Chance is acting alone**".



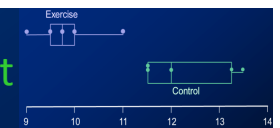
Randomisation S11

The Walking Babies Experiment

Possible explanation:

One *possible* explanation for the observed difference between these two groups:

Chance is acting alone (the exercise has no effect)



Randomisation S12

The Walking Babies Experiment

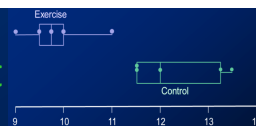
Possible explanation:

One *possible* explanation for the observed difference between these two groups:

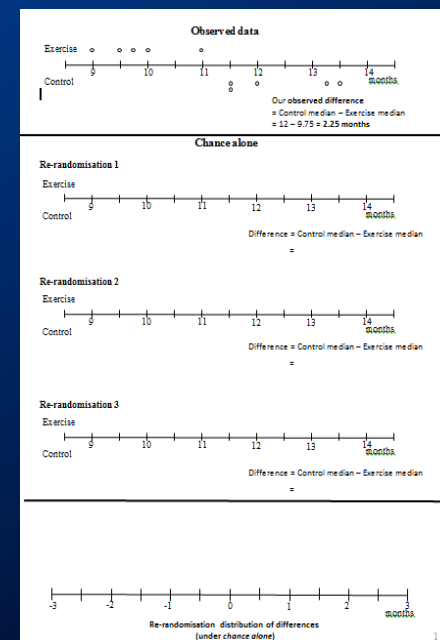
Chance is acting alone (the exercise has no effect)

Is the '*chance alone*' explanation simply **not plausible**?

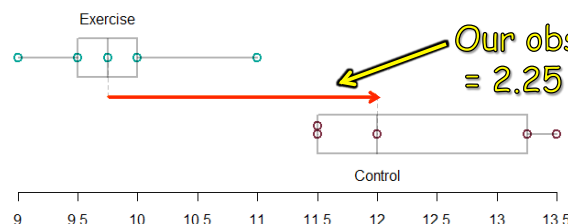
- Would our **observed difference** be **unlikely** when chance is acting alone?
 - How do we determine whether an observed difference is *unlikely* when chance is acting alone?
- Answer:** See what's **likely** and what's **unlikely** when chance is acting alone.



Randomisation S13



Randomisation S14



Our observed difference = 2.25 months

Is *chance alone* likely to generate differences as big as our difference?

The Walking Babies Experiment



An observed difference of 2.25 months or greater is highly unlikely when chance is acting alone . . . therefore, it probably isn't.

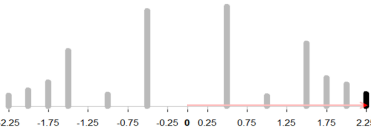
It's a fairly safe bet chance is not acting alone.

- Under chance alone, it would be **highly unlikely** to get a difference equal to or bigger than our observed difference of 2.25 months.

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The Walking Babies Experiment



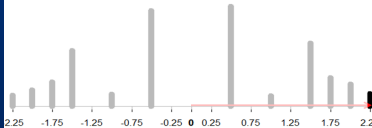
Possible explanation:
One *possible* explanation for the observed difference between these two groups:
Chance is acting alone (the exercise has no effect)

- We can **rule out** 'chance is acting alone' as a **plausible** explanation for the difference between the two groups.
- We have evidence **against** 'chance is acting alone'
- We have evidence that **chance is not acting alone**

Randomisation S17

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Guidelines for assessing 'Chance alone'



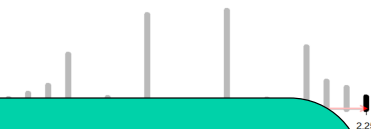
When the tail proportion is less than 10%:

- the observed difference would be unlikely when chance is acting alone . . . therefore, it's a fairly safe bet chance is not acting alone.*
- we have evidence **against** 'chance-is-acting-alone'*
- we have evidence that chance is **not** acting alone*

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The Walking Babies Experiment



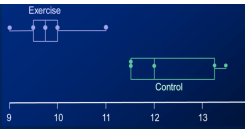
If chance is **not** acting alone, then **what else** is also acting to help produce the observed difference?

Remember:
Random assignment to 2 groups & each group receives different treatment.

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The Walking Babies Experiment

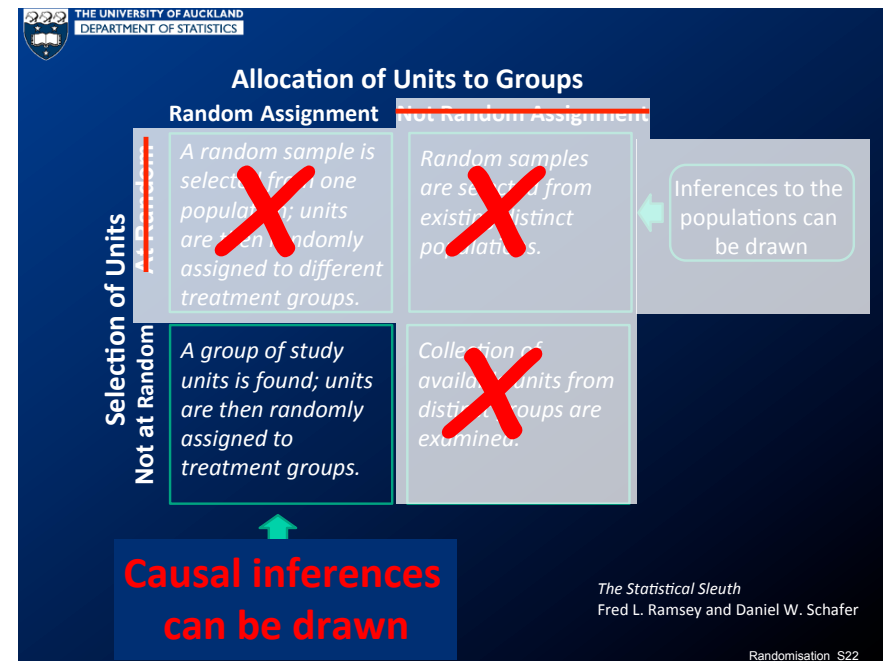
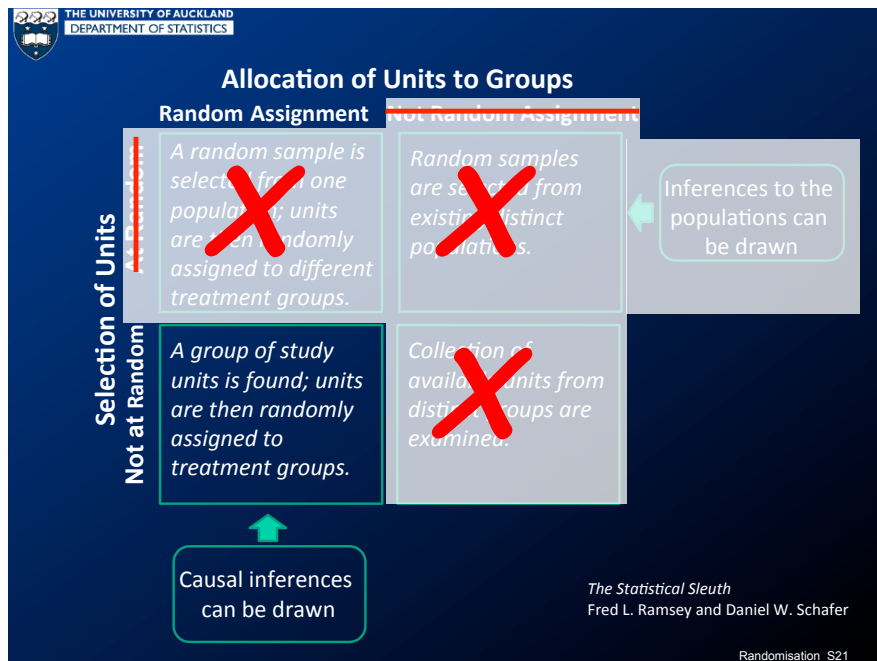


Conclusion:

Because the male infants (& parents) were **randomly assigned** to the groups, we may **claim** that the **exercise was effective** in lowering the walking age.

Because these subjects in this experiment were volunteers (**not randomly selected**), then we would need to consider carefully as to which wider group(s) this conclusion may apply.

Randomisation S20



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Did Alice brush her teeth?

Steps

- Statement to test.
- Collect data (information).
- Consider 1. and the data:
If 1. is true, then what are the chances of getting data like that in 2.?
- Review the statement in 1. in light of 3. together with the data in 2.

- She has brushed her teeth.
- The toothbrush is dry.
- If she had brushed her teeth, then the toothbrush-is-dry would be highly unlikely.
- Therefore, it's a fairly safe bet she has not brushed her teeth.
I have evidence that she has not brushed her teeth.

Randomisation S23

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Is the exercise programme effective?

Steps

- Statement to test.
- Collect data.
- Consider 1. and the data:
If 1. is true, then what are the chances of getting data like that in 2. or more?
- Review the statement in 1. in light of 3. together with the data in 2.

- Chance is acting alone.
(The exercise has no effect.)
- Diff between medians = 2.25 mths.
- A difference of 2.25 months or more is highly unlikely when chance is acting alone.
(Tail prop = roughly 3%)
- Therefore, it's a fairly safe bet chance is *not acting alone*. We have evidence against 'chance is acting alone'.

Randomisation S24

Is the exercise programme effective?

Steps

1. Statement to test.
 1. Chance is acting alone.
(The exercise has no effect.)
2. Collect data.
 2. Median diff = 2.25 mths.
3. Consider 1. and the data:
If 1. is true, then what are the chances of getting data like that in 2. or more?
 3. A median diff of 2.25 mths or more is highly unlikely when chance is acting alone.
4. Review the statement in 1. in light of 3. together with the data in 2.
 4. Therefore, it's a fairly safe bet chance is *not* acting alone. We have *evidence* against chance is acting alone.

Randomisation S25

The Walking Babies Experiment

Does a special exercise programme lower walking age?

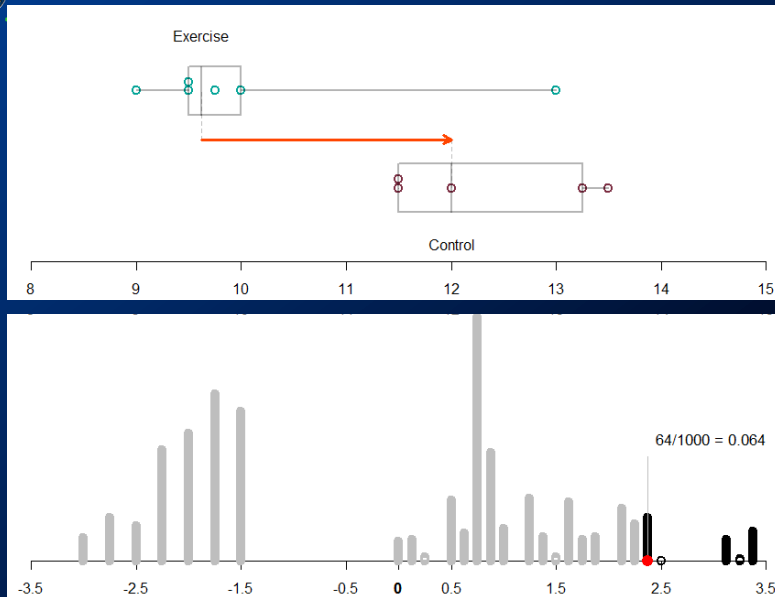
Phillip R. Zelazo, Nancy Ann Zelazo, & Sarah Kolb, "Walking in the Newborn" *Science*, Vol. 176 (1972), pp314-315

11 male infants (& parents) *randomly assigned* to one of two treatment groups.

First walked without support:

Treatment	Age (months)					
Exercise	9	9.5	9.75	10	13	9.5
Control	13.25	11.5	12	13.5	11.5	

Randomisation S26



Randomisation S27

Disclaimer: Materials under development

- Software (under development) available for PCs from iNZight website:
www.stat.auckland.ac.nz/~wild/iNZight

- PowerPoint slides available at:
www.censusatschool.org.nz

• **THANK YOU**

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Randomisation S28