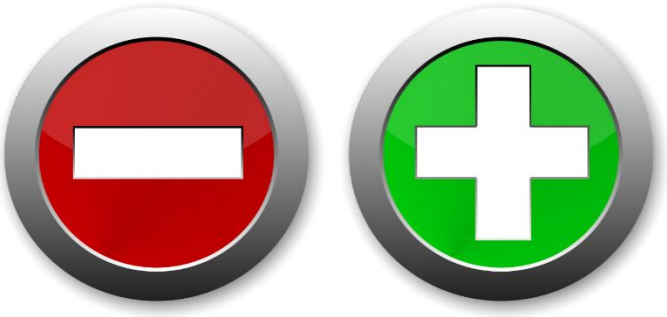
Lesson 10

The Sign Test



Lesson Objectives

- All students **will** justify use of the sign test.
- All students **should** be able to calculate the sign test in full.
- All students **could** use the table of critical values to draw an effective conclusion in terms of significance.

Key Words

- Significance
- Probability
- Nominal data
- The sign test
- Calculated value
- Critical value

Extension activity:

- Complete the extension and 'apply it' activities on page 198-199 of the digi-book.

Questions to guide your thinking ...

- What are the three criteria for using the sign test?
- Do you know how to calculate the sign test?
- Can you use the table of critical values for the sign test to conclude whether results are statistically significant?

Descriptive Vs Inferential Statistics

In the last two lessons, we looked at descriptive statistics – statistics such as measures of central tendency and graphical displays that simply *describe* the data obtained without making any inferences (i.e. drawing conclusions) about it.

Inferential statistics allow us to go beyond what the data looks like to make judgements about whether our findings are **significant** – whether a difference (or association) between two sets of data is important rather than due to mere chance factors. Such statistical testing therefore provides a way of determining whether a research hypothesis should be accepted or rejected.

Suppose for example that we wanted to investigate if the amount of Red Bull someone drinks influences their performance on a memory test. Our results might suggest the group who had Red Bull achieved higher memory test scores than the group who drank the placebo. We need to work out whether the difference is significant (i.e. is the difference between the scores of the two groups large enough for us to be confident that it was down to Red Bull rather than just chance or a fluke?).

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The concept of probability

Statistical tests work on the basis of **probability** rather than certainty. We can never be 100% certain that results aren't due to chance, so instead of 'proving' a hypothesis, we have to be content with finding out whether it's *likely* to be true.

In psychology, the accepted level of probability, known as the **level of significance**, is **0.05** or **5%.** This is the 'level of proof' a researcher typically requires to accept the research hypothesis or not.

If the research hypothesis is accepted, it means that that there is less than (or equal to) 5% probability that the results occurred by chance. In other words, the researcher can be pretty confident that any difference found was due to their manipulation of the independent variable.

The level of significance is expressed as a decimal value in the form: **P ≤0.00**

Here '**P**' stands for the probability that chance factors are responsible for the results.

The **5%** level of significance is written as: **P ≤ 0.05**

Lower levels of significance

Using a significance level of 0.05 **is sufficient for most tests**. Occasionally, a more **stringent** (or strict) level of significance, such as **0.01**, is used in studies where there may be a human cost – such as drug trials – or 'one-off' studies that could not, for practical reasons, be repeated in the future.

The sign test

One simple statistical calculation we can use to determine whether a difference is significant is the sign test.

Like other tests in psychology, the sign test has certain conditions of use – certain requirements that must be met before the test can be carried out:

1. We need to be looking for a **difference** between two sets of data rather than an association.
2. We need to have a **repeated measures** design.
3. Data need to be organized into categories, i.e. **nominal data**. If data is not in nominal form, it can be converted for the purpose of the test.

The sign test: A worked example

A psychology teacher wanted to see whether having breakfast would improve students test results in a morning exam. They tested the students when they had not had breakfast and then got them to complete the same test again the following day after all having a bowl of porridge for breakfast. The test was scored out of 20. The scores were placed in the table below.

The teacher predicts that students' test results will improve when breakfast has been eaten. (A directional or '**one-tailed'** hypothesis'.)

Participant	No breakfast score	With breakfast score	No breakfast - breakfast	Direction of difference
1	5	15	**-10**	**-**
2	7	12	**-5**	**-**
3	10	10	**0**	**Omitted**
4	3	9	**-6**	**-**
5	9	7	**2**	**+**
6	7	16	**-9**	**-**
7	14	14	**0**	**Omitted**
8	4	15	**-11**	**-**
9	9	11	**-2**	**-**
10	5	4	**1**	**+**

Steps to calculating the sign test:

Step 1: Covert the data to **nominal** data. We do this by subtracting the 'with breakfast' score from the 'no breakfast' score. If the answer is a negative, we record this sign, if it is positive, we record a plus sign.

Step 2: From the table above, we add up the plus and minus signs.

Step 3: We take the **less frequent sign** (in this case the total number of plus signs) and call this **S**. Therefore the calculated (or observed) value of **S = 2**.

Note that participants who have the **same** 'no breakfast' and 'with breakfast' score (i.e. participants 3 and 7) are omitted from the calculations. Therefore N (number of scores) in this case = **8**.

Step 4: Compare the **calculated value** of S with the **critical value**:

Table of critical values of the sign test (S)

Calculated value of S must be EQUAL TO or LESS THAN the critical value in this table for significance to be shown.

Level of significance for a **one-tailed test**				
	.05	.025	.01	.005
Level of significance for a **two-tailed test**				
	.10	.05	.02	.01
N				
5	0			
6	0	0		
7	0	0	0	
8	1	0	0	0
9	1	1	0	0
10	1	1	0	0
11	2	1	1	0
12	2	2	1	1
13	3	2	1	1
14	3	2	2	1
15	3	3	2	2
16	4	3	2	2
17	4	4	3	2
18	5	4	3	3
19	5	4	4	3
20	5	5	4	3
25	7	7	6	5
30	10	9	8	7
35	12	11	10	9

NOTE: Once any statistical test has been calculated, the result is a number – the **calculated value** (or observed value). To check for **statistical significance** (i.e. how sure we can be that a difference or correlation found is meaningful and unlikely to have occurred by chance), the calculated value must be compared with a **critical value** – a number that tells us whether or not we can reject the null hypothesis and accept the alternative hypothesis.

Step 5: Complete the following statement:

Conclusion:

We can see from the investigation that the calculated value of **S=2** is more/less than/equal to the critical value of _____ where N = _____. Therefore the difference is/is not significant at the accepted **P ≤ 0.05 level**. Therefore the researcher should accept/reject the null hypothesis that:

[If the result is significant add the following:] This means we can accept the research

hypothesis that:

Your turn …

- **Calculate the sign test using the data provided**:

A food manufacturer wishes to know if its new breakfast cereal 'Fizz-buzz' will be as popular as its existing product 'Kiddy Slop.' Ten participants try both and choose which they prefer. One participant prefers the existing product, seven prefer the new product and two like both equally.

There has not been any previous research in this area, and the psychologists are using a standard significance level.

The first row of the table has been completed for you:

Participant	Preference	Direction of difference
1	Kiddy Slop	-
2		
3		
4		
5		
6		
7		
8		
9		
10		

- **Calculate the value of S. Show your workings.**

- **Is the result significant? Explain your answer.**

- **What can the researcher conclude about the new Fizz-Buzz cereal?**

Mini-Practical with the Sign Test

and Review of Experimental Research Methods

Aim: To investigate if participants remember more English words or French words

IV -

DV -

Directional research hypothesis:

Null Hypothesis:

What research method is this study?

Which experimental design is being used?

Which sampling technique was used?

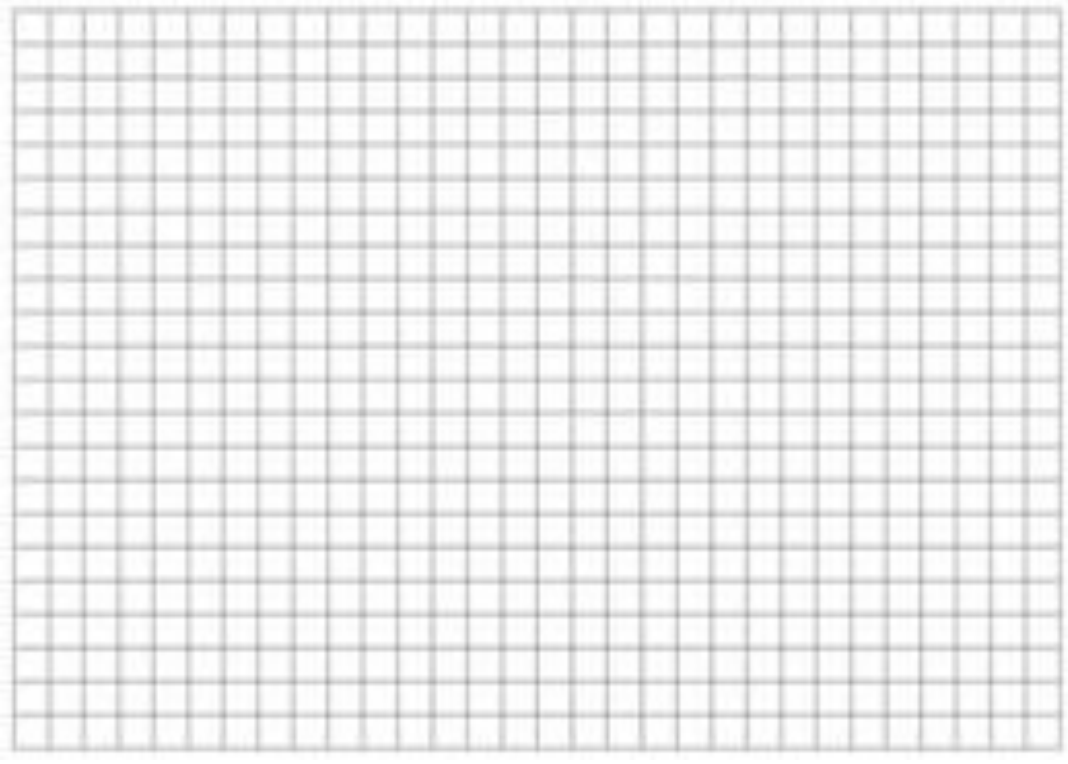
State one advantage and one disadvantage of this technique:

- **Complete the table of results**

1. Table of results:

Participant No.	English Words (A)	French Words (B)	A-B	Direction of difference

- **Use the data to create a suitable graphical display:**



Standardised instructions were used in this study. Briefly explain *why* it is important to use standardized instructions and procedures in research.

Exam Practice: The Sign Test

AS Psychology (7181/2) – Specimen Material Third Set

Read the item and then answer the questions that follow.

Twenty primary school teachers were sent by their individual head teachers to attend a training course in classroom behaviour management run by educational psychologists at a local university. Before the training course, and again after training, the teachers were asked to say how confident they were in managing difficult classroom behaviour.

The researchers compared the before and after answers to see how many teachers rated their confidence as 'better', 'worse', or 'the same' as it had been at the start of the course.

The results are shown in **Table 1** below:

Table 1

	Confidence Better	Confidence Worse	Confidence Same
Number of teachers	16	2	2

Question 16:

The psychologists conducting the training decided to use the Sign Test to see whether there was a significant difference in confidence in managing difficult classroom behaviour before and after the course.

Give the calculated value of S in this study and explain how you arrived at this figure. [3 marks]

Question 17

Explain why statistical testing is used in psychological research. [2 marks]