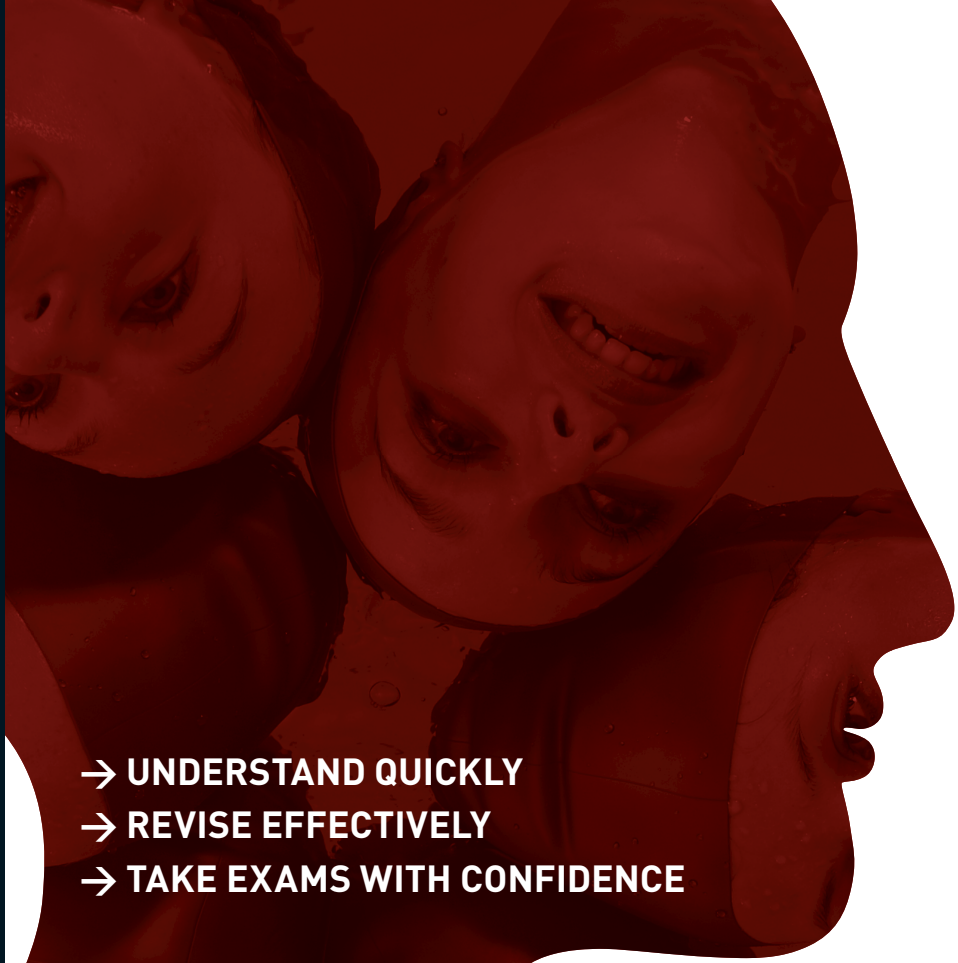

Psychology Express

→ UNDERSTAND QUICKLY
→ REVISE EFFECTIVELY
→ TAKE EXAMS WITH CONFIDENCE

Statistics in Psychology

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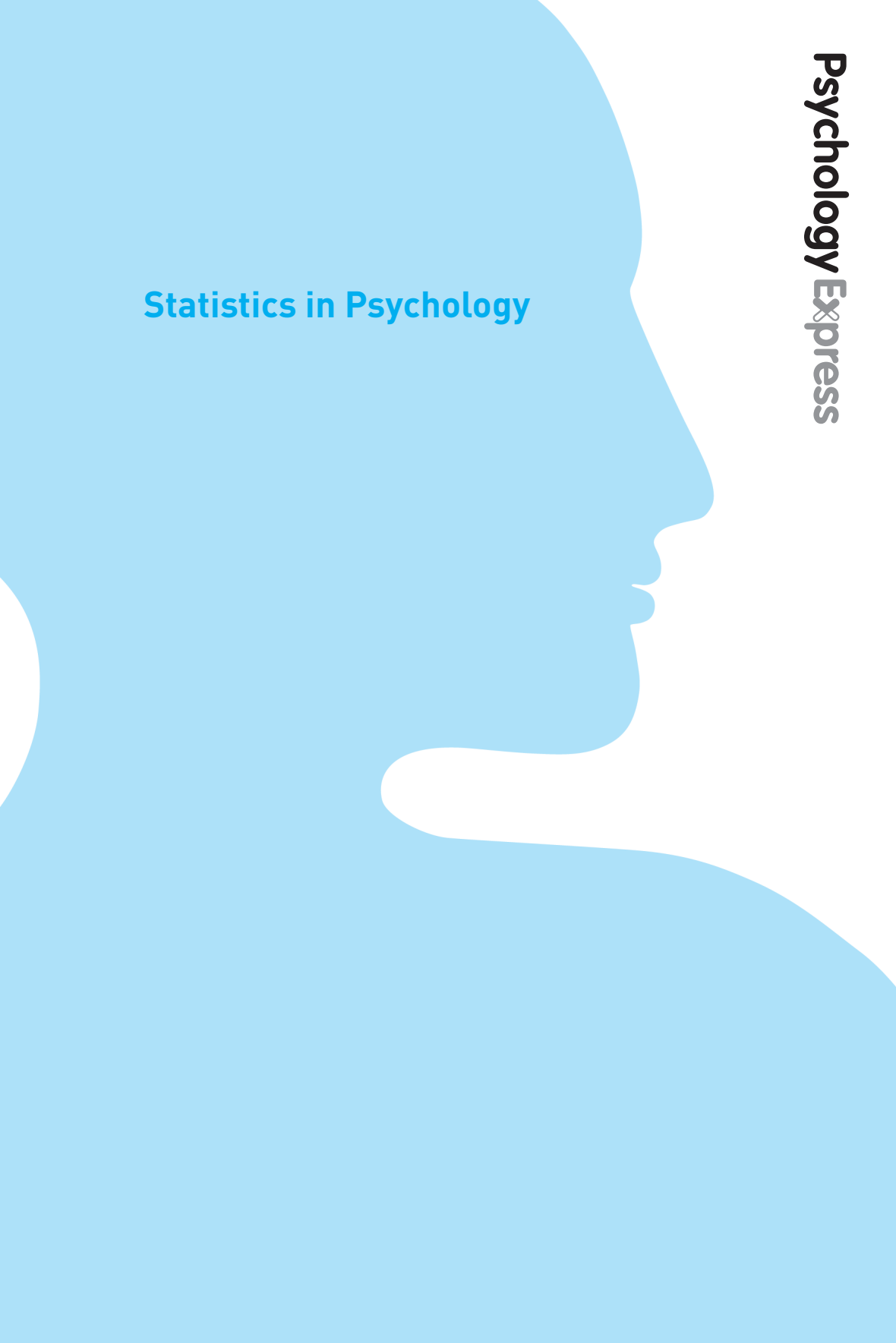
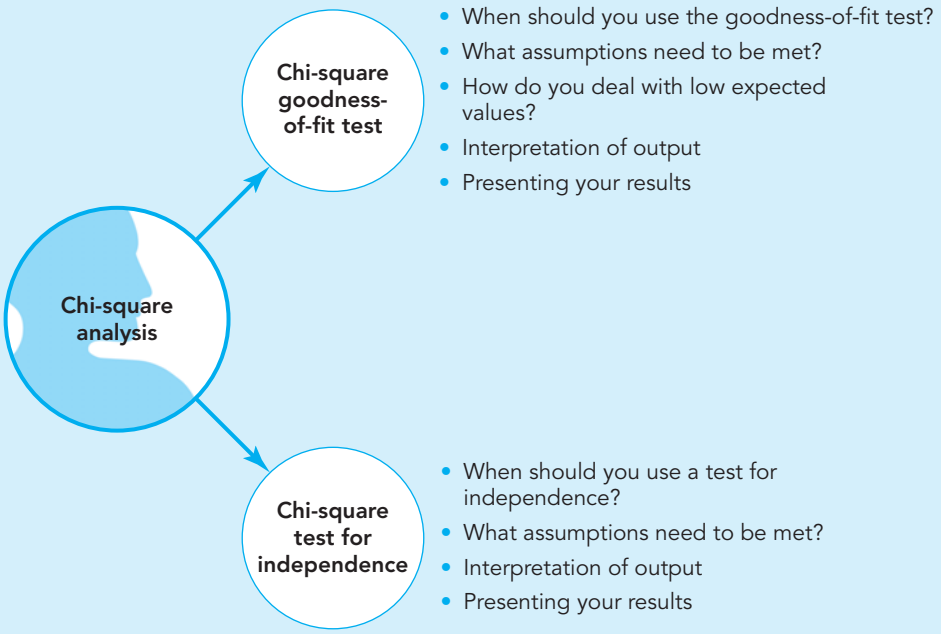
Psychology Express

Statistics in Psychology



4

Chi-square analysis



A printable version of this topic map is available from
www.pearsoned.co.uk/psychologyexpress

Introduction

This chapter will cover chi-square tests: the goodness-of-fit (one sample chi) and the chi-square test for independence (chi-square contingency table analysis). Chi-square tests are part of the non-parametric family of tests, and are used for dealing with categorical data (where cases are placed into groups). The goodness-of-fit test is used to compare the frequency distribution of a single variable against a hypothetical distribution. The test for independence is used to find out whether there is a relationship between two categorical variables. As with all statistical tests, each chi-square test comes with a series of assumptions that need to be met in order for the test to give accurate results.

Revision checklist

Essential points to revise are:

- ❑ When to use chi-square goodness-of-fit and test for independence analyses
- ❑ How to decide if your data is suitable for these analyses
- ❑ How to interpret and present your results

Assessment advice

With all assessments in statistics there are usually three main components that the examiner is looking for you to demonstrate:

- justified choice of test;
- correct implementation of the test;
- correct interpretation and presentation of results.

When justifying your use of a test, you need to consider the research question you are investigating and the type of data you have. Faced with an exam question or a piece of coursework, do not be afraid to spend some time considering exactly what you are dealing with. If it helps you, write down the variables in the scenario or draw a diagram to help you visualise what is going on. Time and effort spent at this stage will help you reach top marks.

Be aware of the limitations of the test you are using and possible alternative tests. Some courses require you to calculate statistics by hand, others allow you to use SPSS in assessments. Whichever method your course allows, make sure you complete all the steps in the analysis carefully and show your working. Even if you make a mistake in your execution you may still get marks for using the correct procedure, although this is not guaranteed.

When interpreting your results, always check that you have not violated any assumptions of the test.

A good answer will show a good grasp of what is indicated by a significant (or non-significant) result and what cannot be inferred. Always take care to present your results in APA format.

For chi-square tests in particular consider the following:

- Always state why you have chosen to use a chi-square test.
  - Chi-square tests are always used when you have only categorical data.
  - If you chose to transform continuous data into categorical data you must be able to justify doing this.
- Interpret your results carefully.
  - In the goodness-of-fit test a significant result indicates that it is not likely that your sample is representative of the population it was drawn from, or that a treatment has had an effect on the variable in question.
  - In the test for independence a significant result suggests that there is a relationship between the two variables. What cannot be inferred is which of the observed values are significantly different from their expected values. No cause and effect is implied by a significant result.
- Watch out for low expected values, as these may reduce the accuracy of the test.

Sample question

Could you answer this question? Below is a typical problem-based question that could arise on this topic.

Sample question *Problem-based learning*

A clinical psychologist is interested in the relationship between early aggression in childhood and later diagnoses of conduct disorder in adolescence. She examines the files of 108 of her past clients and records whether they showed evidence of early aggression and whether they were later given a diagnosis of conduct disorder. Given the data in Table 4.1, assess whether there is a relationship between early childhood aggression and a later diagnosis of conduct disorder. The data set is available on the website.

Table 4.1 Patient early aggression and conduct disorder

	Conduct disorder diagnosis	No conduct disorder diagnosis
Early aggression	27	24
No early aggression	45	12

Guidelines on answering this question are included at the end of this chapter, whilst further guidance on tackling other exam questions can be found on the companion website at: **www.pearsoned.co.uk/psychologyexpress**

Chi-square goodness-of-fit test

Key term

Chi-square goodness-of-fit test: also referred to as the *one-sample chi-square*. A non-parametric test used to compare the frequency distribution of cases on a single, categorical variable to hypothesised values.

When should you use the goodness-of-fit test?

- To see if a sample is representative of a population in terms of a particular variable, e.g. is the distribution of gender in my sample of 50 people the same as the distribution found in the UK population?
- To test whether a treatment given to a sample has had an effect on a given variable, e.g. is the distribution of smokers and non-smokers in a sample who have received hypnotherapy different from the distribution in the general population?

Why use the goodness-of-fit test?

- It assesses whether a sample is different from the population in terms of central tendency, variability and shape of distribution.
- It can be used with nominal, ordinal and interval/ratio data (if the latter are transformed into categorical data).
- It can be used with data that is not normally distributed.

Disadvantages

- Being non-parametric, it is less powerful than parametric tests.

What assumptions need to be met?

There are three main assumptions that need to be met in order for your data to be suitable for a goodness-of-fit test:

- the data is categorical;
- expected values are greater than 5;
- cases only appear in one category.

Key term

Expected values: the number of cases you expect within a particular category if the null hypothesis is true. These are based on hypothesised values specified by the researcher. The hypothesised values may come from known values within the population, or be based on theoretical values.

How do you deal with low expected values?

There are two ways to deal with low expected values:

- increase your sample size;
- join two or more categories together into one larger category.

Consider the following research scenario. You are interested in finding out whether students found their research methods module difficult. You place an advert on a notice board asking students who took the module to volunteer to take part in your research. Out of the 129 students who took the module, 44 respond to your advertisement. You believe that the grade the student received in the module will impact upon whether they rate the module as difficult. How will you check whether the students who responded to the notice are representative of all the students in the class in terms of the grades they received?

A chi-square goodness-of-fit test is suitable in this situation. The goodness-of-fit-test can compare the number of students achieving each grade in your sample to the distribution in the population. This is known as comparing observed values to expected values. The expected values will be calculated based on the frequency distribution known to have occurred in the class (the population).

A chi-square test can be performed by hand or using SPSS. The following section will guide you through interpreting the output SPSS produces when you compute a chi-square goodness-of-fit analysis. For more information on computing chi-square analyses by hand please consult the Further Reading box at the end of this chapter.

Interpretation of output

The following Output Boxes will be produced by SPSS when you have performed a goodness-of-fit test.

The table labelled 'Grade' (Output Box 4.1) shows the observed frequencies from your data in the first column and the expected frequencies in the second column. The third column shows you the difference between the observed and expected values. In this case you can see that we have roughly the same proportion of students achieving a low pass in our sample as is found in the population, but we have more students who failed and less who achieved a high pass than was expected, given the frequency distribution in the population.

Output Box 4.1 **Grade**

	Observed N	Expected N	Residual
High pass	2	9.8	–7.8
Low pass	26	25.3	.7
Fail	16	8.9	7.1
Total	44		

The 'Test statistics' table (Output Box 4.2) gives you the results of the chi-square analysis. In this case you can see that the chi-square test statistic is 11.920 (first row) with 2 degrees of freedom (second row). This exceeds the critical value of chi-square at the 0.05 level (see the significance level on the third row). We can therefore conclude that there is a significant difference between the distribution of grades in the sample and the population. This means our sample is not representative of the population in terms of the grades they received.

Output Box 4.2 **Test statistics**

	Grade
Chi-square	11.920[a]
df	2
Asymp. sig.	.003

[a] 0 cells (0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.9.

'Footnote [a]' provides information on whether you have violated the assumption that expected values are greater than 5. You can see in this case none of the expected values are less than 5, therefore you have not violated the assumption.

Presenting your results

You need to give the following information:

- the test used;
- the degrees of freedom;
- the number of cases;
- the test statistic;
- the *p* value.

A chi-square goodness-of-fit test indicated that the sample of research methods students who responded to the advertisement for participants was not representative of the population of research methods students in terms of their grade achievement $\chi^2(2, n = 44) = 11.92$, $p<0.003$. The proportion of students in the sample who achieved high pass grades (4.5%) was lower than the proportion in the entire population (22.3%). Conversely, the proportion of students in the sample that failed (36.3%) was higher than the proportion who failed in the population (20.2%).