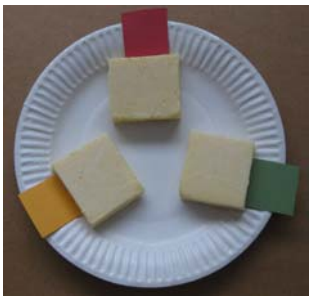

Food and drink manufacturers often offer an alternative product for those customers who are very health conscious. For example, they may sell a 'low fat' cheese, a 'low sugar' drink or a 'reduced salt' meal alongside their usual products.

When introducing such healthy options, manufacturers often worry that consumers may not buy them unless they taste as good as the original products.

This activity is about testing whether people can tell the difference between a product and a healthier alternative. The hypothesis test used is called the **triangle** test.

Information sheet A

The triangle test

In a triangle test each participant is given three samples that look identical. Two of these samples are also identical in other respects, but one is different in some way. Each participant is asked to say which sample they think is the odd one out.

What you will need for a triangle test

- a group of volunteers to take part in the test - check that they have no food allergies
- for each participant you need two samples of product A (the usual product) and one sample of product B (the healthier option). The three samples must look identical. It is better to present them in a triangle rather than in a straight line. Mark the samples in some way to help you to remember which is which.
- a cup of water for each participant
- a pen and instruction sheet (see below) for each participant

Think about…

Why is it **not** a good idea to label the samples 1, 2, 3 or A, B, C?

Instruction sheet Triangle test

Thank you for taking part in this test which aims to find out whether people can tell the difference between a product and a healthier alternative.

What to do

Please take a drink of water before tasting any of the samples and also between samples. You may want to re-taste a sample, so do not consume the whole sample at once.

Mark the sample that you think is different from the others with an X.

Carrying out the triangle test

- Go through the test instructions with the participants, answering any questions that arise. For example, a participant may ask what to do if they cannot tell which is the odd one out – in this case ask them to guess.
- Emphasise that volunteers should remain silent during the test and not influence any of the other participants in any way. (Enforce this rule during the test.)
- At the end of the test, thank all the volunteers for taking part.
- Count the number of correct and incorrect identifications of the 'odd one out'.

Information sheet B

Analysing the results

The null and alternative hypotheses are:

H_0: Participants cannot tell the difference.
The probability of a person choosing the correct odd one out, $p = \frac{1}{3}$

H_1: Participants can tell the difference.
The probability of a person choosing the correct odd one out, $p > \frac{1}{3}$

Under H_0, the number of volunteers who chose the correct odd one out, X, is Binomial with n = the number in the group, $p = \frac{1}{3}$ and $q = \frac{2}{3}$

Think about…

What assumptions are being made by using the Binomial distribution?

Using $P(X = r) = \binom{n}{r} p^r q^{n-r}$, the probability of the test result or better is found.

If this is less than 0.05, the test result is significant and H_0 should be rejected in favour of H_1.

Example

Suppose 8 out of 12 people identified the correct odd one out, then

$P(X \geq 8) = P(8) + P(9) + P(10) + P(11) + P(12)$

Think about…

Why is the test one-tailed, rather than two-tailed?

$$= \binom{12}{8}\left(\frac{1}{3}\right)^8\left(\frac{2}{3}\right)^4 + \binom{12}{9}\left(\frac{1}{3}\right)^9\left(\frac{2}{3}\right)^3 + \binom{12}{10}\left(\frac{1}{3}\right)^{10}\left(\frac{2}{3}\right)^2 + 12\left(\frac{1}{3}\right)^{11}\frac{2}{3} + \left(\frac{1}{3}\right)^{12}$$

= 0.0187…

This is less than 0.05 and means that the result is significant at the 5% level.

The conclusion is that people can tell the difference between the original product and the healthier option.

Try this

Carry out the triangle test with a group of volunteers and analyse the results.

Reflect on your work

- Why do food companies use triangle tests?
- Describe what you need to provide and how you should carry out a triangle test.
- Did you have any problems in carrying out your triangle test?
  If so, how did you overcome them?
- List the steps in the hypothesis test that you used to analyse the results of your triangle test.
  What was the result?
- How would a 1% significance test differ from the 5% test?
  Would the result have been the same?
- What limitations does a triangle test have?
  Can you think of any ways to improve it?