Children’s understanding of probability and certainty: an intervention study

Support: The Nuffield Foundation

The children’s progress in measures of understanding associations between variables

In everyday life, risks are defined by an association between two things: for example, habitually listening to a very loud iPod and developing hearing problems. We assessed the children’s ability to analyse whether there is an association between two variables by asking them to examine data on a 2x2 table. An example of an item is given in the figure; the oral description that we gave when presenting the question helped the children understand what they were being asked to evaluate. There were four items in the test; in two of them, there is an association between the two variables, and there is no sign of an association in the other two.

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<table>
<thead>
<tr>
<th>People who have skin allergies</th>
<th>People who do not have skin allergies</th>
</tr>
</thead>
<tbody>
<tr>
<td>People who do not take much exercise</td>
<td>13</td>
</tr>
<tr>
<td>People who take exercise regularly</td>
<td>2</td>
</tr>
</tbody>
</table>
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Do you think that there is a connection between not taking exercise and having skin allergies? Yes No

Explain, using the information in the table, why you think so.

The children participated in only one lesson in which they discussed 2x2 tables and the association between variables. However, we expected them to have learned how to make comparisons that are relevant to answer this question from their experience with quantification of probability. When comparing probabilities across two situations, the children learned to examine the ratio between the favourable cases and the unfavourable cases (e.g. the chance of drawing a purple marble versus drawing a yellow marble). When examining the association between variables in a 2x2 table, they also need to compare the ratio of the cases that support the existence of an association with those that go against it.

All the children answered the same items on three occasions. On the first, the probability group had not yet had a chance to discuss the association between variables. The second test was given about one week after they had the lesson about analysing associations in 2x2 tables. The third test took place about two months after they had completed all the lessons. In the tests, the children received one point for making the correct judgement about the association between the variables and a graded score that considered the quality of the argument for each of their explanations.

The first, very interesting, result of our analyses was that the probability group did show a clear sign of being able to use what they had learned in the probability lessons when they analysed the 2x2
table. This group did significantly better than each of the other two groups in the correlations assessment before they had the lesson about association between variables. The means (and error bars) in the figure below show the difference between the groups. This difference could only result from their learning experiences with probability.

![Graph showing the difference in performance between groups](image)

In order to see whether the lesson on 2x2 tables had a further positive effect on the children’s understanding of associations between variables, we compared the performance of the probability group with the performance of the other two groups in the post-tests, controlling for their performance before the teaching started, because the probability group had done better at pre-test. Even after this stringent criterion for the intervention’s success, the comparison between the groups showed that the probability group did significantly better in analysing 2x2 tables than each of the other groups. Their performance in this assessment had not decayed in the delayed post-test they answered two months after the lesson had taken place. The mean scores in the immediate and delayed post-tests are displayed in the figure below.

![Graph showing the performance over time](image)

We conclude that there is very good evidence that teaching can help primary school children achieve some understanding of probability and of the basic ideas related to risk when two variables are associated (e.g. listening to an IPod at high volumes and developing hearing problems).