**Goodness of fit test**

**QUESTION 2.**  **2013**

Many animals defend themselves from predation by producing toxins. Others can gain some protection by having a lower nutritional content than co-occurring prey. To test how nutrients and toxins interact to determine food choice in predatory fish, a behavioural ecologist ran 40 trials, each offering an individual fish a choice of four diets. The artificial diets were: 1) a control diet that matched their usual prey, 2) a diet with additional nutrients, 3) a diet with a toxin added (from an abundant sea slug) and 4) a diet with both nutrients and toxins added. After each trial, the ecologist recorded which diet was first selected, and obtained the following data on number of times each diet was selected:

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment | | | |
| Control | + Nutrients | + Toxin | + Nutrients, + Toxin |
| 12 | 18 | 6 | 4 |

Answer all parts 2A to 2D.

**2A)** What statistical test could you use to test the hypothesis that diet selection by the fish varied among the four diets? (2 marks)

**2B)** Conduct the test, and give the value of the test statistic. (8 marks)

**2C)** Is your null hypothesis rejected or retained? (2 marks)

**2D)** In the experiment described above, the ecologist used 40 separate fish, with each individual fish used for one trial only. He also wanted to test the same hypothesis with a different species of fish, but only had four individuals of the second species. Describe an experimental design to test the same hypothesis with the second species. How could that design be analysed? (8 marks)

**QUESTION 1. 2010**

Behavioural scientists recently analysed the decision making of soccer goalkeepers when faced with penalty kicks (reported in the journal *Progress in Brain Research*, 2009). They viewed 311 penalty kicks and recorded the direction the direction that the goal keeper moved (left, centre or right of goalkeeper) to try to stop the ball. The data are summarised as follows:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Left | Centre | Right |
| Direction of keeper’s movement | 153 | 20 | 138 |

They then analysed the direction of the kicks to examine whether goalkeepers were making rational decisions about how to save the goal. 32.2% of the kicks went to the left, 28.7% of the kicks were in the centre, and 39.2% were to the right (direction from the goal keeper’s perspective).

Answer all parts 1A-1E.

**1A)** What statistical test could test the hypothesis that goalkeeper movements were in proportion to the likelihood that the ball is heading in that direction? (2 marks)

**1B)** What are the expected movements if the goal keepers are making entirely rational decisions, with their movements related to the likelihood of the ball heading in each direction? What are the null and alternative hypotheses for the test you have chosen? (6 marks)

**1C)** Conduct the test, and give the value of the test statistic. (4 marks)

**1D)** Is your null hypothesis rejected or retained? (2 marks)

**1E)** The study’s authors suggested that the highly paid soccer players were reluctant to stand still (i.e., the centre movement) because it would look like they weren’t trying to save the ball. Does your analysis support this conclusion? Give reasons for your answer (6 marks)