Quiz 2

ANOVA for multi-factor Designs

Learning from Picture Book Reading

An experiment was designed to examine toddlers' ability to learn from reading picture books. The experiment involved 36 children at each of three different ages (18, 24 and 36 months). The children were randomly assigned to one of three reading book conditions (books with **photos**, books with **drawings** and **control** books with neither photos nor drawings). After a reading session, each child was scored on comprehension of the activities described in the book.

McClave and Sincich, 12th Ed., problem 10.95.

Learning from Picture Book Reading

Partial ANOVA Table:

Source	DF	F	p
Age	-	11.93	< 0.001
Book	-	23.64	< 0.001
Age:Book	-	2.99	< 0.05
Error	-		
Total	107		

Learning from Picture Book Reading

Partial ANOVA Table:

Source	DF	F	p
Age	-	11.93	< 0.001
Book	-	23.64	< 0.001
Age:Book	-	2.99	< 0.05
Error	-		
Total	107		

Q1: How many treatments are there ?

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Book	-	23.64	< 0.001
Age:Book	-	2.99	< 0.05
Error	-		
Total	107		

Q2: What are the missing degrees of freedom ?

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Age	-	11.93	< 0.001
Book	-	23.64	< 0.001
Age:Book	-	2.99	< 0.05
Error	-		
Total	107		

Q3: Is there any evidence of an interaction between the two factors ?

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Age:Book	-	2.99	< 0.05
Error	-		
Total	107		

Q4: Explain what such an interaction would mean.

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Book	-	23.64	< 0.001
Age:Book	-	2.99	< 0.05
Error	-		
Total	107		

Q5: At the design stage, would this experiment be better considered as a randomized block design or a factorial design ?

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Error	-		
Total	107		

A1: $3 \times 3 = 9$

Learning from Picture Book Reading

Partial ANOVA Table:

Source	DF	F	p
Age	2	11.93	< 0.001
Book	2	23.64	< 0.001
Age:Book	4	2.99	< 0.05
Error	99		
Total	107		

A2: 2,2,4 and 99, that is

$$\begin{aligned} a-1 &= 3-1=2 \\ b-1 &= 3-1=2 \\ (a-1)(b-1) &= (3-1)(3-1)=2\times 2=4 \\ n-ab &= (3\times 36)-(3\times 3)=108-9=99 \end{aligned}$$

Learning from Picture Book Reading

Partial ANOVA Table:

Source	DF	F	p
Age	2	11.93	< 0.001
Book	2	23.64	< 0.001
Age:Book	4	2.99	< 0.05
Error	99		
Total	107		

A3: Yes: the p-value is < 0.05, so under the usual choice of significance level $\alpha = 0.05$, this is significant. The null distribution in the test of the hypothesis

$$H_0 \quad = \quad \text{No interaction between factors}$$

and, under this H_0

$$F \sim Fisher((a-1)(b-1), n-ab) \equiv Fisher(4, 99).$$

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Partial ANOVA Table:

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Age:Book	4	2.99	< 0.05
Error	99		
Total	107		

A4: It means (for example) that changes in scores across **Book** types are significantly different for the different **Ages**.

Equivalently, it means that, the changes in scores across **Age** groups are significantly different for the different **Books**.

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Book	2	23.64	< 0.001
Age:Book	4	2.99	< 0.05
Error	99		
Total	107		

A5: Probably better as a randomized block design, with **Age** as the blocking factor. This is because children at different ages are likely to have different scores.