**Psy 633 Factorial Analysis of Variance - overview**

Thus far: analyses single-factor designs

*t*-test: one-group, two-group

*F*-test: one IV, three or more groups (“One-way AOV”)

But life is complex -- usually multiple factors (IV’s) simultaneously affect behaviors

Research designs to address this complexity:

Multiple regression – determine factors that are most influential in affecting a behavior

Often used to predict behaviors based on underlying factors

Multi-factor AOV – determine diff’s among groups based on main effects of IV’s

+ interactions among the IV’s

The logic for the factorial AOV is exactly the same as for the one-way AOV:

*F* = (variance between sample means) / (variance within groups)

– or –

*F* = (variance between treatments) / (variance within treatments)

The following assumes only two factors (IV’s) but it applies to any number of factors.

Since there is more than one factor (IV), we speak of the effects of each separate factor.

Called “Main Effects.” The factors are labeled alphabetically: factor A, factor B, etc.

That is, factor A = IV(A), factor B = IV(B), etc.

Main Effects refer to possible diffs among the means in each separate factor (IV).

There are now **three** null hypotheses rather than just one.

The first two are the null hypotheses for factor A & factor B taken separately.

(1) The means of the DV for the groups in factor A do not statistically differ

(2) The means of the DV for the groups in factor B do not statistically differ

So what’s the third one? It’s called an “Interaction.”

The effects of one factor change across its levels, depending on its relation to the other factor.

We call this “the interaction of A by B,” and symbolically, it’s A x B.

Thus the third null hypothesis refers to the interaction:

(3) The effects of factors A and B on the DV do not interact with one another

Vocabulary:

Factor – IV

Levels - # of groups within each IV

Examples via graphs of Main effects versus Interactions

For ALL *F*-test formulae (both single-factor & factorial designs), the structure is the same.

*F* = MSB/MSW

Between-treatments effects (numerator of the *F-*formula) are caused by three things:

The actual treatment effects (the IVs)

Individual differences

Experimental error

Within-treatment effects (denominator of the *F*-formula) are caused by only two things:

Individual differences

Experimental error

Thus, the formula is a ratio – the three numerator effects divided by the two denominator effects:

*F* = (tx effects + Individual diffs + Exper error) / (Individual diffs + Exper error)

NOTE: remember that in stats, we often refer to both of the items in the denominator collectively as “Error variance.” Don’t confuse this with “Experimental error,” which is only one part of the total Error variance.

Partitioning of the variance:

Total var in the DV = Factor A var + Factor B var + A x B var + Within-treatments var

Based on this, we can compute the percentage of variance explained by each component:

100% total var = % due to Factor A + % due to Factor B + % due to A x B interaction + % due to “error”

In the social sciences, and especially in psychology, “Error variance” usually accounts for most of the variance. That is, differences among the scores usually reflect the effects of individual differences and experimental error far more than the effects of the IV’s and their interaction.

Examples

Four Assumptions – same as for one-way AOV & *t*-test

[Remember: *these assumptions MUST be ensured in order for parametric test to be valid*]

Normal distribution of the DV in the population of interest

Ensured by:

1. Prior knowledge that the DV is normally distributed

2. n per group of around 30 or higher

Homogeneity of variance (the variances of the groups are equal to one another)

Ensured by:

“Relatively large” and equal n’s among the groups

Independence of participant’s responses

Ensured by:

Random sampling [but note re: volunteers & convenience samples]

Random assignment of participants to groups [but note re: pre-existing groups]

Careful testing protocols

Number scale of the DV is either interval or ratio

Higher-order designs: i.e., three or more factors.

Great advantage:

They account for more of the variance in the DV, since they include more info

That is, they allow us to explain differences among groups more accurately.

Great disadvantage:

Interactions involving several IV’s can be impossible to interpret.

Pragmatic disadvantages:

# participants, resources, time etc are usually greatly increased

Problem: Let’s say that a researcher is interested in the effects of temperature and humidity level on test performance. She decides to use three levels of temperature and two levels of humidity, and measures test performance by scores on a moderately difficult cognitive task.

In the first graph below, we see an example of results that depict two main effects but no interaction between the IV’s.

In the second graph, we see results that depict two main effects plus an interaction between the IV’s.

