Meta Analysis & Programmatic Research

- Re-introduction to Programmatic research
- Importance of literature reviews
- Meta Analysis – the quantitative contribution to a literature review
  - Combination & Comparison
    - Weighting & Combining & Significance testing
    - The "file drawer" problem
- Comparison – why do different studies find different results?

Library Research
Learning “what is known” about the target behavior

Hypothesis Formation
Based on Lib. Rsh., propose some “new knowledge”

Research Design
Determine how to obtain the data to test the RH:

the “Research Loop”
- Novel RH:
- Replication
- Convergence

Draw
Conclusions
Decide how your “new knowledge” changes “what is known” about the target behavior

Data Collection
Carrying out the research design and getting the data.

Data Analysis
Data collation and statistical analysis

Hypothesis Testing
Based on design properties and statistical results

Is there an effect ??
H0: v Miss ?!

Is the effect “the same” under “different versions” of the study ??

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Literature reviews & meta analyses …

The Introduction to any research paper includes 3 basic parts:
1. The purpose of the research
2. A review of the related literature
3. A statement of the research hypotheses about the relationships among characteristics and/or behaviors

Most literature reviews address the reliability, size and/or importance of the effects under consideration, using a combination of significance testing and effect sizes.

Sometimes, even after considerable research in an area, there is dispute or debate about “whether or not there is an effect”…

Sometimes there is dispute or debate about “the right way” to run a study – with the implication that different methods produce different results…

These are the two questions meta analysis can help answer!
Combining studies to answer the questions “How large is the effect?” & “Is the effect significant?”

As you know, the size of the effect and the size of the sample combine to lead to the statistical significance of the result!

The study was designed to test the RH: that, “Students with faster reading speeds get higher test grades.” Eighty 4th grade students from a local elementary school were recruited for the study. Each student was tested using the Elementary Reading Speed Measure (ERSM) and an aggregate academic score (AAS) was composed from their math and social studies grades. The correlation between these measures was found to be $r(78) = .38$, $p = .001$.

This is a “medium” effect size, and it is statistically significant (only 1/1000 chance of a Type I error.

So far, so good ….

Upon hearing the results of this study, several teachers decided to replicate the study in their own classes. Each administered the ERMS and correlated it with exam scores. The results are listed below:

<table>
<thead>
<tr>
<th>School</th>
<th>$r(n)$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carter Elementary</td>
<td>.36</td>
<td>.063</td>
</tr>
<tr>
<td>Fartner Elementary</td>
<td>.46</td>
<td>.082</td>
</tr>
<tr>
<td>Cressewell Elementary</td>
<td>.38</td>
<td>.057</td>
</tr>
<tr>
<td>Lettrennth Elementary</td>
<td>.36</td>
<td>.107</td>
</tr>
<tr>
<td>Kostplen Elementary</td>
<td>.37</td>
<td>.062</td>
</tr>
<tr>
<td>Kostplen Elementary</td>
<td>.45</td>
<td>.101</td>
</tr>
<tr>
<td>Planary Elementary</td>
<td>.38</td>
<td>.121</td>
</tr>
<tr>
<td>Madison Elementary</td>
<td>.37</td>
<td>.213</td>
</tr>
<tr>
<td>Bellemiso Elementary</td>
<td>.47</td>
<td>.059</td>
</tr>
</tbody>
</table>

The author of the original research was disheartened at these findings!

Nine replication studies & none gave confirmation of the results of the original study !?!?

Let’s not be too hasty!

None have $p < .05$… But look at the $r$-values!!!

Each of these effect size is comparable to the original study, or larger ($r=.38$)! If so, why were none of these effect significant?

One of the important uses of meta analysis is to ask, what does a set of studies tell us about the likely effect size and significance of the relationship being studied?

It does this by combining the results from multiple studies into a single quantitative estimate of the represented effect size!

Then, you can perform a significance test of this estimate, taking advantage of the sample size from the combined studies!!!

In 1952 Hans J. Eysenck reviewed the available literature and concluded that there were no favorable effects of psychotherapy, starting a raging debate. Hundreds of studies run over the next 20 years failed to resolve the debate!!!

In 1978 Gene V. Glass statistically aggregated the findings of 375 psychotherapy outcome studies (building on earlier statistical models developed by Fisher and Cochran) and concluded that psychotherapy did indeed work !!!

Glass called his method “meta-analysis”
How can we apply this to the reading speed – exam performance data?

We put in the effect sizes and sample sizes from each study.

There's some math...

We get an estimate of the population effect size aggregated from the studies.

And a significance test based on the total sample size.

With N=196, no surprise that $r=.39$ is significant !!!

Even though I've worked hard to sell the importance of replication, it doesn't always work that way...

Glass concluded..

“A scientific study should be designed and reported in such a way that it can be replicated by other researchers. However, researchers seldom attempt to replicate previous findings. Instead, they pursue funding for the new, the novel… The result can be an overwhelming number of studies on a given topic, with no two studies exactly alike.”

Extensions of meta analyses allow us to compare studies, trying to find what study attributes are related to the size and significance of the effect.

Remember that we pointed out that, rejecting the idea of a single “critical experiment,” there were many, many different ways to run a particular study of how an IV and a DV are related within a given population...

- different types of research design
- different manipulations of the IV
- different measurements of the DV
- different setting
- different task/stimulus

The simplest type of meta analytic comparison is much like an ANOVA, you have 2 (or more) ways of running the studies, and want to know if that difference ways of running the study produce different effect sizes.

In these comparative analyses:
- the “case” is the individual study
- the “DV” is the effect size
- the “IV” is how the studies differ!!!
Applying this to the reading speed studies…

Some of the studies used Social Studies tests, and others used Math tests – could the type of test change the resulting effect size?

We put in the effect sizes from the studies that use Social Studies exams and those that used Math exams.

There’s some math… We get an estimate of the population effect size from each type of study.

And a significance test the effect size difference.

Meta analytic studies of what leads different studies to find different effect sizes can involve hundreds of studies, several study-difference variables, and sophisticated multivariate models!

The results of these studies help researchers:

• understand the rich research literature of an area of study
• decide the best ways to conduct future research studies!!!