

Lecture 31/Chapter 25

More about Meta-Analysis

- Benefits and Pitfalls
- An Application: Mendel's Data
- Mozart Effect Meta-Analysis Details
- Sugar/Hyperactivity Meta-Analysis Details



Issues in Meta-Analysis (*Review*)

- Which studies should be included?
 - What **types** of studies to include---all those available, or only those which meet specific requirements, such as publication in a properly reviewed journal?
 - **Timing** of the studies---only “modern”? If so, how old do we consider to be “outdated”?
 - **Quality control**---should we exclude or segregate studies guilty of “difficulties and disasters” outlined in Chapter 5?
- Should results be compared or combined?



Multiple Studies: Separate or Combine?

- Because of the role of sample size in statistical significance, meta-analysis (incorporating results from multiple studies) helps us see “big picture”
- Because of Simpson’s Paradox, combining results from groups that differ with respect to confounding variable can cloud issue of causation



Benefits of Meta-Analysis

- Detect small or moderate effects/relationships
- Obtain more precise estimates
- Determine future research
- Find patterns across studies



Pitfalls of Meta-Analysis

- Simpson's Paradox, confounding variables
- Subtle differences in explanatory conditions
- "File drawer" problem: studies **with** statistically significant results are more likely to be published than studies **without** significance
- Biased or flawed original studies
- Statistical significance but no practical significance
- False findings of "no difference" or "no effect"

Example: Mendel's Tests about Plant Color

- **Background:** Mendel back-crossed 8023 yellow plants with recessive green gene to test theory of heredity.

	y	g
y	yy	yg
g	gy	gg

- **Question:** What does null hypothesis say about population proportion with green offspring?
- **Response:**
null hypothesis: population proportion green _____



Example: *Mendel's Tests about Plant Color*

- **Background:** 2,001 of 8,023 offspring were green.
- **Questions:** What's the probability of being this **far** from 0.25? Of being this **close** to 0.25?
- **Response:** $2,001/8,023=0.2494$; standardize to

The probability of being this **far** from 0 is _____.

The probability of being this **close** to 0 is _____.



Example: *Pooling Mendel's Results*

- **Background:** In almost all of Mendel's studies, the sample proportion was quite close (statistically) to the hypothesized population proportion.
- **Questions:** Should we be suspicious of a single sample proportion that is very close? What about if almost all are very close?
- **Response:** One sample proportion that happens to be very close to the hypothesized population proportion is

Almost all sample proportions very close would be



Pooling Mendel's Results

R.A. Fisher used chi-square to pool the results of all Mendel's tests about plant characteristics. The probability of obtaining sample proportions so close to the hypothesized population proportions (P -value) turned out to be 0.00004: unbelievable!

Fisher: "I have no doubt that Mendel was deceived by a gardening assistant, who knew only too well what his principal expected from each trial made."

More recently, a CMU statistician published results exonerating the gardener, attributing the close agreement to Mendel's use of subsequent generations of plants, and to growth conditions in Austria.



Pooling Mendel's Results

Whether or not some data were fudged, Mendel's theory is, of course, beyond reproach. Perhaps if Mendel and his gardener had known more about the vagaries of random behavior, their reported results would have been more realistic.

MUSIC AND MATH SCORES Second grade students who took piano lessons for four months scored significantly higher on math than children who did not, according to a study in the journal *Neurological Research*.

Piano instruction helps to “hardwire the brain in such a way that children are better able to visualize and transform objects in space and time,” said Dr. Gordon Shaw, a University of California-Irvine emeritus physics professor.

Playing music involves mathematical concepts such as counting time, understanding intervals, ratios, fractions and proportions.

Musical training appears to help children to grasp concepts basic to proportional math.

In the 1990s, a variety of studies were undertaken to show that listening to classical music can boost intelligence. People were taken with the idea...



Example: *Meta-Analysis of the “Mozart Effect”*

- **Background:** Chabris (Harvard) conducted a meta-analysis, combining the results of all 16 published studies on the “Mozart effect.”
- **Questions:** Which studies were included, in terms of type, timing, and quality control? Were results compared or combined?
- **Response:**
 - type:
 - timing:
 - quality control:
 - compared or combined?



Benefits of Meta-Analysis (*Review*)

- Detect small or moderate effects/relationships
- Obtain more precise estimates
- Determine future research
- Find patterns across studies



Example: *Mozart Meta-Analysis: Benefits*

- **Background:** Chabris (Harvard) conducted a meta-analysis, combining the results of all 16 published studies on the “Mozart effect.”
- **Questions:** Which benefits apply to his meta-analysis?
- **Response:**
 - detecting small relationships:
 - obtaining more precise estimate:
 - determining future research:
 - finding patterns across studies:



Pitfalls of Meta-Analysis (*Review*)

- Simpson's Paradox, confounding variables
- Subtle differences in explanatory conditions
- “File drawer” problem: studies **with** statistically significant results are more likely to be published than studies **without** significance
- Biased or flawed original studies
- Statistical significance but no practical significance
- False findings of “no difference” or “no effect”



Example: *Mozart Meta-Analysis: Flaws*

- **Background:** Consider Chabris' meta-analysis.
- **Questions:** Which flaws apply?
- **Response:**
 - Simpson's Paradox, confounding variables, subtle differences in conditions?
 - “file drawer” problem?
 - flawed original studies?
 - statistical but not practical significance?
 - false finding of no effect?



Example: *Meta-Analysis of Hyperactivity*

- **Background:** Consider Center for Science in the Public Interest study.
- **Questions:** Which studies were included, in terms of type, timing, and quality control? Were results compared or combined?
- **Response:**
 - type:
 - timing:
 - quality control:
 - compared or combined?



Example: *Hyperactivity Meta-Analysis: Benefits*

- **Background:** Consider CSPI study.
- **Questions:** Which benefits apply to the meta-analysis?
- **Response:**

detecting small relationships:

obtaining more precise estimate: _____

determining future research:

asked HHS to commission new and better studies on the relationship between diet and behavior; asked FDA to require behavioral tests for food additives

finding patterns across studies: _____



Example: *Hyperactivity Meta-Analysis*

- **Background:** Consider CSPI meta-analysis.
- **Question:** Does sugar cause hyperactivity?
- **Response:**

For next time, read night lights article, evaluate according to 7 Guidelines p. 108.

Extra Credit (Max 5 pts.) Based on information from the following article on night lights, construct a two-way table and carry out a chi-square test for a relationship between type of lighting and nearsightedness. Use the fact that for a 3-by-2 table, the “magic” number for comparison is 6.0, not 3.84.

NIGHT LIGHTS BAD FOR KIDS? Children who sleep under the soft glow of a night light to keep the scary monsters away may be more likely to suffer a very real and lifelong problem--nearsightedness. Researchers at the University of Pennsylvania and the Children's Hospital of Philadelphia say that youngsters who sleep in a dimly lighted room until age 2 may be as much as five times more likely to develop myopia, or nearsightedness, as they grow up. Genetic and environmental factors, such as nutrition and eyestrain from TV and computer screens, are thought to hurt people's vision. The Philadelphia study raises the possibility that too much light makes eyes grow excessively and skews their natural focus during the first two years of life, when the eyes develop most rapidly. The study of 479 children was published in today's issue of the journal Nature.

"Just as the body needs to rest, this suggests that the eyes need a period of darkness," said ophthalmologist Dr. Graham E. Quinn, the study's lead author. However, eye specialists from many institutions dismissed the study as premature and incomplete.

(continued) They said the researchers had failed to take into account obvious risk factors, such as heredity.

“There are other factors involved in childhood myopia, the most important of which is whether the parents are nearsighted or not,” said myopia researcher Donald Mutti of the University of California at Berkeley.

Also, they said the study is flawed because the researchers relied on information supplied by the parents of nearsighted children after several years. Nor did they account for other, stronger sources of light that parents cannot control, such as a streetlight shining through a bedroom window.

A more reliable approach would be to conduct controlled experiments in the illuminated and darkened bedrooms of children, then check their vision several years later, the experts said.

“I don’t think a retrospective study based on a questionnaire is valid,” said Dr. Robert Cykiert, an ophthalmologist at the NYU School of Medicine. “They’re grasping at straws.”

(continued) Nearsightedness results when the eye grows excessively and its shape is too long rather than perfectly round. This causes incoming light to converge in front of the retina instead of on it, making things blurry.

About one in four Americans is myopic. Children usually discover they are nearsighted when they have trouble seeing the blackboard. In most cases, myopia is corrected with glasses. Later in life, nearsighted people are more likely to develop macular degeneration, detached retinas and other disorders that can lead to blindness.

The Philadelphia researchers asked the parents of children who had been patients at the doctors' eye clinic to recall the lighting conditions in the youngsters' bedrooms between birth and age 2. A total of 172 of the children slept in darkness; 10% developed nearsightedness. A total of 232 slept with a nightlight; 34% had become nearsighted. An additional 75 slept with a lamp on; 55% developed myopia.

(continued) Quinn acknowledged the study does not conclusively demonstrate that low light causes myopia, but he urged parents to provide sleeping infants and toddlers with a dark bedroom -- within reason.

Other researchers said parents should wait for the results of follow-up research before tossing their night lights in the trash. Mutti said: “Do what is comfortable for your children in order to get them to sleep.”