



Meta-Analysis: *An Introduction*

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center for
research
children youth families & schools

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OVERVIEW



- What is meta-analysis?
- When is it appropriate to do a meta-analysis?
- What are the steps for conducting a meta-analysis?
 - Problem formation and literature search
 - Coding and analysis
 - Interpretation and presentation of results



WHAT IS META-ANALYSIS?

- Literature review
 - Theoretical review
 - Research synthesis (i.e., research review, systematic review)
 - *Meta-analysis*: quantitative procedures for combining results



WHEN TO DO A META-ANALYSIS?

“High parent involvement in the child’s education w[as] associated with school success in terms of school records of achievement.”

~Miliotis, Sesma, & Masten, 1999, p. 111

“The findings suggest that parental involvement does not independently improve children's learning.”

~Domina, 2005, p. 223

“Parental involvement in 3rd grade had a significant direct effect on achievement in 3rd grade.”

~Englund, Luckner, Whaley, & Egeland, 2004, p.723

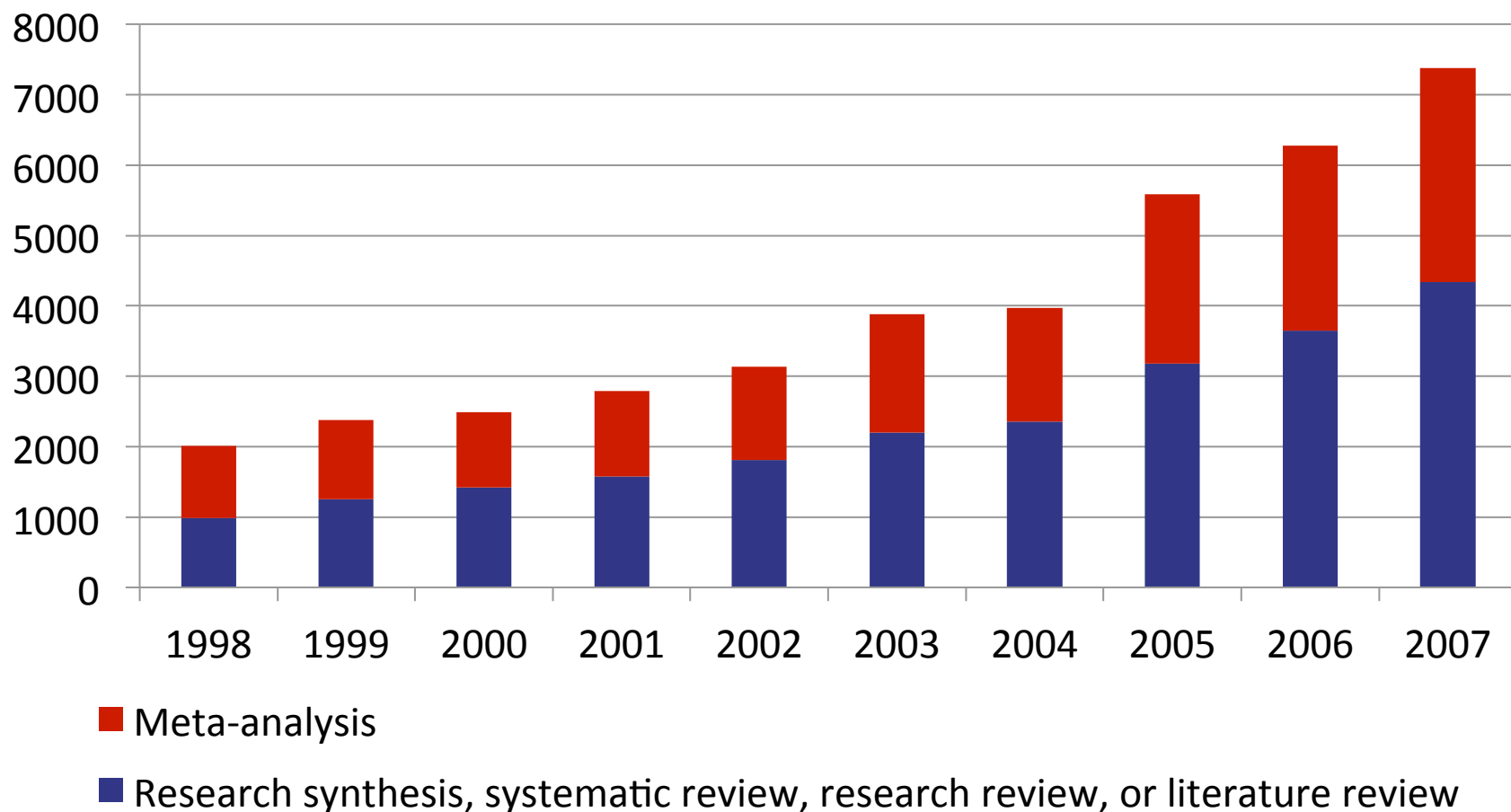
“The results of the between-child analyses suggested that higher parent involvement...is unrelated to average achievement across elementary school.”

~El Nokali, Bachman, & Votruba-Drzal, 2010, p. 1001

What should we conclude from these findings?



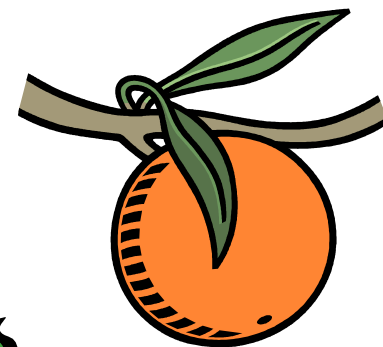
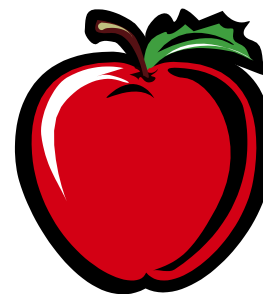
Citations for the Years 1998 to 2007



From Cooper, H. (2010). *Research synthesis and meta-analysis*. Thousand Oaks, CA, USA: Sage.

WHEN TO DO A META-ANALYSIS?

- Body of empirical research
- Producing quantitative findings
 - Utilizes data typically reported in research reports
- Comparable conceptually
- Similar statistical forms
 - Apples and oranges



STEPS IN META-ANALYSIS

1. Specifying the Problem
2. Searching the Literature
3. Report Coding
4. Data Analysis
5. Interpretation and Presentation of Results



1. SPECIFYING THE PROBLEM

- Consider it carefully
 - Breadth vs. Specificity
 - Does not need to be highly detailed early on
 - Research literature
 - Independent variables
 - Dependent variables
 - Type of relationship



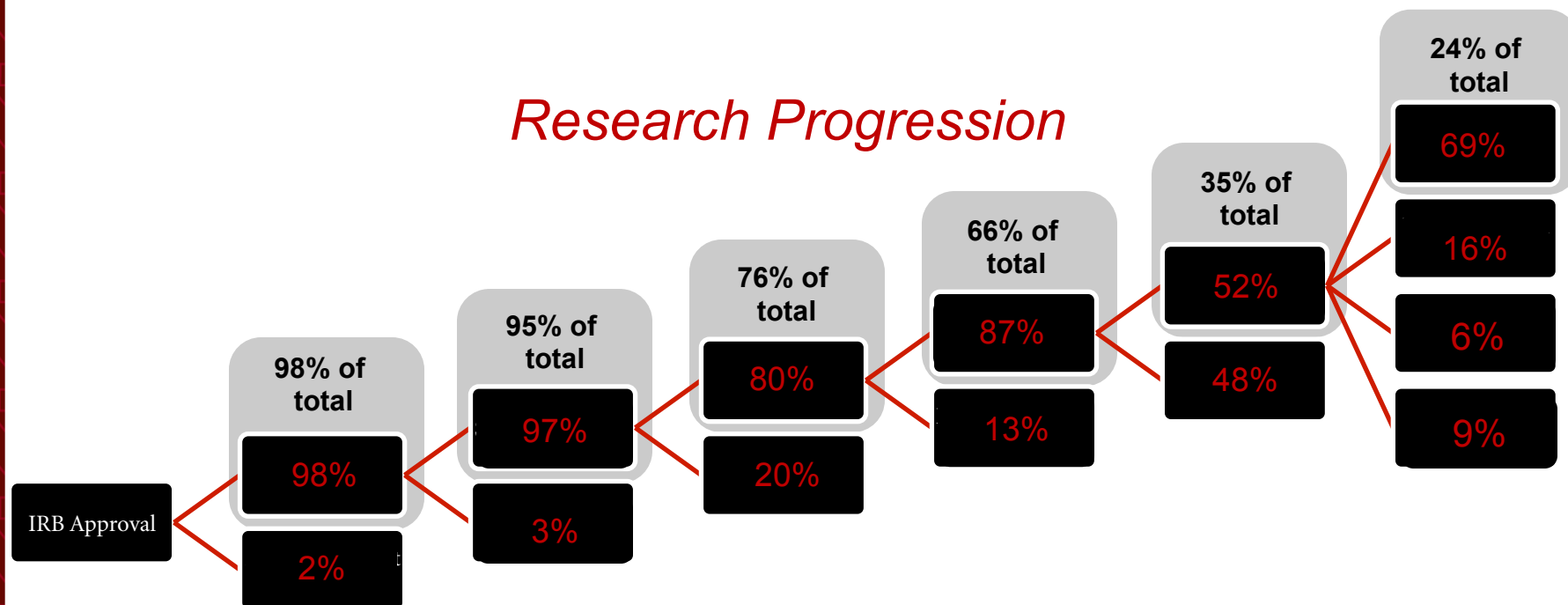
2. SEARCHING THE LITERATURE

- How should I conduct my search?
- What outlets should I use for gathering studies?
- What criteria should I use in my search?
- How do I go about retrieving the studies?
- How do I manage the yielded reports?



2. SEARCHING THE LITERATURE

Research Progression



From "Finding the missing science: The fate of studies submitted for review by a human subjects committee," by H. Cooper, K. DeNeve, & K. Charlton, 1997, *Psychological Methods*, 2, 448-449.



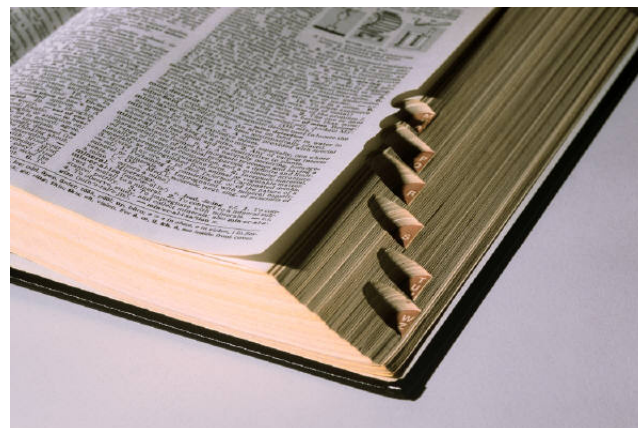
2. SEARCHING THE LITERATURE

- Approaches
 - Contact
 - Mass Solicitation
 - Conference Presentations
 - Journals
 - References
 - Reference Databases



2. SEARCHING THE LITERATURE

- Reference Databases
 - Which ones should I use?
 - Consider published and unpublished
 - How do I decide on my search terms?
 - Thesaurus



2. SEARCHING THE LITERATURE

New Search **Thesaurus** Cited References Indexes Sign In Folder Preferences Languages New Features! Help

UNIV OF NEBRASKA-LINCOLN LIBRARIES

Searching: PsycINFO Choose Databases »

New Search Thesaurus Cited References Indexes Sign In Folder Preferences Languages New Features! Help

Basic Search

Searching: PsycINFO Choose Databases »

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Basic Search Advanced Search Visual Search Search History

Browsing: PsycINFO

Parental involvement

Term Begins With

Page: Previous Next

Select term, then add to search using: OR Add

(Click term to display details)

<input type="checkbox"/>	Parental Inv			
<input type="checkbox"/>	Genetic Cour			
<input type="checkbox"/>	Permissive P			
<input type="checkbox"/>	Animal Paren			
<input type="checkbox"/>	Parent Child			
<input type="checkbox"/>	Parent Traini			
<input type="checkbox"/>	Parenting Sty			
<input type="checkbox"/>	Authoritarian			
<input type="checkbox"/>	Authoritative			

Done

Browsing: PsycINFO -- Thesaurus

Parental involvement Browse

Term Begins With Term Contains **Relevancy Ranked**

Back to List

Previous Next

Select term, then add to search using: OR Add	Explode	Major Concept
<input type="checkbox"/> Parental Involvement Year Term Introduced 2005 Scope Note The involvement of parents in the care and education of their children. History Note This term was introduced in August 2005. Relevant records were re-indexed with this term. The posting note reflects the number of records that were re-indexed.		<input type="checkbox"/>
Broader Terms <input type="checkbox"/> Involvement <input type="checkbox"/> Parenting	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
Related Terms <input type="checkbox"/> Parent Child Relations + <input type="checkbox"/> Parent School Relationship <input type="checkbox"/> Parental Attitudes + <input type="checkbox"/> Parental Investment <input type="checkbox"/> Parental Role	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Used for Parental Participation		<input type="checkbox"/>

2. SEARCHING THE LITERATURE

- Eligibility criteria
 - Distinguishing Features
 - Respondents
 - Variables
 - Design
 - Culture/Language
 - Time
 - Type of Publication



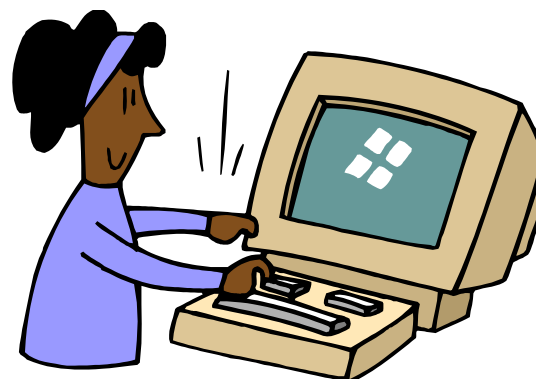
2. SEARCHING THE LITERATURE

Limit your results

Linked Full Text <input type="checkbox"/>	References Available <input type="checkbox"/>
Publication Name <input type="text"/>	Publication Year from <input type="text"/> to <input type="text"/>
Published Date from Month: <input type="text"/> Year: <input type="text"/> to Month: <input type="text"/> Year: <input type="text"/>	Peer Reviewed <input checked="" type="checkbox"/>
Publication Status All first posting fully published	Publisher <input type="text"/>
English <input checked="" type="checkbox"/>	Publication Type Peer Reviewed Journal Peer-Reviewed Status-Unknown All Books Authored Book
Age Groups All Childhood (birth-12 yrs) Neonatal (birth-1 mo) Infancy (2-23 mo)	Language Dutch English Finnish French Georgian
Intended Audience All General Public Juvenile Psychology: Professional & Research	Population Group All Human Animal Male
Book Type All Classic Book Conference Proceedings Handbook/Manual	Document Type Erratum/Correction Journal Article Letter Obituary
Classification Codes All 2100 General Psychology 2140 History & Systems 2200 Psychometrics & Statistics & Methodology	Methodology All BRAIN IMAGING CLINICAL CASE STUDY EMPIRICAL STUDY
	Exclude Dissertations <input checked="" type="checkbox"/>

2. SEARCHING THE LITERATURE

- Search terms
 - Operators
 - “AND” vs. “OR”
 - Truncation
 - Field



2. SEARCHING THE LITERATURE

The screenshot displays the EBSCOhost search interface. At the top, there are navigation tabs: "New Search", "Thesaurus", "Cited References", and "Indexes". On the right side of the top bar, there are links for "Sign In", "Folder", "Preferences", "Languages", "New Features!", and "Help".

The main search area shows the following search criteria:

- Search term: **parent*** (highlighted with a red arrow)
- Database: **AB Abstract**
- Operator: **AND**
- Search term: **involvement**
- Database: **AB Abstract**
- Operator: **AND**
- Field: **Select a Field (optional)**

Buttons for "Search" and "Clear" are visible. Below the search criteria, there are links for "Basic Search", "Advanced Search", "Visual Search", and "Search History".

On the left side, there is a sidebar with a "Refine your results" section. A red box highlights the "4784 Results for..." button. Other options in the sidebar include "Linked Full Text", "References Available", and "Peer Reviewed".

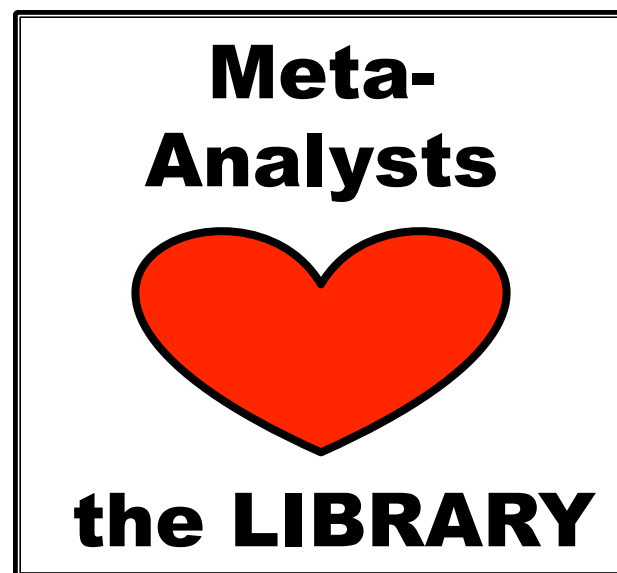
The search results are displayed on the right side. The first result is:

- Parental involvement and children's readiness for school in China.** [Journal Article]
Lau, Eva Y. H.; Li, Hui; Rao, Nirmala; Educational Research, Vol 53(1), Mar, 2011. pp. 95-113.
Subjects: Learning; Parental Involvement; School Readiness; Childhood (birth-12 yrs); Preschool Age (2-5 yrs); Adulthood (18 yrs & older); Thirties (30-39 yrs); Middle Age (40-64 yrs); Male; Female
Database: PsycINFO
Add to folder | Relevancy: [Progress bar] | Cited References: (60)



2. SEARCHING THE LITERATURE

- Literature Retrieval
 - Library System
 - Inter-Library Loan
 - Personal Contact
- Maintain Records



2. SEARCHING THE LITERATURE

The screenshot shows the EBSCOhost interface. At the top, there are navigation tabs: "New Search", "Thesaurus", "Cited References", and "Indexes". Below these are links for "Sign In", "Folder", "Preferences", "Languages", "New Features!", and "Help". The "Export Manager" section is active, with a "Back" link and the EBSCO logo. The main content area displays a message: "Your library has set the maximum number of items to print to 500" and "Number of items to be saved: 500". There is a "Save" button and a checkbox for "Remove these items from folder after saving". A dialog box titled "Opening delivery" is open, showing options to open the file with "ResearchSoft Direct Export Helper (default)" or to save it. The dialog also includes a checkbox for "Do this automatically for files like this from now on." and "OK" and "Cancel" buttons. The footer contains links for "Top of Page", "EBSCO Support Site", "Privacy Policy", "Terms of Use", and "Copyright", along with the copyright notice "© 2011 EBSCO Industries, Inc. All rights reserved." and the University of Nebraska-Lincoln logo.

2. SEARCHING THE LITERATURE

The screenshot shows the EndNote X4 interface. The main window displays a list of 23 references. The selected reference (number 1) is by Lau, E. Y. H., H. Li, et al. (2011) titled "Parental involvement and children's readiness for school in China." The preview pane shows the abstract and background information of this article.

Reco...	Author	Year	Title	Journal/Secondary Title	Reference Type	Research Notes
1	Lau	2011	Parental involvement and children's r...	Educational Research	Journal Article	
2	Graves	2011	Parent involvement at school entry: A ...	School Psychology Int...	Journal Article	
3	Semke	2010	Family involvement for children with d...	Journal of School Psyc...	Journal Article	
4	Hingle	2010	Parental involvement in interventions ...	Preventive Medicine: ...	Journal Article	
5	Rowe	2010	Family and individual factors associa...	Journal of Consulting a...	Journal Article	
6	Hornby	2011	Barriers to parental involvement in ed...	Educational Review	Journal Article	
7	Garcia-Domi...	2010	Identifying barriers that hinder onsite ...	Health Promotion Prac...	Journal Article	
8	Ryan	2010	Parenting factors associated with re...	Australian and New Ze...	Journal Article	
9	Wanat	2010	Challenges balancing collaboration a...	The School Communit...	Journal Article	
10	Gu	2010	Working with parents and family: Fac...	Journal of Instructional ...	Journal Article	
11	Park	2011	Parental involvement and students' c...	Sociology of Education	Journal Article	
12	Wiebe	2010	Parental involvement buffers associa...	Journal of Pediatric Ps...	Journal Article	
13	Walker	2010	Why do parents become involved in t...	Professional School C...	Journal Article	
14	Gascon-Ra...	2010	Influences on parental evaluation of th...	Child: Care, Health an...	Journal Article	
15	Xu	2010	The relationship between parental inv...	Social Psychology of ...	Journal Article	
16	Harper	2010	Parent involvement in early childhood...	International Journal of ...	Journal Article	
17	Stewart	2010	Children with nonresident parents: Li...	Journal of Marriage an...	Journal Article	
18	Kaljee	2011	Parent-youth communication and co...	Journal of Adolescent ...	Journal Article	
19	Taylor	2010	Child involvement in the paediatric c...	Child Care, Health & D...	Journal Article	
20	Axelin	2010	Mothers' different styles of involveme...	Journal of Obstetric, G...	Journal Article	
21	Copenhaver	2010	The living arrangement may differenti...	AIDS Care	Journal Article	
22	Bartel	2010	Home and school factors impacting ...	Journal of Research in ...	Journal Article	
23	Skalintis	2010	Changes in parental involvement in s...	British Educational Re...	Journal Article	

Preview Search Quick Edit

Lau, E. Y. H., H. Li, et al. (2011). "Parental involvement and children's readiness for school in China." *Educational Research* 53(1): 95-113.

Background: The remarkable academic advancement of Asian students in cross-national studies has been attributed to numerous factors, including the value placed on education by Chinese parents. However, there is a dearth of research on how exactly Chinese parents are involved in children's early learning. Purpose: This study has two major research questions: (1) How are Chinese parents involved in young children's learning?; and (2) What is the relationship between their involvement and children's readiness for school? Sample: A total of 431 kindergarten students (194 girls) with a mean age of 72.24 months (SD = 4.34) from five kindergartens in Hong Kong and five kindergartens in Shenzhen and their parents participated in the study. Design and methods: Children's Chinese literacy and cognitive readiness were assessed. Their parents were surveyed on their child's readiness for school and their own parental involvement with their children. Means across parental involvement dimensions were compared to explore the pattern of Chinese parental involvement in early childhood education, while correlational and regression analyses were conducted to examine the relationship between parental involvement and children's readiness for school. Results: Chinese parents had a higher level of home-based involvement than school-based involvement during the early years. Parental involvement was highly correlated with overall readiness for school. Parent Instruction, Language and Cognitive Activities and Homework Involvement were the significant predictors of overall readiness for school, whereas home-based involvement predicted more variance of readiness for school than did school-based involvement. Only Language and Cognitive Activities and Home-school Conferencing were associated with children's Chinese literacy and cognitive readiness. Conclusion: Cross-cultural studies are needed to explore the real reasons for Chinese parents to practise more home-based than school-based involvement. The importance of parental involvement during the early years for maximizing children's readiness for school has also been emphasized. Nevertheless, the present study is limited in its lack of

Showing 500 of 500 references in Group. (All References: 500) Hide Tab Pane
Ready NUM



3. REPORT CODING

- Developing a coding protocol
 - Planning
 - A priori
 - Review of literature
 - Frequency
 - Content
 - Study descriptors
 - Moderators
 - Effect sizes
 - Effect size statistic
 - Associated sample size



3. REPORT CODING

- Study Descriptors
 - Bibliographic Information
 - e.g., type of report, publication year, authors, etc.

Parental Involvement Research Synthesis

Study Descriptors

Bibliographic Information	Code
1. Record Number <i>EndNote Record Number</i>	_____
2. Study Authors <i>Last Name, First Initial; etc.</i>	
3. Year <i>Publication Year</i>	_____
4. Type of Report <i>1 = Journal article</i> <i>2 = Book or book chapter</i> <i>3 = Government report</i> <i>4 = Conference paper</i> <i>9 = Other (please specify)</i>	_____



3. REPORT CODING

- Study Descriptors
 - Setting
 - e.g., country, type of community (urban, rural), type of school (public, private), etc.

Setting Information	Code
5. Country 1 = USA 2 = Canada 3 = Mexico 9 = Other (please specify)	_____
6. Community type 1 = Urban 2 = Suburban 3 = Rural 4 = Heterogeneous 9 = Other (please specify)	_____
7. Language research conducted in 1 = English 2 = Spanish 9 = Other (please specify)	_____
8. Type of school 1 = Public 2 = Private 9 = Other	_____



3. REPORT CODING

- Study Descriptors
 - Description of the Sample
 - e.g., age, ethnicity, gender, etc.

Description of Sample	Code
9. Number of children <i>Specify number of children participating</i>	
10. Grade(s) in school <i>-1 = Preschool</i> <i>0 = Kindergarten</i> <i>1 = First grade</i> <i>...</i> <i>12 = 12th grade</i>	_____
11. Socioeconomic status <i>1 = Low SES</i> <i>2 = Low-middle SES</i> <i>3 = Middle SES</i> <i>4 = Middle-upper SES</i> <i>5 = Upper SES</i> <i>6 = Heterogeneous</i> <i>9 = Other (please specify)</i>	_____
12. Gender <i>% Male</i> <i>% Female</i>	_____ _____



3. REPORT CODING

- Study Descriptors
 - Research Design
 - e.g., unit of assignment, type of assignment, etc.

Research Design	Code
13. Unit of assignment <i>1 = Individual children/parents</i> <i>2 = Small groups</i> <i>3 = Classroom</i> <i>4 = School</i> <i>5 = Region</i> <i>9 = Other (please specify)</i>	_____
14. Type of assign <i>1 = Completely randomized</i> <i>2 = Randomized block</i> <i>3 = Nonrandomized</i> <i>4 = Nonrandomized block</i> <i>9 = Other (please specify)</i>	_____
15. Control group procedures <i>1 = Business-as-usual</i> <i>2 = Attention placebo</i> <i>3 = Alternative intervention</i> <i>4 = Wait list/delayed intervention</i> <i>9 = Other (please specify)</i>	_____



3. REPORT CODING

- Study Descriptors
 - Independent Variables

Independent Variables	Code
16. Type of Involvement <i>Home-based</i> 11 = Homework involvement 12 = Talking about school 13 = Reading together 14 = Planning 19 = Other home-based (please specify) <i>School-based</i> 21 = Volunteering 22 = Parent-teacher association 23 = Parent-teacher conferences 24 = Open houses 29 = Other school-based (please specify)	_____
17. Reporter 1 = Parent 2 = Child 3 = Teacher 9 = Other (please specify)	_____



3. REPORT CODING

- Study Descriptors

- Dependent Variables

Dependent Variables	Code
18. Child Academic Adjustment <i>Grades</i> 111 = Grades: Combined Subjects 112 = Grades: Language Arts 113 = Grades: Math 119 = Grades: Other <i>Standardized Test Scores</i> 121 = Test Scores: Combined 122 = Test Scores: Language Arts 123 = Test Scores: Math 129 = Test Scores: Other <i>Academic Competence</i> 131 = Academic Competence: Combined 132 = Academic Competence: Language Arts 133 = Academic Competence: Math 139 = Academic Competence: Other	_____
19. Reporter 1 = Records 2 = Parent 3 = Child 4 = Teacher 9 = Other (please specify)	_____



3. REPORT CODING

- Effect Size Coding

Standardized Mean Difference

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s_{pooled}}$$

\bar{x}_1 = observed mean of group 1

\bar{x}_2 = observed mean of group 2

s_{pooled} = pooled standard deviation

Bias-Corrected

$$ES'_{sm} = \left[1 - \frac{3}{4N - 9} \right] d$$

N = total sample size

(Hedges, 1981)

Sampling Variance

$$v_i = \frac{n_1 + n_2}{n_1 n_2} + \frac{(ES'_{sm})^2}{2(n_1 + n_2)}$$

n_1 = sample size in group 1

n_2 = sample size in group 2



3. REPORT CODING

Effect Size Information	Code
17. Treatment Group Mean	_____
18. Treatment Group Standard Deviation	_____
19. Treatment Group Sample Size	_____
20. Control Group Mean	_____
21. Control Group Standard Deviation	_____
22. Control Group Sample Size	_____
23. Effect Size (<i>calculated</i>)	_____



3. REPORT CODING

- Effect Size Coding

Correlation Coefficient

$$r_{xy} = \frac{\sigma_{xy}^2}{\sigma_x \sigma_y}$$

σ_{xy}^2 = covariance between x and y

σ_x = standard deviation of x

σ_y = standard deviation of y

Z-transformation

$$ES_{z_r} = \frac{1}{2} \ln \left[\frac{1+r}{1-r} \right]$$

r = correlation coefficient

\ln = natural logarithm

Sampling Variance

$$v_{z_r} = \frac{1}{N-3}$$

N = total sample size



3. REPORT CODING

Correlation Coefficient Information	Code
26. Correlation Coefficient	_____
27. Correlation Sample Size	_____



3. REPORT CODING

- Coder Training
 - Choosing coders
 - Elaborated coding protocol
 - Independent coding, group comparison and discussion
 - Double coding



4. DATA ANALYSIS

- Data Preparation
 - Converting effect sizes to a common metric
 - Direction of effect
 - Multiple effect sizes
 - Random selection
 - Underrepresented areas
 - Aggregation
 - Statistical artifacts (Hunter & Schmidt, 2004)
 - Sampling error
 - Measurement unreliability
 - Range restriction
 - Dichotomization



4. DATA ANALYSIS

- Model Selection

$$ES_i = \theta_i + \varepsilon_i$$

- Fixed effects model

$$\text{i.e., } \theta_1 = \theta_2 = \dots = \theta_k$$

- Fixed effects with moderators

- Differences due to presence of moderators

- Random-effects

- Differences due to random heterogeneity

- Mixed-effects

- Differences due to presence of moderators and random heterogeneity



4. DATA ANALYSIS

- Model Selection

Model	Moderators present	Random heterogeneity
Fixed effects	No	No
Fixed effects with moderators	Yes	No
Random effects	No	Yes
Mixed effects	Yes	Yes

From Roberts, B. W., Kuncel, N. R., Viechtbauer, W., & Bogg, T. (2007). Meta-analysis in personality psychology: A primer. (Ch. 36, pp. 652-672). In R. W. Robins, R. C. Fraley, & R. F. Krueger (Eds.), *Handbook of Research Methods in Personality Psychology*. New York, NY, USA: Guilford Press.



4. DATA ANALYSIS

- Standardized Mean Difference

Inverse Variance

$$w_i = \frac{2(n_{i1} + n_{i2})n_{i1}n_{i2}}{2(n_{i1} + n_{i2})^2 + n_{i1}n_{i2}d_i^2}$$

n_{i1} = number of data points in group 1

n_{i2} = number of data points in group 2

d_i = effect size

Weighted Average Effect Size

$$d_{\cdot} = \frac{\sum_{i=1}^k d_i w_i}{\sum_{i=1}^k w_i}$$

k = number of independent samples

95% Confidence Interval

$$CI_{d,95\%} = d_{\cdot} \pm 1.96 \sqrt{\frac{1}{\sum_{i=1}^k w_i}}$$



4. DATA ANALYSIS

Study	n_{i1}	n_{i2}	d_i	w_i	$d_i w_i$
1	111	117	0.06	56.93	3.42
2	64	63	0.14	31.67	4.43
3	55	51	0.25	26.26	6.56
4	200	194	0.11	98.33	10.82
5	285	290	0.08	143.62	11.49
6	120	129	0.30	61.48	18.44
7	71	75	0.16	36.36	5.82
Σ	906	919	1.10	454.65	60.98

Weighted Average Effect Size:
$$d. = \frac{\sum_{i=1}^k d_i w_i}{\sum_{i=1}^k w_i} = \frac{60.98}{454.65} = .13$$

95% Confidence Interval:
$$CI_{d,95\%} = d. \pm 1.96 \sqrt{\frac{1}{\sum_{i=1}^k w_i}} = .13 \pm 1.96 \sqrt{\frac{1}{454.65}} = .13 \pm .09 = [.04, .22]$$



4. DATA ANALYSIS

- Correlation Coefficient (Z-transformed)

Weighted Average Effect Size

$$z_{\bullet} = \frac{\sum_{i=1}^k (n_i - 3)z_i}{\sum_{i=1}^k (n_i - 3)}$$

n_i = sample size for i^{th} independent sample

z_i = z-transformed correlation

95% Confidence Interval

$$CI_{z, 95\%} = z_{\bullet} \pm \frac{1.96}{\sqrt{\sum_{i=1}^k (n_i - 3)}}$$



4. DATA ANALYSIS

Study	n_i	r_i	z_i	n_i-3	$(n_i-3)z_i$
1	538	0.22	0.22	535	119.66
2	60	0.21	0.21	57	12.15
3	115	0.20	0.20	112	22.58
4	109	0.17	0.17	106	18.41
5	323	0.29	0.30	320	94.44
6	335	0.12	0.12	332	41.29
Σ	1480	1.21	1.23	1462	308.53

Weighted Average Effect Size:
$$z. = \frac{\sum_{i=1}^k (n_i - 3)z_i}{\sum_{i=1}^k (n_i - 3)} = \frac{308.53}{1462} = .21$$

95% Confidence Interval:
$$CI_{z, .95\%} = z. \pm \frac{1.96}{\sqrt{\sum_{i=1}^k (n_i - 3)}} = .21 \pm \frac{1.96}{\sqrt{1462}} = .21 \pm .05 = [.16, .26]$$



4. DATA ANALYSIS

- Correlation Coefficient (untransformed)

Sampling Variance

$$v_r = \frac{(1 - r_i^2)^2}{n_i - 1}$$

n_i = sample size for i^{th} independent sample

r_i = correlation coefficient

Inverse Variance

$$w_i = \frac{1}{v_r}$$

Weighted Average Effect Size

$$r_{\bullet} = \frac{\sum_{i=1}^k r_i w_i}{\sum_{i=1}^k w_i}$$

95% Confidence Interval

$$CI_{r, 95\%} = r_{\bullet} \pm \frac{1.96}{\sqrt{\sum_{i=1}^k w_i}}$$



4. DATA ANALYSIS

Study	n_i	r_i	v_i	w_i	$r_i w_i$
1	538	0.22	0.00	593.01	130.46
2	60	0.21	0.02	64.57	13.56
3	115	0.20	0.01	123.58	24.58
4	109	0.17	0.01	114.68	19.72
5	323	0.29	0.00	382.33	109.67
6	335	0.12	0.00	344.47	42.63
Σ	1480	1.21	0.04	1622.65	340.62

Weighted Average Effect Size:

$$r. = \frac{\sum_{i=1}^k r_i w_i}{\sum_{i=1}^k w_i} = \frac{340.62}{1622.65} = .21$$

95% Confidence Interval:

$$CI_{r.95\%} = r. \pm \frac{1.96}{\sqrt{\sum_{i=1}^k w_i}} = .21 \pm \frac{1.96}{\sqrt{1622.65}} = .21 \pm .05 = [.16, .26]$$



4. DATA ANALYSIS

- Homogeneity
 - Is the variance observed different than would be expected by sampling error only?
 - Q statistic
 - If so, what might moderate this effect?



4. DATA ANALYSIS

- Standardized Mean Difference

$$Q = \sum_{i=1}^k w_i d_i^2 - \frac{\left(\sum_{i=1}^k w_i d_i \right)^2}{\sum_{i=1}^k w_i} = 11.04 - \frac{60.98^2}{454.65} = 11.04 - 8.18 = 2.86$$

Compare to chi-square with $k-1$ degrees of freedom

Study	n_{i1}	n_{i2}	d_i	w_i	$d_i w_i$	$w_i d_i^2$
1	111	117	0.06	56.93	3.42	0.20
2	64	63	0.14	31.67	4.43	0.62
3	55	51	0.25	26.26	6.56	1.64
4	200	194	0.11	98.33	10.82	1.19
5	285	290	0.08	143.62	11.49	0.92
6	120	129	0.30	61.48	18.44	5.53
7	71	75	0.16	36.36	5.82	0.93
Σ	906	919	1.10	454.65	60.98	11.04



4. DATA ANALYSIS

- Correlation Coefficient (Z-transformed)

$$Q = \sum_{i=1}^k (n_i - 3)z_i^2 - \frac{\left[\sum_{i=1}^k (n_i - 3)z_i \right]^2}{\sum_{i=1}^k (n_i - 3)} = 70.11 - \frac{308.53^2}{1462} = 70.11 - 65.11 = 5$$

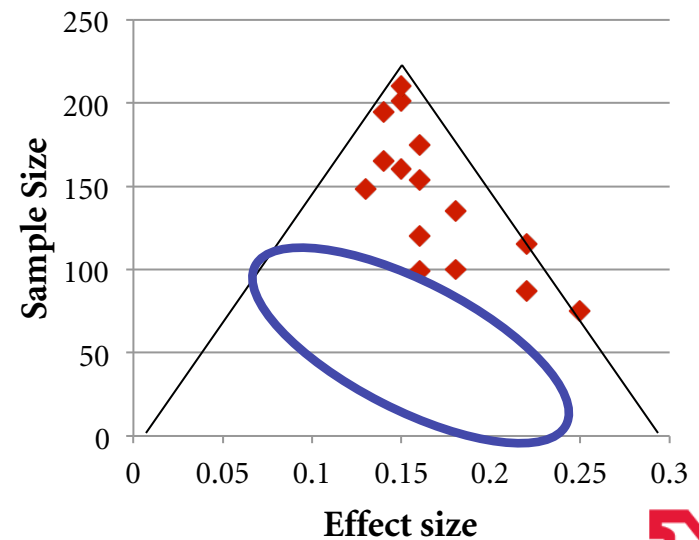
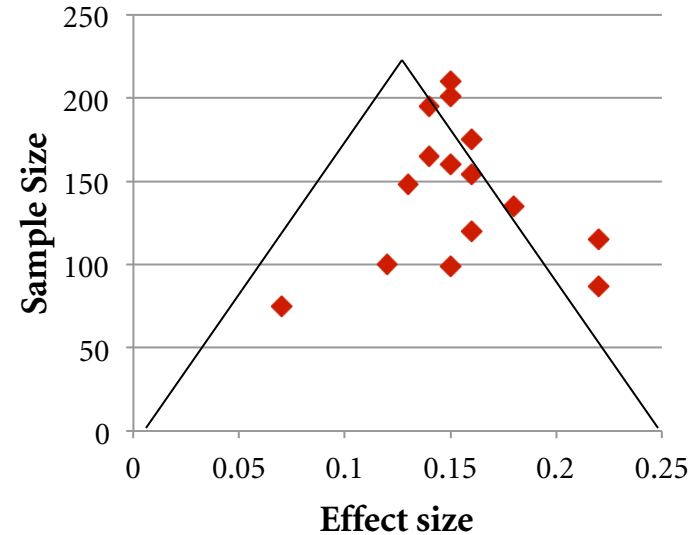
Compare to chi-square with $k-1$ degrees of freedom

Study	n_i	r_i	z_i	n_i-3	$(n_i-3)z_i$	$(n_i-3)z_i^2$
1	538	0.22	0.22	535	119.66	26.76
2	60	0.21	0.21	57	12.15	2.59
3	115	0.20	0.20	112	22.58	4.55
4	109	0.17	0.17	106	18.41	3.20
5	323	0.29	0.30	320	94.44	27.87
6	335	0.12	0.12	332	41.29	5.14
Σ	1480	1.21	1.23	1462	308.53	70.11



4. DATA ANALYSIS

- Publication Bias
 - File drawer problem
 - Funnel plot
 - *Fail-safe N* (Rosenthal, 1979)
 - Trim and fill (Duval & Tweedie, 2000)



4. DATA ANALYSIS

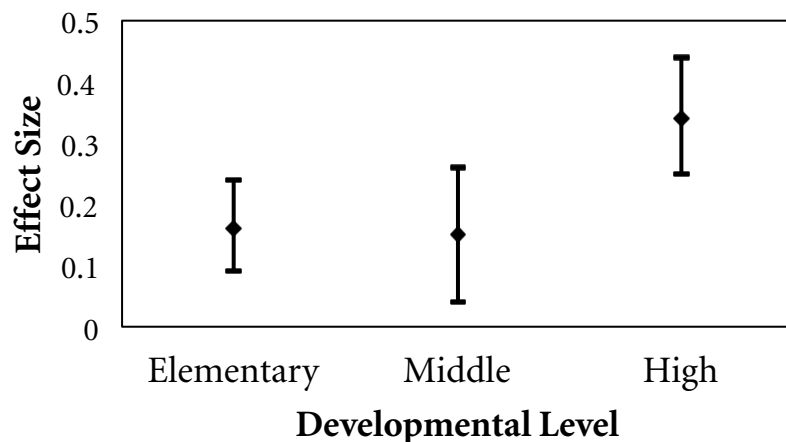
- Programs
 - SAS
 - SPSS
 - STATA
 - R
 - Stand-alone programs
 - Comprehensive Meta-Analysis (Borenstein, Hedges, Higgins, & Rothstein, 2005)



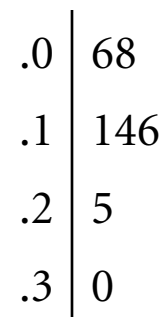
5. PRESENTATION OF RESULTS

- Graphical Presentation

Error-Bar Chart



Stem and Leaf Display



- **Meta-Analysis Reporting Standards** (MARS; Publication Manual of the American Psychological Association (2010))



HOW DO I GET STARTED?

- Resources
 - Research team
 - Supplies
- Funding Mechanisms
 - IES Goal 1: Exploration
 - NIH R21: Exploratory/Developmental



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Thank You!
Questions?

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