EVAL 6970: Meta-Analysis Subgroup Analysis

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Agenda

Subgroup analyses
 In-class activity

Subgroup Analyses

- Three methods
 - Method 1: Z-test
 - Method 2: *Q*-test based on ANOVA
 - Method 3: Q-test for heterogeneity
- All three methods are used to assess differences in subgroup effects relative to the precision of the difference
- All three are mathematically equivalent

Subgroup Analyses

- The computations for each of the three methods vary slightly depending on how subgroups are analyzed
 - Fixed-effect model within subgroups
 - Random-effects model with separate estimates of τ^2
 - Random-effects model with pooled estimate of τ^2

Subgroup Analyses

Model	Method 1	Method 2	Method 3
Fixed-effect	1	2	3
Random-effects with separate estimates of τ^2	4	5	6
Random-effects with pooled estimate of τ^2	7	8	9

- Method 1: Z-test (similar to t-test in primary studies)
- Used when there are only two subgroups
 - In the fixed-effect model θ_A and θ_B are the true effects underlying groups and M_A and M_B are the estimated effects with variance V_A and V_B

• The difference between the two effects is

$$Diff = M_B - M_A$$

Which is tested as

$$Z_{Diff} = \frac{Diff}{SE_{Diff}}$$

• Where

$$SE_{Diff} = \sqrt{V_{M_A} + V_{M_B}}$$

• Where

$$H_0: \ \theta_A = \theta_B$$

For a two-tailed test

$$p = 2\left[1 - \left(\Phi(|Z|)\right)\right]M_B - M_A$$

=(1-(NORMDIST(ABS(Z))))*2

Groups		E	ffect size an	nd 95% confic	lence interv	al	Test of nu	ıll (2-Tail)		Hetero	geneity			Tau-se	quared	
Group	Number Studies	Point estimate	Standard error	Variance	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	l-squared	Tau Squared	Standard Error	Variance	Tau
Fixed effect analysis																
А	Ę	5 0.32	24 0.053	0.003	0.219	0.429	6.063	0.000	8.432	4	0.077	52.559	0.016	0.022	0.001	0.1
В	Ę	5 🔪 0.61	1 / 0.057	0.003	0.499	0.723	10.701	0.000	4.543	4	0.337	11.951	0.002	0.013	0.000	0.0
Total within				K					12.975	8	0.113					
l otal between Overall	1(n n	59 D D 29	0.002	0.382	0.535	11 7/0	0.000	13.463 26.437	1	0.000	65 957	0.030	0.022	0.000	0.1
Mixed effects analys	is															
А	Ę	5 0.32	24 0.080	0.006	0.168	0.481	4.060	0.000								
В	Ę	5 / 0.61	0 0.061	0.004	0.490	0.730	9.983	0.000	0.055		0.005					
l otal between Overall	1(0.50	15 0.049	0.002	0.410	0.60	10 397	0.000	8.055	1	0.005					
M_A a	/ and	d N	A_B													

- Method 2: *Q*-test based on ANOVA
 - For comparisons between more than two subgroups
 - An analogy to ANOVA in primary studies
 - Used to partition the total variance into variance within groups and variance between groups

- The following quantities are required
 - Q_p , the weighted SS of all studies about the mean for all p subgroups (separately; e.g., Q_A , Q_B)
 - Q_{within} , the sum of all Q_p subgroups (e.g., $Q_A + Q_B$)
 - Q_{bet} , the weighted SS of the subgroup means about the grand mean ($Q_{bet} = Q - Q_{within}$
 - Q, the weighted SS of all effects about the grand mean

• Each source of variance (Q statistic) is evaluated with respect to the corresponding degrees of freedom

=CHIDIST(Q, df)

• Which returns the exact *p*-value associated with each source of variance

	Q	df	p
A	8.4316	4	0.0770
В	4.5429	4	0.3375
Within	12.9745	8	0.1127
Between	13.4626	1	0.0002
Total	26.4371	9	0.0017

Q-test ANOVA table

Groups		Eff	ect size and	l 95% confid	ence interv	al	Test of nu	ıll (2-Tail)		Hetero	ogeneity			Tau-s	quared	
Group	Number Studies	Point estimate	Standard error	Variance	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value -	squared	Tau Squared	Standard Error	Variance	Tau
Fixed effect analy	sis											\				
Α	5	0.324	0.053	0.003	0.219	0.429	6.063	0.000	8.432	4	0.077	52.559	0.016	0.022	0.001	0.1
В	5	0.611	0.057	0.003	0.499	0.723	10.701	0.000	4.543	4	0.337	1.951	0.002	0.013	0.000	0.0
Total within									12.975	8	0.113	/				
Total between									13.463	1	0.000					
Overall	10	0.458	0.039	0.002	0.382	0.535	11.740	0.000	26,437	9	D 902	65.957	0.030	0.022	0.000	0.1
Mixed effects and	lysis									1						
Α	5	0.324	0.080	0.006	0.168	0.481	4.060	0.000		/						
В	5	0.610	0.061	0.004	0.490	0.730	9.983	0.000		,						
Total between									8.0.5	1	0.005					
Overall	10	0.505	0.049	0.002	0.410	0.600	10.397	0.000								

Variance components

- Method 3: Q-test for heterogeneity
 - Each subgroup is the unit of analysis
 - Subgroup summary effects and variances are tested for heterogeneity using the same method for testing the dispersion of single studies about the summary effect

Comprehensive meta	a analysis - [Analysis	;]														
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Groups		Eff	ect size and	l 95% confic	lence interv	al	Test of nu	ll (2-Tail)		Hetero	ogeneity			T au-s	quared	
Group	Number Studies	Point estimate	Standard error	Variance	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	l-squared	Tau Squared	Standard Error	Variance	Tau
Fixed effect	analysis															
A B Total within		5 0.324 5 0.611	0.053 0.057	0.003 0.003	0.219 0.499	0.429 0.723	6.063 10.701	0.000 0.000	8.432 4.543 1 2.975	4 4 8	0.077 0.337 9.113	52.559 11.951	0.016 0.002	0.022 0.013	0.001	0.128 0.047
Total between Overall		0 0.458	0.039	0.002	0.382	0.535	11.740	0.000	13.463 26.437	1 9	0.000 0.002	65.957	0.030	0.022	0.000	0.173
Mixed effect: A B	ts analysis	5 0.324 5 0.610	0.080 0.061	0.006 0.004	0.168 0.490	0.481 0.730	4.060 9.983	0.000 0.000		Ì	\backslash					
Total between Overall		0 0.505	0.049	0.002	0.410	0.600	10.397	0.000	8.055	1	0.005					
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Magnitude of Subgroup Differences

• With

$$Diff = M_B - M_A$$

• The 95% confidence interval is $Diff \pm 1.96 \times SE_{Diff}$ • Where

$$SE_{Diff} = \sqrt{V_{M_A} + V_{M_B}}$$

Random-Effects Model with Separate Estimates of τ^2

 For all three methods (Z-test, Q-test based on ANOVA, and Q-test for heterogeneity) the same computations are used, but with random-effects weights and a separate estimate of τ² for each subgroup

Random-Effects Model with Separate Estimates of τ^2

Compreh	ensive met	a analysis - [A	nalysis]																				
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Model	Group by Subgroup	Study name										Calcula	ations (Separat	e tau)									
			Point	Study Variance	Tau^2 Within	Tau^2 Between	Total Variance	IV-Weight	w	T*₩	T^2*₩	W^2	w k	C	Q	Q df	1^2	в	к	Summary Point	Summary Variance	Group T^2	Group T^2 Variance
	Δ,	Thomhill	0.110	0.010	0.016	0.000	0.026	37.846	37.846	4.163	0.458	1432.308	54206.937	123.957	3.388	4.000	0.000	4.000	5.000	0.324	0.006	0.016	0.00
10	Δ,	Kendall	0.224	0.030	0.016	0.000	0.046	21.541	21.541	4.825	1.081	464.017	9995.420	123.957	3.388	4.000	0.000	4.000	5.000	0.324	0.006	0.016	0.00
10	Δ,	Vandamm	0.338	0.020	0.016	0.000	0.036	27.455	27.455	9.280	3.137	753.788	20695.394	123.957	3.388	4.000	0.000	4.000	5.000	0.324	0.006	0.016	0.00
10	Δ,	Leonard	0.451	0.015	0.016	0.000	0.031	31.824	31.824	14.353	6.473	1012.757	32229.832	123.957	3.388	4.000	0.000	4.000	5.000	0.324	0.006	0.016	0.00
	Δ,	Professor	0.480	0.010	0.016	0.000	0.026	37.846	37.846	18.166	8.720	1432.308	54206.927	23.957	3.388	4.000	0.000	4.000	5.000	0.324	0.006	0.016	0.00
	А,		1.603	0.085	0.082	0.000	0.167		156.512	50.787	19.868	5095.179	171334.500	128.957	3.388	4.000	0.000	4.000	5.000	0.324	0.006	0.016	0.00
	B	Jeffries	0.440	0.015	0.002	0.000	0.017	57.983	57.983	25.512	11.225	3362.002	194938.233	211 732	3.952	4.000	0.000	4.000	5.000	0.610	0.004	0.002	0.00
	В	Fremont	0.492	0.020	0.002	0.000	0.022	44.951	44.951	22.116	10.881	2020.582	90826.980	211.72	3.952	4.000	0.000	4.000	5.000	0.610	0.004	0.002	0.00
	В	Dovle	0.651	0.015	0.002	0.000	0.017	57,983	57,983	37.747	24.573	3362.002	194938.233	211.732	3.952	4,000	0.000	4.000	5.000	0.610	0.004	0.002	0.00
	В	Stella	0.710	0.025	0.002	0.000	0.027	36,702	36,702	26.058	18,501	1347.034	49438.786	211,732	3.952	4,000	0.000	4.000	5.000	0.610	0.004	0.002	0.00
	В	Thorwald	0.740	0.012	0.002	0.000	0.014	70.193	70.193	51,943	38.438	4927.012	345840.129	211.732	3.952	4.000	0.000	4.000	5.000	0.610	0.004	0.002	0.00
	В	COLUMN TO THE OWNER	3.033	0.087	0.011	0.000	0.098	000000	267.811	163.376	103.619	15018.633	875982.361	211.732	3.952	4,000	0.000	4.000	5.000	0.610	0.004	0.002	0.00
	Overall		4.636	0.172	0.093	0.000	0.265	424.323	424.323	214,163	123,487	20113.812	1047316.86	376.921	6.395	9.000	41.540	26.807	10.000	0.505	0.002	0.030	0.00

Random-effects model with separate estimates of τ^2

• For all three methods (*Z*-test, *Q*-test based on ANOVA, and *Q*-test for heterogeneity) the same computations are used, but with random-effects weights and a pooled estimate of τ^2 , referred to as τ^2_{within}

• The pooled estimate of τ^2 , τ^2_{within} , is

$$T_{within}^2 = \frac{\sum_{j=1}^p Q_j - \sum_{j=1}^p df_j}{\sum_{j=1}^p C_j}$$

• Where

$$C = \sum W_i - \frac{\sum W_i^2}{\sum W_i}$$

	Q	df	С
A	8.4316	4	269.8413
В	4.5429	4	241.6667
Total	12.9745	8	511.5079

$$T_{within}^2 = \frac{12.9745 - 8}{511.508} = 0.00974$$

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Groups			Eff	ect size an	d 95% confi	lence interv	val	Test of nu	ll (2-Tail)		Hetero	ogeneity			T au-se	quared	
Group	Num Stud	ber lies	Point estimate	Standard error	Variance	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	l-squared	Tau Squared	Standard Error	Variance	Tau
Fixed el	ffect analysis																
A B Lotal with		5 5	0.324 0.611	0.053 0.057	0.003 0.003	0.219 0.499	0.429 0.723	6.063 10.701	0.000 0.000	8.432 4.543 12.975	4 4 8	0.077	52.559 11.951	0.016 0.002	0.022 0.013	0.001 0.000	0.128 0.047
Total by Overall	ween	10	0.458	0.039	0.002	0.382	0.535	11.740	0.000	13.463 26.437	1 9	0.000 0.002	65.957	0.030	0.022	0.000	0.173
A B	analysis	5 5	0.324 0.610	0.080 0.061	0.006 0.004	0.168 0.490	0.481 0.730	4.060 9.983	0.000 0.000			\					
Overall	ween	10	0.505	0.049	0.002	0.410	0.600	10.397	0.000	8.055	I						
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Model	Group by Subgroup	Study name										Calcu	lations (Pooled	tau)									
			Point	Study Variance	Tau^2 Within	Tau^2 Between	Total Variance	IV-Weight	w	T*₩	T^2*W	W^2	wra	c	Q	Q df	1^2	в	к	Summary Point	Summary Variance	Group T^2	Group T^2 Variance
	A	Thornhill	0.110	0.010	0.010	0.000	0.020	50.697	50.697	5.577	0.613	2570.150	130298,014	158.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	A	Kendall	0.224	0.030	0.010	0.000	0.040	25.173	25.173	5.639	1.263	633.678	15951.5 4	158.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	A	Vandamm	0.338	0.020	0.010	0.000	0.030	33.642	33.642	11.371	3.843	1131.752	38073.868	158.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	A	Leonard	0.451	0.015	0.010	0.000	0.025	40.445	40.445	18.241	8.226	1635.767	66157.973	158.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	A	Professor	0.480	0.010	0.010	0.000	0.020	50.697	50.697	24.334	11.681	2570.150	130298.014	158.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	A		1.603	0.085	0.049	0.000	0.134		200.652	65.161	25.627	8541.498	380779.413	58.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	В	Jeffries	0.440	0.015	0.010	0.000	0.025	40.445	40.445	17.796	7.830	1635.767	66157.973	150.536	2.771	4.000	0.000	4.000	5.000	0.608	0.005	0.010	0.00
	В	Fremont	0.492	0.020	0.010	0.000	0.030	33.642	33.642	16.552	8.143	1131.752	38073.868	150,536	2.771	4.000	0.000	4.000	5.000	0.608	0.005	0.010	0.00
	В	Doyle	0.651	0.015	0.010	0.000	0.025	40.445	40.445	26.329	17.140	1635.767	66157.973	150.536	2.771	4.000	0.000	4.000	5.000	0.608	0.005	0.010	0.00
	В	Stella	0.710	0.025	0.010	0.000	0.035	28.798	28.798	20.446	14.517	829.299	23881.791	150.538	2.771	4.000	0.000	4.000	5.000	0.608	0.005	0.010	0.00
	В	Thorwald	0.740	0.012	0.010	0.000	0.022	46.030	46.030	34.062	25.206	2118.721	97523.775	150.536	2.771	4.000	0.000	4.000	5.000	0.608	0.005	0.010	0.00
	В		3.033	0.087	0.049	0.000	0.136		189.358	115.185	72.837	7351.306	291795.379	150.536	2.771	4.000	0.000	4.000	5.000	0.608	0.005	0.010	0.00
	Overall		4,636	0.172	0.097	0.000	0.269	390.010	390.010	180.346	98,463	15892.804	672574,792	349.261	15 069	9.000	40.275	25.397	10.000	0.462	0.003	0.010	0.00

Random-effects model with pooled estimate of τ^2

Comprehensi	ive meta	analysis - [Ai	nalysis]																			
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Model Gr	roup by	Study name										Calculations (Fix	ed)									
	ngioup		Point	Study Variance	Tau^2 Within	Tau^2 Between	Total Variance	IV-Weight	w	T*W	T^2*W	W^2 W^2	c	Q	Q df	I^2	в	к	Summary Point	Summary Variance	Group T^2	Group T^2 Variance
А	1	[hornhill	0.110	0.010	0.000	0.000	0.010	100.000	100.000	11.000	1.210	10000.000 100000.00	269.841	8.432	4.000	52.559	18.374	5.000	0.324	0.003	0.016	0.00
A	K	Kendall Kandarara	0.224	0.030	0.000	0.000	0.030	33.333	33.333	7.467	1.673	1111.111 57037.037	269.841	8.432	4.000	52.559	18.374	5.000	0.324	0.003	0.016	0.00
A		eonard	0.338	0.020	0.000	0.000	0.020	50.000	50.000	30.067	13,560	4444 44 296296 296	269.841	8.432	4.000	52,559	18.374	5.000	0.324	0.003	0.016	0.00
A	F	Professor	0.480	0.010	0.000	0.000	0.010	100.000	100.000	48.000	23.040	10000.000 1000000.00	209.041	8.432	4.000	52.559	18.374	5.000	0.324	0.003	0.016	0.00
A			1.603	0.085	0.000	0.000	0.085		350.000	113.433	45.195	2055.556 2458333 33	269.841	8.432	4.000	52.559	18.374	5.000	0.324	0.003	0.016	0.00
В		leffries	0.440	0.015	0.000	0.000	0.015	66.667	66.667	29.333	12.907	4444.444 296296.296	241 07	4.543	4.000	11.951	5.163	5.000	0.611	0.003	0.002	0.00
B		remont	0.492	0.020	0.000	0.000	0.020	50.000	50.000	24.600 43.400	22 253	2000.000 120000.000 4444 444 296296 296	241.667	4.543	4.000	11.951	5.163	5,000	0.611	0.003	0.002	0.00
В		Stella	0.710	0.025	0.000	0.000	0.025	40.000	40.000	28,400	20.164	1600.000 64000.000	241.667	4.543	4.000	11.951	5.163	5.000	0.611	0.003	0.002	0.000
В	1	horwald	0.740	0.012	0.000	0.000	0.012	83.333	83.333	61.667	45.633	6944.444 578703.704	241.667	543	4.000	11.951	5.163	5.000	0.611	0.003	0.002	0.000
В			3.033	0.087	0.000	0.000	0.087		306.667	187.402	119.061	19933.333 1360296.23	241.667	4.54	4.000	11.951	5.163	5.000	0.611	0.003	0.002	0.000
UVe	erall		4.636	0.172	0.000	0.000	0.172	636.667	636.667	300 533	164.200	4/368.663 3616623.65		26.437	9.000	60.307	81.102	10.000	0.498	0.002	0.030	0.000
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Proportion of Explained Variance

- Unlike the traditional interpretation of R² (i.e., the ratio of explained variance to total variance), R² as used in meta-analysis is interpreted as proportion of true variance to total variance explained by covariates
- Computational model assumes that τ^2 is the same for all subgroups (i.e., pooled τ^2)

Proportion of Explained Variance

 In a meta-analysis, R² is the between-studies variance within subgroups divided by the total between-studies variance (withinsubgroups plus between-subgroups)

$$R^{2} = 1 - \left(\frac{T_{within}^{2}}{T_{total}^{2}}\right)$$

Calculating R^2

Compreh	ensive met	a analysis - [A	nalysis]																				
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Model	Group by Subgroup	Study name										Calculations	: (Pooled tau)										
			Point	Study Variance	Tau^2 Within	Tau^2 Between	Total Variance	IV-Weight	w	T*W	T^2*₩	w^2 w	c C		Q	Q df	1^2	в	к	Summary Point	Summary Variance	Group T^2	Group T^2 Variance
	A	Thornhill	0.110	0.010	0.010	0.000	0.020	50.697	50.697	5.577	0.613	2570.150 13029	98,014 158	8.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	A	Kendall	0.224	0.030	0.010	0.000	0.040	25.173	25.173	5.639	1.263	633.678 1595	51.5 4 158	8.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	A	Vandamm	0.338	0.020	0.010	0.000	0.030	33.642	33.642	11.371	3.843	1131.752 3807	73.868 158	8.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	A	Leonard	0.451	0.015	0.010	0.000	0.025	40.445	40.445	18.241	8.226	1635.767 6615	57.973 158	8.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	A	Professor	0.480	0.010	0.010	0.000	0.020	50.697	50.697	24.334	11.681	2570.150 13029	98.014 158	8.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	A		1.603	0.085	0.049	0.000	0.134		200.652	65.161	25.627	8541.498 38077	79.413 58	8.084	4.466	4.000	10.434	4.989	5.000	0.325	0.005	0.010	0.00
	В	Jeffries	0.440	0.015	0.010	0.000	0.025	40.445	40.445	17.796	7.830	1635.767 6615	57.973 13	0.536	2.771	4.000	0.000	4.000	5.000	0.608	0.005	0.010	0.00
	в	Fremont	0.492	0.020	0.010	0.000	0.030	33.642	33.642	16.552	8,143	1131,752 3807	73.868 150	0,636	2.771	4.000	0.000	4.000	5.000	0.608	0.005	0.010	0.00
	в	Dovle	0.651	0.015	0.010	0.000	0.025	40.445	40.445	26.329	17.140	1635,767 6615	57.973 150	0.586	2.771	4.000	0.000	4.000	5.000	0.608	0.005	0.010	0.00
	В	Stella	0.710	0.025	0.010	0.000	0.035	28,798	28.798	20,446	14.517	829,299 2388	81,791 150	0.538	2.771	4.000	0.000	4.000	5.000	0.608	0.005	0.010	0.000
	в	Thorwald	0.740	0.012	0.010	0.000	0.022	46.030	46.030	34 062	25,206	2118 721 9752	23,775 150	0.536	2.771	4 000	0.000	4 000	5 000	0.608	0.005	0.010	0.000
	B		3.033	0.087	0.049	0.000	0.136		189,358	115 185	72 837	7351.306 29179	95.379 150	0.536	2 771	4 000	0.000	4 000	5 000	0.608	0.005	0.010	0.000
	Overall		4 636	0.172	0.097	0.000	0.269	390.010	390.010	180.346	98 463	15892 804 67257	74 792 349	9.261	15.069	9,000	40.275	25,397	10,000	0.462	0.003	0.010	0.001

Random-effects model with pooled estimate of τ^2

Calculating R^2

🕂 Comprehensive meta analysis - [Analysis]

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Groups		Eff	iect size and	d 95% confid	lence interv	al	Test of nu	ll (2-Tail)		Hetero	geneity			Tau-sq	juared	
Group	Number Studies	Point estimate	Standard error	Variance	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
Fixed effect analy	sis															
A	5	5 0.324	0.053	0.003	0.219	0.429	6.063	0.000	8.432	4	0.077	52.559	0.016	0.022	0.001	0.128
В	5	5 0.611	0.057	0.003	0.499	0.723	10.701	0.000	4.543	4	0.337	11.951	0.002	0.013	0.000	0.047
Total within									12.975	8	0.113					
Total between									13.463	1	0.000					
Overall	10	0.458	0.039	0.002	0.382	0.535	11.740	0.000	26.437	9	0.002	65.957	0.030	0.022	0.000	0.173
Random effects ar	nalysis												T			
A	5	5 0.325	0.071	0.005	0.186	0.463	4.600	0.000								
В	5	5 0.608	0.073	0.005	0.466	0.751	8.371	0.000								
Total between									7.832	1	0.005					
Overall	10	0.466	0.142	0.020	0.188	0.744	3.287	0.001					•			

 T_{total}^2

Variance Explained by Subgroup Membership



Summary Effects in Subgroup Analyses

- Depends on questions and the nature of data
- If question is one of superiority, best not to report a summary effect across subgroups
- If question is one of equivalence, a summary effect across subgroups may or may not be warranted
- Most important are substantive implications and what summary effect represents

Models for Subgroup Analyses

- Three models
 - Fixed-effect analysis: Fixed-effect model within and across subgroups
 - Mixed-effect analysis: Random-effects model within subgroups and fixed-effect model across subgroups (generally recommended model)
 - Fully random-effects analysis: Randomeffects model within and across subgroups

Today's In-Class Activity

- From the "Tutoring Subgroup.CMA" data set
 - Using Method 1 (*Z*-test) calculate the mean difference, *p*, and the *LL* and *UL* of the mean difference between subgroups A and B for the fixed-effect model, random effects model with separate estimates of τ^2 and random effects model with pooled estimate of τ^2

– Calculate and interpret R^2