# 8. G\*Power

<u>http://www.psycho.uni-</u> <u>duesseldorf.de/abteilungen/aap/g</u> <u>power3/</u>

### 8. Stichprobenumfang, Effekt- und Teststärke

### 8. Stichprobenumfangsplanung, Effektstärken und Teststärkenberechnung mit G\*Power 3.0

- 8.1 Stichprobenumfangsplanung
  - t-Test
  - Varianzanalyse
- 8.2 Effektstärkenberechnung
  - t-Test
  - Varianzanalyse
- 8.3 Teststärkenberechnung
  - t-Test
  - Varianzanalyse

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### 8.1 Stichprobenumfangsplanung t-Test (2) – GPower: Eingabe

File	Edit View Tests Calculator I	Help		
Ce	ntral and noncentral distributio	ns Protocol of pou	wer analyses	
	st family Statistical test			
	Second and a second cost			
tt	ests Means: Differ	ence between two i	ndependent means (two groups)	*
tt	ests Means: Differ	ence between two ii	ndependent means (two groups)	
Ty	ests Means: Differ pe of power analysis priori: Compute required samp	ence between two ii le size – given α, po	ndependent means (two groups) wwer, and effect size	
Ty A In	ests Means: Differ pe of power analysis priori: Compute required samp put Parameters Tail(s)	ence between two i le size – given «, po	ndependent means (two groups) wer, and effect size Output Parameters Noncentrality parameter 6	2
	ests Means: Differ pe of power analysis priori: Compute required samp out Parameters Tail(s) etermine => Effect size d	ence between two i le size - given α, po Two	ndependent means (two groups) wer, and effect size Output Parameters Noncentrality parameter 6 Critical t	2
Ty A In	ests Means: Differ pe of power analysis priori: Compute required samp out Parameters Tail(s) etermine => Effect size d	ence between two is le size - given α, po Two 0.5 0.05	ndependent means (two groups) wer, and effect size Output Parameters Noncentrality parameter 6 Critical t	3
Ty A Inj	ests Means: Differ pe of power analysis priori: Compute required samp out Parameters Tail(s) etermine => Effect size d α err prob Power (1-β err prob)	ence between two is le size - given α, po Two 0.5 0.05 0.90	ndependent means (two groups) wer, and effect size Output Parameters Noncentrality parameter 6 Critical t Df Sample size group 1	3
Try A Inj	ests Means: Differ pe of power analysis priori: Compute required samp out Parameters Tail(s) etermine => Effect size d α err prob Power (1-β err prob) Allocation ratio N2/N1	ence between two is le size – given o, po Two 0.5 0.05 0.90 1	ndependent means (two groups) wer, and effect size Output Parameters Noncentrality parameter 6 Critical t Df Sample size group 1 Sample size group 2	5
Ty A Inj	ests Means: Differ pe of power analysis priori: Compute required samp out Parameters Tail(s) etermine => Effect size d α err prob Power (1-β err prob) Allocation ratio N2/N1	ence between two ii le size - given 10, pc 0.5 0.05 0.90 1	ndependent means (two groups) wer, and effect size Output Parameters Noncentrality parameter 6 Critical t Df Sample size group 1 Sample size group 2 Total sample size	5

- Es müssen folgende Parameter eingegeben werden:
  - 1. Testklasse ⇒ *t-tests*
  - 2. Statistischer Test
    - ⇒ two independent means
  - 3. Art der Analyse ⇒ *A priori*
  - 4. Determinanten
     ⇒ einseitig/zweiseitig
    - ⇒ Effektgröße d
    - ⇒ Alphafehler (a err prob)
    - ⇒ Teststärke (power)
  - Durch Klick auf *Calculate* (5) wird das Ergebnis berechnet







# 8.1 Stichprobenumfangsplanung

t-Test (4) – GPowe	r: Ergebnisprotokoll
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, Edic Merr 1999 Coldidion The	19 1			
Central and noncentral distributions	Protocol of pov	ver analyses		angezeigt:
t tests - Means: Difference betwee Analysis: A priori: Compute red Tai(s) Effect size d err prob Power (1-β err prob) Allocation ratio N2/N Output: Noncentrality parame Critical t Dr Sample size group 1 Sample size group 2 Total sample size Actual power Est family Nearching Statistical test Means: Differer Type of power analysis A priori: Compute required sample nput Parameters Determine => Effect size d Power (1-β err prob) Allocation ratio N2/N1	n two independen quired sample size = 1 = 1 = 1 = 1 = 1 = 1 = 1 = 1 = 1 = 1	t means (two groups)  We O S O S O S O S O S O S O S O S O S O	Clear Save Print Save Print S.278719 1.974017 1.	Hier findet man das Ergebnis auf einem Protokoll; man kann es sichern, oder ausdrucken.
		transfer and the second s		Fraebnis der Stichproben-



# 8.1 Stichprobenumfangsplanung

t-Test (5) – GPower: Anzeige der Wertebereiche

File Edit View Graph Table							<ul> <li>…öffnet sich ein Fenster:</li> <li>Hier kann man sich</li> </ul>
							<ul> <li>Hier kann man sich alle möglichen Zusammenhänge zwischen den Kennwerten des t-Tests anzeigen lassen.</li> <li>Man erhält das Ergebnis durch</li> </ul>
Plot Parameters							Klick auf
Plot (on y axis)	otal sample size ower (1-β err prob)	from	kers 🔲 and dis 0.6 in	playing the values in the pl steps of 0.0	ot through to	0.95	
Plot 4 🚽 gr	aph(s) interpolating p	points	~				
with E	fect size d	y from	0.1 in	steps of 0.0	5		
	Construction and a local sector	e at	0.05			Draw plot	Augurahi Datawainant







8.1 Stichprobenumfangsplanung Parameter: t-Test
t-Test für unabhängige Stichproben
<u>Test family</u> ⇒ t-tests
Statistical test ⇒ Means: Difference between two independent means (two groups)
Type of power analysis $\Rightarrow$ A priori: Compute required sample size – given $\alpha$ , power, effect size
<u>Effektgröße</u> ⇒ d
EDV-Tutorium (A)+(B) Buchwald & Thielgen (2008) 119

8	8.1 Stichprobenumfangsplanu Parameter: t-Test	ung
• t-Test für a	abhängige Stichproben	
<u>Test famil</u> ⇒ t-tests	Y	
<u>Statistical</u> ⇒ Means	<u>test</u> s: Difference between two dependent mear	ns (matched pairs)
<u>Type of po</u> ⇒ A prior	ower analysis ri: Compute required sample size – given o	α, power, effect size
<u>Effektgröß</u> ⇒ d	<u>Se</u>	
EDV-Tutorium (A)+	H(B) Buchwald & Thielgen (2008)	120

8.1 Stichprobenumfangsplanung Parameter: Varianzanalyse
Einfaktorielle Varianzanalyse
<u>Test family</u> ⇒ F-tests
<u>Statistical test</u> ⇒ ANOVA: Fixed effects, omnibus, one-way
<u>Type of power analysis</u> $\Rightarrow$ A priori: Compute required sample size – given $\alpha$ , power, effect size
<u>Effektgröße</u> ⇒ f
EDV-Tutorium (A)+(B) Buchwald & Thielgen (2008) 121

8.1 Stichprobenumfangsplanung Parameter: Varianzanalyse	
Mehrfaktorielle Varianzanalyse	
<u>Test family</u> ⇒ F-tests	
Statistical test ⇒ ANOVA: Fixed effects, special, main effects and interactions	
Type of power analysis $\Rightarrow$ A priori: Compute required sample size – given $\alpha$ , power, effect size	
<u>Effektgröße</u> ⇒ f	
EDV-Tutorium (A)+(B) Buchwald & Thielgen (2008) 122	









# 8.2 Effektstärkenberechnung

t-Test (2) – GPower: Eingabe

Central and noncentral distribut	tions Destant		
		wer analyses	
$\sim$			
2	)		
Test family Statistical t	est	- Anna Anna anna Anna anna A	
Transformation in the second second	rerence between avoi	nuepenuent means (avo groups)	
Sensitivity: Compute required a	effect size - given α, p	ower, and sample size	
hanna Barrana		Contract Descention	
Input Parameters Tail	(s) Two	Noncentrality narameter 6	
ov err pr	ob 0.05	Critical t	
Power (1-8 err pro	0.90	Df	
Sample size group	1 86	Effect size d	
Sample size group	2 86		
Samala cita graun			
Power (1-β err pro Sample size group	b) 0.90	Df Effect size d	

- Es müssen folgende Parameter eingegeben werden:
  - 1. Testklasse ⇒ *t-tests*
  - Statistischer Test
    - ⇒ two independent means
  - 3. Art der Analyse
    - Compute required effect size
  - 4. Determinanten
    - ⇒ einseitig/zweiseitig
    - $\Rightarrow$  Sample size 1 / 2
    - ⇒ Alphafehler (a err prob)
    - ⇒ Teststärke (power)
- Durch Klick auf *Calculate* (5) wird das Ergebnis berechnet

# 8.2 Effektstärkenberechnung



t-Test (3) – GPower: Ergebnis

Ergebnis der Effektstärkenberechnung





# 8.2 Effektstärkenberechnung

t-Test (4) – GPower: Ergebnisprotokoll

File Edit View Tests Calculator	Help			wird der zweite Keiter
Central and noncentral distribution	ns Protocol of po	ver analyses		angezeigt:
[1] Monday, June 25, 2007 t tests - Means: Difference betw Analysis: Sensitivity, Compu- input: Tail(s)	9.03.49 een two independer e required effect sij 1 = 2 meter δ = = ence between two in ect size - given α, p Two ♥ 0.05 0.90 86 6 86	t means (two groups) te Two 0.05 0.90 86 86 3.259986 1.974017 170 0.497143 mdependent means (two groups) ower, and sample size Output Parameter S Noncentrality parameter S Critical t Df Effect size d	Clear Save Print 3.259986 1.974017 170 0.497143	Hier findet man das Ergebnis auf einem Protokoll; man kann es sichern, oder ausdrucken.
				Ergebnis der Effektstarken-
		Contraction of the Contraction		horochnung Drotokoll



## 8.2 Effektstärkenberechnung

t-Test (5) - GPower: Anzeige der Wertebereiche

File Edit View							…öffnet sich ein
Craph Table Plot Parameters Plot (on y axis) as a function of Total	size d sample size	With markers from	and displaying the value	es in the plot	rough to	100	<ul> <li>Fenster:</li> <li>Hier kann man sich alle möglichen Zusammenhänge zwischen den Kennwerten des t-Tests anzeigen lassen.</li> <li>Man erhält das Ergebnis durch Klick auf <i>Draw Plot</i>.</li> </ul>
with Powe	s) Interpolating point (1-β err prob)	from	0.6 in steps of	0.05	_		
						1000	





### 8.2 Effektstärkenberechnung Parameter

• Wenn man eine Effektstärkenberechnung durchführen will, dann müssen folgende Parameter angegeben werden:

Buchwald & Thielgen (2008)



8.2 Eff	ektstärkenberechnung Parameter: t-Test	
• t-Test für abhängige	Stichproben	
<u>Test family</u> ⇔ t-tests		
<u>Statistical test</u> ⇒ Means: Differenc	e between two dependent means (mat	tched pairs)
<u>Type of power analys</u> ⇒ Sensitivity: Comp and sample size	bis pute required effect size – given $\alpha$ , pow	/er
<u>Effektgröße</u> ⇔ d		
EDV-Tutorium (A)+(B)	Buchwald & Thielgen (2008)	138













# 8.3 Teststärkenberechnung

t-Test (2) – GPower: Eingabe

File Edit View Tests Calculator He	elp		
Central and noncentral distribution	Protocol of po	wer analyses	
Test family Statistical test			
Test family Statistical test tests Means: Differe	nce between two i	ndependent means (two groups)	
Test family Statistical test t tests Type of power analysis	nce between two i	ndependent means (two groups)	
Test family Statistical test Means: Differe Type of power analysis Post hoc: Compute achieved power	nce between two i r - given α, sample	ndependent means (two groups) e size, and effect size	
Test family t tests V Means: Differe Type of power analysis Post hoc: Compute achieved power Input Parameters	nce between two i r - given α, sample	ndependent means (two groups) e size, and effect size Output Parameters	
Test family Statistical test Means: Differe Type of power analysis Post hoc: Compute achieved power Input Parameters Tail(s)	nce between two i r - given œ, sample Two	ndependent means (two groups) e size, and effect size Output Parameters Noncentrality parameter 8	
Test family t tests Type of power analysis Post hoc: Compute achieved power Input Parameters Determine => Effect size d	r - given «, sampl Two 0.5	ndependent means (two groups) e size, and effect size Output Parameters Noncentrality parameter 8 Critical t	
Test family     Statistical test       ttests     Means: Differe       Type of power analysis     Post hoc: Compute achieved power       Input Parameters     Tail(s)       Determine =>     Effect size d α err prob	nce between two i r - given «, sampl Two 0.5 0.05	ndependent means (two groups) e size, and effect size Output Parameter S Noncentrality parameter & Critical t Df	
Test family     Statistical test       ttests     Means: Differe       Type of power analysis     Post hoc: Compute achieved power       Input Parameters     Tail(s)       Determine =>     Effect size d α err prob       Sample size group 1	rre between two i r - given «, sampli Two 0.5 0.05 86	ndependent means (two groups) e size, and effect size Output Parameter S Noncentrality parameter 6 Critical t Df Power (1-β err prob)	

- Es müssen folgende Parameter eingegeben werden:
  - 1. Testklasse ⇒ *t-tests*
  - 2. Statistischer Test
    - ⇒ two independent means
  - 3. Art der Analyse ⇒ *Compute achieved*

### power

- 4. Determinanten
   ⇒ einseitig/zweiseitig
  - $\Rightarrow$  Effect size d
  - $\Rightarrow$  Sample size 1 / 2
  - ⇒ Alphafehler (a err prob)
- Durch Klick auf *Calculate* (5) wird das Ergebnis berechnet

# 8.3 Teststärkenberechnung



t-Test (3) – GPower: Ergebnis

Ergebnis der Teststärkenberechnung





### 8.3 Teststärkenberechnung t-Test (4) – GPower: Ergebnisprotokoll

	s Calculator H	felp			wird der zweite Keiter
Central and noncen	tral distribution	ns Protocol of pov	ver analyses		angezeigt:
[2] Monday, Jun       [2] Monday, Jun       tests - Means. Dot       Analysis: Date       [anut: Tail( Effector       Output: Tail( Effector       Output: Nonci       Output: Nonci       Output: Nonci       Test family       ttests       Type of power anali       Post hoc: Compute       Input Parameters       Determine =>	e 25, 2007 11 ifference betwe hoc: Compute a s) t size d prob ple size group 1 ple size group 2 centrality param calt tr (1-B err prob) Statistical test Means: Differ Statistical test Means: Differ Tail(s) Effect size d a ser prob	25.09 en two independen ichieved power eter 6 eter 6 e ence between two ir r - given a, sample Two 0.5 0.05 86 86	t means (two groups) Two 0.5 0.05 86 86 8.278719 1.974017 70 0.903230 size, and effect size Output Parameters Noncentrality parameter δ Critical t Df Power (1-β err prob)	Clear Save Print 3.278719 1.974017 170 0.903230	Hier findet man das Ergebnis auf einem Protokoll; man kann es sichern, oder ausdrucken.
Sampl					



### 8.3 Teststärkenberechnung

t-Test (5) – GPower: Anzeige der Wertebereiche

File Edit View	n								<ul> <li>…öffne</li> </ul>	et sich ein
Graph Table Plot Parameters Plot (on y axis)	Power (1-9 err p	105)	with mark	ers 📋 and	I displaying the v	alues in the pio	τ.		Fenste Hier ka alle m Zusam zwisch Kennw des t- anzeig Man e Ergebr Klick a <i>Draw</i>	er: ann man sicl öglichen menhänge en den verten Tests en lassen. rhält das nis durch uf <b>Plot</b> .
as a function of	Total sample siz		from	10	in steps of	5	through to	100		
and the second s	graph(s) interi	polating points		*			-			
Plot 4	La con mark		Con .	0.05	He March	0.05				





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8.3 Teststärkenberechnung Parameter: t-Test	
t-Test für abhängige Stichproben	
<u>Test family</u> ⇒ t-tests	
Statistical test ⇒ Means: Difference between two dependent means (matched pairs)	
<ul> <li><u>Type of power analysis</u></li> <li>⇒ Post hoc: Compute achieved power – given a, sample size, and effect size</li> </ul>	
<u>Effektgröße</u> ⇒ d	
EDV-Tutorium (A)+(B) Buchwald & Thielgen (2008) 156	







8.3	3 Teststärkenberechnun Parameter: Varianzanalyse	g
<ul> <li>Varianzanalyse</li> <li>bezogen auf m</li> </ul>	mit Messwiederholung (2) esswiederholte Faktoren -	
<u>Test family</u> ⇔ F-tests		
<u>Statistical test</u> ⇔ ANOVA: Rep	peated measures, within factors	
Type of power a ⇒ Post hoc: Co and effect siz	<u>nalysis</u> ompute achieved power – given a, s ze	ample size,
<u>Effektgröße</u> ⇔ f		
EDV-Tutorium (A)+(B)	Buchwald & Thielgen (2008)	160

8.3 Teststärkenberechnung Parameter: Varianzanalyse	
<ul> <li>Varianzanalyse mit Messwiederholung (3)</li> <li>bezogen auf Interaktion nicht messwiederholte Faktoren und messwiederholte Faktoren -</li> </ul>	
<u>Test family</u> ⇒ F-tests	
Statistical test ⇒ ANOVA: Repeated measures, within-between interaction	
<u>Type of power analysis</u> ⇒ Post hoc: Compute achieved power – given a, sample size, and effect size	
<u>Effektgröße</u> ⇒ f	
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