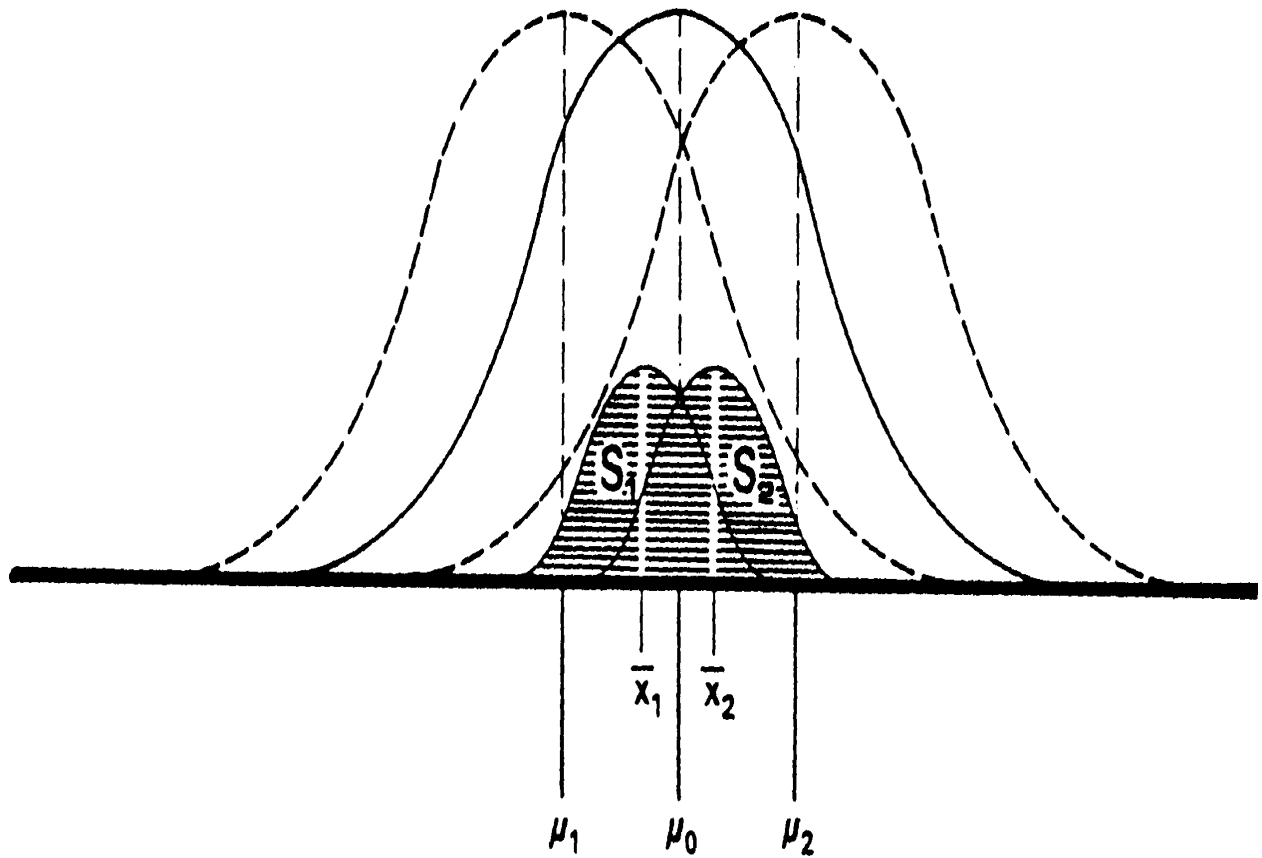


Stichproben und Grundgesamtheit



Testverfahren für Gruppenunterschiede (Mittelwertvergleiche)

| Skalenniveau | Verteilungsart | Verhältnis der Stichproben zueinander | |
|----------------|--|---------------------------------------|--------------------------|
| | | unabhängige Stichproben | abhängige Stichproben |
| Intervallskala | Normalverteilung $\sigma_1 = \sigma_2$ | t-Test | t-Test |
| | Normalverteilung $\sigma_1 \neq \sigma_2$ | t-Test | |
| | Parameterfreie Verteilung | U-Test | Wilcoxon-Test |
| Ordinalskala | | U-Test | Wilcoxon-Test |
| Nominalskala | | χ^2 -Test | χ^2 -Test |

Quelle: WILLIMCZIK, K.: Statistik im Sport Hamburg 1997

Kritische t-Werte

Tafel 2: t-Verteilung; kritische Werte $t_{\alpha; df}$

| df | Irrtumswahrscheinlichkeit α für einseitige Fragestellung | | | | | | | |
|----------|--|------|------|-------|-------|-------|--------|--------|
| | .25 | .125 | .05 | .025 | .01 | .005 | .001 | .0005 |
| | Irrtumswahrscheinlichkeit α für zweiseitige Fragestellung | | | | | | | |
| | .50 | .25 | .10 | .05 | .02 | .01 | .002 | .001 |
| 1 | 1.000 | 2.41 | 6.31 | 12.17 | 31.82 | 63.66 | 318.31 | 636.62 |
| 2 | .816 | 1.60 | 2.92 | 4.30 | 6.97 | 9.92 | 22.33 | 31.60 |
| 3 | .765 | 1.42 | 2.35 | 3.18 | 4.54 | 5.84 | 10.21 | 12.92 |
| 4 | .741 | 1.34 | 2.13 | 2.78 | 3.75 | 4.60 | 7.17 | 8.61 |
| 5 | .727 | 1.30 | 2.01 | 2.57 | 3.37 | 4.03 | 5.89 | 6.87 |
| 6 | .718 | 1.27 | 1.94 | 2.45 | 3.14 | 3.71 | 5.21 | 5.96 |
| 7 | .711 | 1.25 | 1.89 | 2.36 | 3.00 | 3.50 | 4.79 | 5.41 |
| 8 | .706 | 1.24 | 1.86 | 2.31 | 2.90 | 3.36 | 4.50 | 5.04 |
| 9 | .703 | 1.23 | 1.83 | 2.26 | 2.82 | 3.25 | 4.30 | 4.78 |
| 10 | .700 | 1.22 | 1.81 | 2.23 | 2.76 | 3.17 | 4.14 | 4.59 |
| 11 | .697 | 1.21 | 1.80 | 2.20 | 2.72 | 3.11 | 4.03 | 4.44 |
| 12 | .695 | 1.21 | 1.78 | 2.18 | 2.68 | 3.05 | 3.93 | 4.32 |
| 13 | .694 | 1.20 | 1.77 | 2.16 | 2.65 | 3.01 | 3.85 | 4.22 |
| 14 | .692 | 1.20 | 1.76 | 2.14 | 2.62 | 2.98 | 3.79 | 4.14 |
| 15 | .691 | 1.20 | 1.75 | 2.13 | 2.60 | 2.95 | 3.73 | 4.07 |
| 16 | .690 | 1.19 | 1.75 | 2.12 | 2.58 | 2.92 | 3.69 | 4.01 |
| 17 | .689 | 1.19 | 1.74 | 2.11 | 2.57 | 2.90 | 3.65 | 3.96 |
| 18 | .688 | 1.19 | 1.73 | 2.10 | 2.55 | 2.88 | 3.61 | 3.92 |
| 19 | .688 | 1.19 | 1.73 | 2.09 | 2.54 | 2.86 | 3.58 | 3.88 |
| 20 | .687 | 1.18 | 1.73 | 2.09 | 2.53 | 2.85 | 3.55 | 3.85 |
| 21 | .686 | 1.18 | 1.72 | 2.08 | 2.52 | 2.83 | 3.53 | 3.82 |
| 22 | .686 | 1.18 | 1.72 | 2.07 | 2.51 | 2.82 | 3.51 | 3.79 |
| 23 | .685 | 1.18 | 1.71 | 2.07 | 2.50 | 2.81 | 3.49 | 3.77 |
| 24 | .685 | 1.18 | 1.71 | 2.06 | 2.49 | 2.80 | 3.47 | 3.74 |
| 25 | .684 | 1.18 | 1.71 | 2.06 | 2.49 | 2.79 | 3.45 | 3.72 |
| 26 | .684 | 1.18 | 1.71 | 2.06 | 2.48 | 2.78 | 3.44 | 3.71 |
| 27 | .684 | 1.18 | 1.70 | 2.05 | 2.47 | 2.77 | 3.42 | 3.69 |
| 28 | .683 | 1.17 | 1.70 | 2.05 | 2.47 | 2.76 | 3.41 | 3.67 |
| 29 | .683 | 1.17 | 1.70 | 2.05 | 2.46 | 2.76 | 3.40 | 3.66 |
| 30 | .683 | 1.17 | 1.70 | 2.04 | 2.46 | 2.75 | 3.39 | 3.65 |
| 40 | .681 | 1.17 | 1.68 | 2.02 | 2.42 | 2.70 | 3.31 | 3.55 |
| 60 | .679 | 1.16 | 1.67 | 2.00 | 2.39 | 2.66 | 3.23 | 3.46 |
| 120 | .677 | 1.16 | 1.66 | 1.98 | 2.36 | 2.62 | 3.17 | 3.37 |
| ∞ | .674 | 1.15 | 1.64 | 1.96 | 2.33 | 2.58 | 3.09 | 3.29 |

| T-Test für abhängige Stichproben!!! | | | | |
|--|----------|-------------|-------------|----------------------|
| Name | Kmax (x) | Kmaxexz (y) | xi-yi | (xi-yi) ² |
| Maurer | 1635 | 1797 | -162 | 26244 |
| Kleine | 1728 | 1953 | -225 | 50625 |
| Strohmeier | 2526 | 2679 | -153 | 23409 |
| Killmann | 1498 | 1751 | -253 | 64009 |
| Backhaus | 1652 | 1606 | 46 | 2116 |
| Bäurle | 1468 | 1702 | -234 | 54756 |
| Zimnik | 1554 | 1557 | -3 | 9 |
| Summe | 12061 | 13045 | -984 | 221168 |
| Mittelwert | 1723 | 1863,571429 | -140,571429 | |
| t = (x-y) / Wurzel((Summe(xi-yi) ² - n*x-y ²)/n(n-1)) | | | | -3,16509449 |
| tkrit(5%,6) = 1,94 | | | | |
| Da t=3,16 > tkrit folgt Ablehnung von H0 => signifikante Unterschiede! | | | | |

| T-Test für unabhängige Stichproben! | | | | | | |
|---|--------------------|--------------------|------|---------------------|-----------|---------------------|
| Proband | Kmax [N] Gr. 1 (x) | Kmax [N] Gr. 2 (y) | xi-x | (xi-x) ² | yi-y | (yi-y) ² |
| 1 | 1635 | 1797 | -88 | 7744 | -66,57143 | 4431,755 |
| 2 | 1728 | 1953 | 5 | 25 | 89,42857 | 7997,469 |
| 3 | 2526 | 2679 | 803 | 644809 | 815,42857 | 664923,8 |
| 4 | 1498 | 1751 | -225 | 50625 | -112,5714 | 12672,33 |
| 5 | 1652 | 1606 | -71 | 5041 | -257,5714 | 66343,04 |
| 6 | 1468 | 1702 | -255 | 65025 | -161,5714 | 26105,33 |
| 7 | 1554 | 1557 | -169 | 28561 | -306,5714 | 93986,04 |
| Summe | 12061 | 13045 | 0 | 801830 | 0 | 876459,7 |
| Mittelwert | 1723 | 1863,571429 | | | | |
| Gewogene Standardabweichung: Wurzel(801830 + 876459,71) / (7 + 7 - 2) | | | | | | 373,9752 |
| t = (x-y)/s * Wurzel((n1*n2)/(n1+n2)) | | | | | | -0,703215 |
| tkrit(5%,12) = 1,78 | | | | | | |
| Da t=0,70 < tkrit folgt Beibehaltung der H0 => keine Unterschiede! | | | | | | |

T-Test-Ausgaben von SPSS

Zweistichproben t-Test unter der Annahme gleicher Varianzen (unabh. Stichproben)

| | <i>Variable 1</i> | <i>Variable 2</i> |
|---|--------------------|-------------------|
| Mittelwert | 1723 | 1863,571429 |
| Varianz | 133638,3333 | 146076,619 |
| Beobachtungen | 7 | 7 |
| Gepoolte Varianz | 139857,4762 | |
| Hypothetische Differenz der Mittelwerte | 0 | |
| Freiheitsgrade (df) | 12 | |
| t-Statistik | -0,70321518 | |
| P(T<=t) einseitig | 0,247669711 | |
| Kritischer t-Wert bei einseitigem t-Test | 1,782286745 | |
| P(T<=t) zweiseitig | 0,495339421 | |
| Kritischer t-Wert bei zweiseitigem t-Test | 2,178812792 | |

Zweistichproben t-Test bei abhängigen Stichproben (Paarvergleichstest)

| | <i>Variable 1</i> | <i>Variable 2</i> |
|---|--------------------|-------------------|
| Mittelwert | 1723 | 1863,571429 |
| t-Statistik | 133638,3333 | 146076,619 |
| Beobachtungen | 7 | 7 |
| Pearson Korrelation | 0,951578102 | |
| Hypothetische Differenz der Mittelwerte | 0 | |
| Freiheitsgrade (df) | 6 | |
| t-Statistik | -3,16509449 | |
| P(T<=t) einseitig | 0,009719571 | |
| Kritischer t-Wert bei einseitigem t-Test | 1,943180905 | |
| P(T<=t) zweiseitig | 0,019439141 | |
| Kritischer t-Wert bei zweiseitigem t-Test | 2,446913641 | |

Manova

Note: there are **2 levels for the BLOCK effect**. Average tests are identical to the univariate tests of significance.

The default error term in MANOVA has been changed from WITHIN CELLS to WITHIN+RESIDUAL. Note that these are the same for all full factorial designs.

***** Analysis of Variance *****

21 cases accepted.
 0 cases rejected because of out-of-range factor values.
 0 cases rejected because of missing data.
 2 non-empty cells.

1 design will be processed.

 Cell Means and Standard Deviations

Variable .. **EWMTO**

| FACTOR | CODE | Mean | Std. Dev. | N | |
|-------------------|------|--------|-----------|----|-------|
| GRUPPE | 0 | 50,861 | 21,607 | 9 | = KG! |
| GRUPPE | 1 | 52,708 | 15,756 | 12 | = VG! |
| For entire sample | | 51,917 | 18,004 | 21 | |

 Variable .. **EWMTO**

| FACTOR | CODE | Mean | Std. Dev. | N |
|-------------------|------|--------|-----------|----|
| GRUPPE | 0 | 52,278 | 21,136 | 9 |
| GRUPPE | 1 | 57,958 | 15,009 | 12 |
| For entire sample | | 55,524 | 17,632 | 21 |

***** Analysis of Variance - design 1 *****

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

| Source of Variation | SS | DF | MS | F | Sig of F | |
|---------------------|----------|-----------|--------|------------|-------------|--|
| WITHIN CELLS | 12448,28 | 19 | 655,17 | | | |
| GRUPPE | 145,72 | 1 | 145,72 | ,22 | ,643 | keine signifikanten Gruppenunterschiede! |

***** Analysis of Variance - design 1 *****

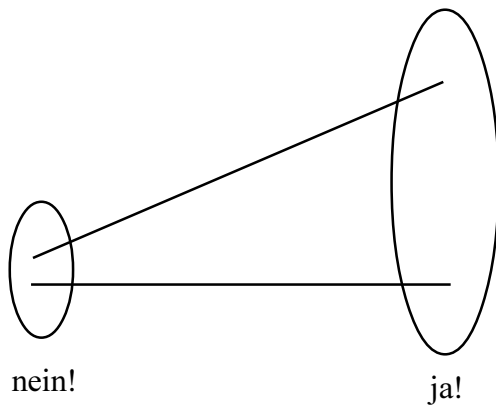
Tests involving 'BLOCK' Within-Subject Effect.

Tests of Significance for T2 using UNIQUE sums of squares

| Source of Variation | SS | DF | MS | F | Sig of F | |
|------------------------|--------|-----------|--------|--------------|-------------|--------------|
| WITHIN CELLS | 68,87 | 19 | 3,62 | | | |
| BLOCK | 114,29 | 1 | 114,29 | 31,53 | ,000 | Blockeffekt! |
| GRUPPE BY BLOCK | 37,79 | 1 | 37,79 | 10,42 | ,004 | Interaktion! |

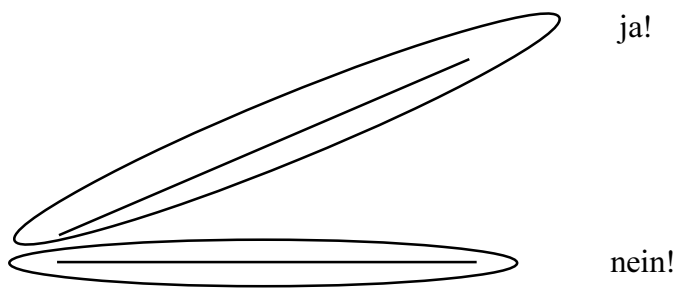
Zweifaktorielle Varianzanalyse mit Meßwiederholung auf einem Faktor

Gruppenunterschiede?



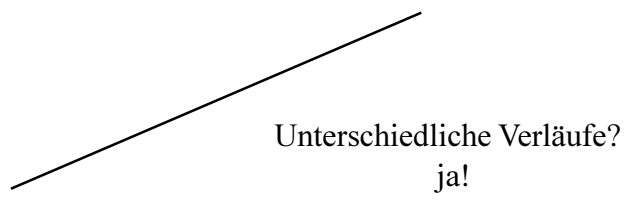
Erweiterung des T-Tests für
unabhängige Gruppen!

Blockeffekt?

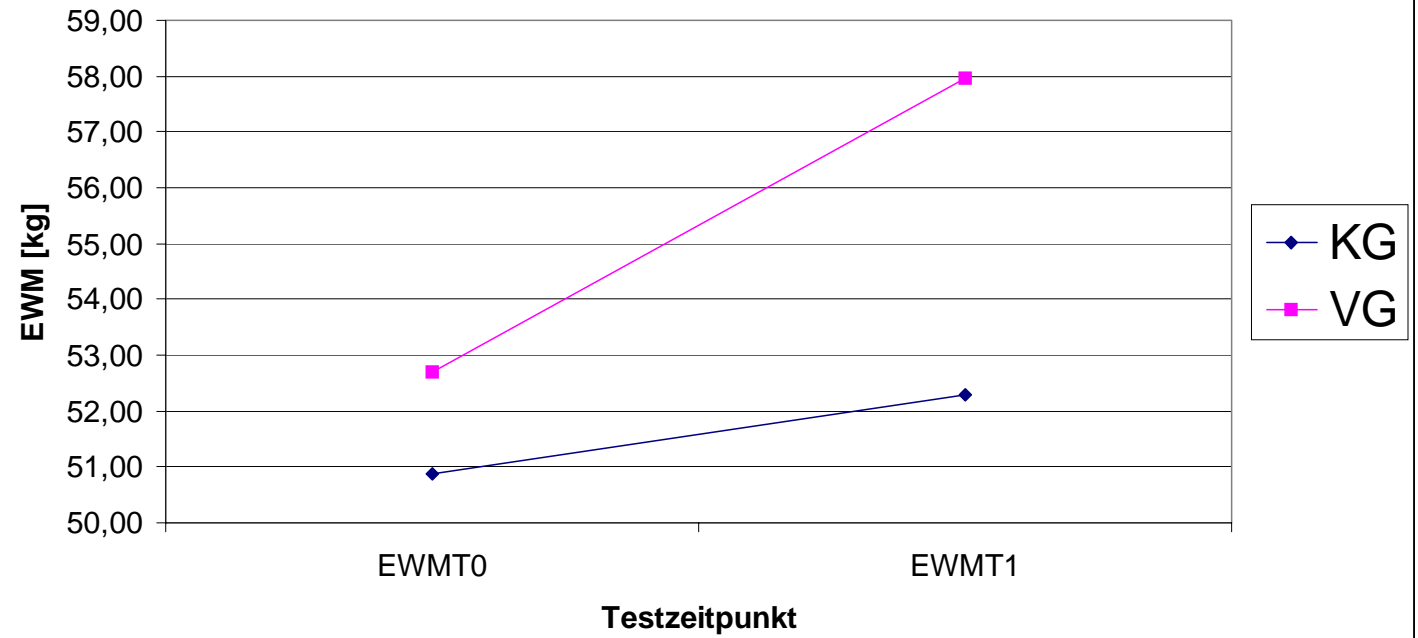


Erweiterung des T-Tests für
abhängige Gruppen!

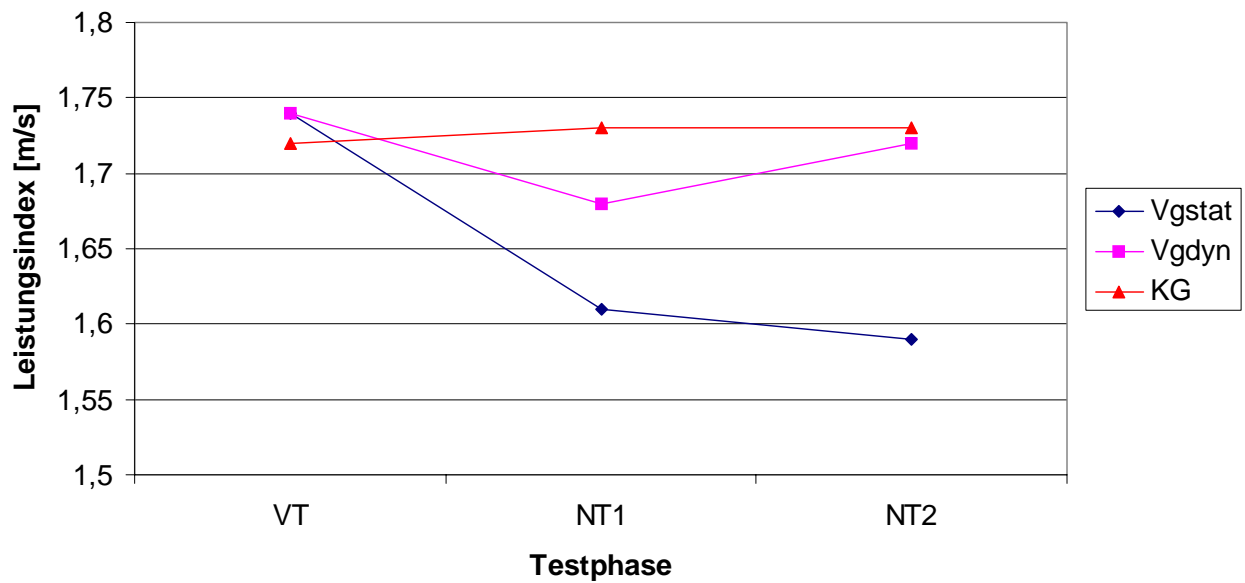
Interaktion?



EWM Vortest-Nachtest 1



Reaktivkraftexperiment



Maximalkräfte

