

Exploratory Factor Analysis on the Twin Data

```
label
  progmatt = 'Progressive matrices (M)'
  reason   = 'Reasoning Ability (R)'
  verbal   = 'Verbal Ability (V)'
  total    = 'Total Psych test score (T)'
  headlng  = 'Head Length (L)'
  headbrd  = 'Head breadth (B)'
  headcir  = 'Head Circumference (C)'
  cephal   = 'Cephalic index (I): head breadth/length'
  headar   = 'Head area (E): Cephalic index * headcir'
  bizyg    = 'Bizygomatic Breadth (Z): Dist betw eyes?'
  weight   = 'Weight of twin (W)'
  height   = 'Height of twin (S)'
  pondrl   = 'Height/weight**1/3 (P)';

/***** twinfac1.sas *****/
TITLE2 'Exploratory Factor Analysis';
%include 'twinread.sas';
proc factor simple corr method=ml nfactor=2 rotate=varimax;
  var progmatt reason verbal /* mental */
      headlng headbrd headcir bizyg height weight; /* physical */
```

Twin Data 1
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The FACTOR Procedure

Means and Standard Deviations from 74 Observations

| Variable | Mean | Std Dev |
|----------|-----------|-----------|
| progmatt | 37.9865 | 8.642034 |
| reason | 53.3514 | 16.510630 |
| verbal | 74.7230 | 24.217641 |
| headlng | 186.3784 | 7.088874 |
| headbrd | 146.8784 | 6.166531 |
| headcir | 543.4865 | 16.591170 |
| bizyg | 130.5541 | 5.888558 |
| height | 1651.1351 | 83.548989 |
| weight | 121.7095 | 21.808476 |

Correlations

| | progmatt | reason | verbal | headlng | headbrd |
|----------|----------|---------|---------|---------|---------|
| progmatt | 1.00000 | 0.55032 | 0.61360 | 0.31380 | 0.16095 |
| reason | 0.55032 | 1.00000 | 0.75374 | 0.15817 | 0.07281 |
| verbal | 0.61360 | 0.75374 | 1.00000 | 0.27770 | 0.14672 |
| headlng | 0.31380 | 0.15817 | 0.27770 | 1.00000 | 0.30018 |
| headbrd | 0.16095 | 0.07281 | 0.14672 | 0.30018 | 1.00000 |
| headcir | 0.33140 | 0.25887 | 0.31487 | 0.83358 | 0.67752 |
| bizyg | 0.18434 | 0.21728 | 0.24734 | 0.45409 | 0.80457 |
| height | 0.28396 | 0.14031 | 0.22415 | 0.59151 | 0.46087 |
| weight | 0.22900 | 0.14521 | 0.15569 | 0.56948 | 0.49422 |

Correlations

| | headcir | bizyg | height | weight |
|----------|---------|---------|---------|---------|
| progmatt | 0.33140 | 0.18434 | 0.28396 | 0.22900 |
| reason | 0.25887 | 0.21728 | 0.14031 | 0.14521 |
| verbal | 0.31487 | 0.24734 | 0.22415 | 0.15569 |
| headlng | 0.83358 | 0.45409 | 0.59151 | 0.56948 |
| headbrd | 0.67752 | 0.80457 | 0.46087 | 0.49422 |
| headcir | 1.00000 | 0.72474 | 0.61149 | 0.69145 |
| bizyg | 0.72474 | 1.00000 | 0.66308 | 0.65697 |
| height | 0.61149 | 0.66308 | 1.00000 | 0.66769 |
| weight | 0.69145 | 0.65697 | 0.66769 | 1.00000 |

Twin Data

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The FACTOR Procedure
Initial Factor Method: Maximum Likelihood

Prior Communality Estimates: SMC

| progmatt | reason | verbal | headlng | headbrd |
|------------|------------|------------|------------|------------|
| 0.45915496 | 0.65218538 | 0.64730716 | 0.86455862 | 0.81350040 |
| headcir | bizyg | height | weight | |
| 0.92119668 | 0.79997089 | 0.62380170 | 0.60818565 | |

Preliminary Eigenvalues: Total = 34.2040852 Average = 3.80045391

| | Eigenvalue | Difference | Proportion | Cumulative |
|---|------------|------------|------------|------------|
| 1 | 25.9921147 | 21.3392395 | 0.7599 | 0.7599 |
| 2 | 4.6528752 | 0.8099972 | 0.1360 | 0.8959 |
| 3 | 3.8428780 | 2.8054203 | 0.1124 | 1.0083 |
| 4 | 1.0374577 | 0.9141814 | 0.0303 | 1.0386 |
| 5 | 0.1232764 | 0.1192130 | 0.0036 | 1.0422 |
| 6 | 0.0040633 | 0.3647915 | 0.0001 | 1.0424 |

| | | | | |
|---|------------|-----------|---------|--------|
| 7 | -0.3607281 | 0.0766780 | -0.0105 | 1.0318 |
| 8 | -0.4374061 | 0.2130398 | -0.0128 | 1.0190 |
| 9 | -0.6504459 | | -0.0190 | 1.0000 |

2 factors will be retained by the NFACTOR criterion.

| Iteration | Criterion | Ridge | Change | Communalities | | | |
|-----------|-----------|--------|--------|---------------|---------|---------|---------|
| 1 | 2.4624138 | 0.0000 | 0.3498 | 0.40014 | 0.30234 | 0.41197 | 0.61032 |
| | | | | 0.66318 | 0.97217 | 0.73835 | 0.49057 |
| | | | | 0.55038 | | | |
| 2 | 2.3336477 | 0.0000 | 0.1649 | 0.44002 | 0.46060 | 0.51228 | 0.77522 |
| | | | | 0.63289 | 0.87180 | 0.67471 | 0.45745 |
| | | | | 0.56393 | | | |
| 3 | 2.0079966 | 0.0000 | 0.2474 | 0.48736 | 0.61763 | 0.75964 | 0.57021 |
| | | | | 0.48998 | 0.96741 | 0.63163 | 0.50783 |
| | | | | 0.56674 | | | |
| 4 | 1.9460303 | 0.0000 | 0.1463 | 0.46456 | 0.68353 | 0.82938 | 0.71653 |
| | | | | 0.51976 | 0.89637 | 0.60128 | 0.44558 |
| | | | | 0.55136 | | | |
| 5 | 1.9271433 | 0.0000 | 0.1000 | 0.46505 | 0.68397 | 0.83148 | 0.61650 |
| | | | | 0.46899 | 0.95520 | 0.59638 | 0.48506 |
| | | | | 0.55596 | | | |
| 6 | 1.9183528 | 0.0000 | 0.0780 | 0.46435 | 0.68339 | 0.83228 | 0.69447 |
| | | | | 0.50281 | 0.91660 | 0.59385 | 0.44858 |
| | | | | 0.54703 | | | |
| 7 | 1.9130477 | 0.0000 | 0.0554 | 0.46473 | 0.68403 | 0.83152 | 0.63908 |
| | | | | 0.47685 | 0.94764 | 0.59255 | 0.47123 |
| | | | | 0.55008 | | | |

Twin Data

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The FACTOR Procedure
Initial Factor Method: Maximum Likelihood

| Iteration | Criterion | Ridge | Change | Communalities | | | |
|-----------|-----------|--------|--------|---------------|---------|---------|---------|
| 8 | 1.9103859 | 0.0000 | 0.0421 | 0.46439 | 0.68366 | 0.83196 | 0.68122 |
| | | | | 0.49579 | 0.92616 | 0.59181 | 0.45190 |
| | | | | 0.54580 | | | |
| 9 | 1.9088365 | 0.0000 | 0.0306 | 0.46462 | 0.68401 | 0.83154 | 0.65067 |
| | | | | 0.48160 | 0.94288 | 0.59144 | 0.46479 |
| | | | | 0.54782 | | | |
| 10 | 1.9080256 | 0.0000 | 0.0230 | 0.46443 | 0.68379 | 0.83181 | 0.67368 |
| | | | | 0.49204 | 0.93096 | 0.59118 | 0.45443 |
| | | | | 0.54568 | | | |
| 11 | 1.9075647 | 0.0000 | 0.0168 | 0.46456 | 0.68398 | 0.83158 | 0.65684 |
| | | | | 0.48424 | 0.94006 | 0.59107 | 0.46165 |
| | | | | 0.54690 | | | |
| 12 | 1.9073179 | 0.0000 | 0.0126 | 0.46446 | 0.68385 | 0.83174 | 0.66945 |
| | | | | 0.48999 | 0.93347 | 0.59098 | 0.45603 |
| | | | | 0.54579 | | | |
| 13 | 1.9071797 | 0.0000 | 0.0093 | 0.46453 | 0.68396 | 0.83161 | 0.66018 |

| | | | | | | | |
|----|-----------|--------|--------|---------|---------|---------|---------|
| | | | | 0.48570 | 0.93845 | 0.59094 | 0.46004 |
| | | | | 0.54649 | | | |
| 14 | 1.9071047 | 0.0000 | 0.0069 | 0.46448 | 0.68388 | 0.83170 | 0.66711 |
| | | | | 0.48887 | 0.93482 | 0.59090 | 0.45697 |
| | | | | 0.54589 | | | |
| 15 | 1.9070631 | 0.0000 | 0.0051 | 0.46452 | 0.68394 | 0.83163 | 0.66200 |
| | | | | 0.48651 | 0.93755 | 0.59089 | 0.45919 |
| | | | | 0.54629 | | | |
| 16 | 1.9070403 | 0.0000 | 0.0038 | 0.46449 | 0.68390 | 0.83168 | 0.66581 |
| | | | | 0.48825 | 0.93555 | 0.59087 | 0.45751 |
| | | | | 0.54597 | | | |
| 17 | 1.9070278 | 0.0000 | 0.0028 | 0.46451 | 0.68393 | 0.83165 | 0.66300 |
| | | | | 0.48695 | 0.93705 | 0.59086 | 0.45873 |
| | | | | 0.54618 | | | |
| 18 | 1.9070209 | 0.0000 | 0.0021 | 0.46449 | 0.68391 | 0.83167 | 0.66510 |
| | | | | 0.48791 | 0.93595 | 0.59085 | 0.45780 |
| | | | | 0.54601 | | | |
| 19 | 1.9070171 | 0.0000 | 0.0015 | 0.46450 | 0.68392 | 0.83165 | 0.66355 |
| | | | | 0.48720 | 0.93678 | 0.59084 | 0.45848 |
| | | | | 0.54613 | | | |
| 20 | 1.9070150 | 0.0000 | 0.0012 | 0.46449 | 0.68391 | 0.83167 | 0.66471 |
| | | | | 0.48772 | 0.93617 | 0.59084 | 0.45797 |
| | | | | 0.54603 | | | |
| 21 | 1.9070138 | 0.0000 | 0.0008 | 0.46450 | 0.68392 | 0.83166 | 0.66386 |
| | | | | 0.48733 | 0.93663 | 0.59084 | 0.45834 |
| | | | | 0.54610 | | | |

Convergence criterion satisfied.

The FACTOR Procedure
Initial Factor Method: Maximum Likelihood

Significance Tests Based on 74 Observations

| Test | DF | Chi-Square | Pr > ChiSq |
|--------------------------------|----|------------|---------------|
| H0: No common factors | 36 | 490.5715 | <.0001 |
| HA: At least one common factor | | | |
| H0: 2 Factors are sufficient | 19 | 129.3591 | <.0001 |
| HA: More factors are needed | | | |

| | |
|--|-----------|
| Chi-Square without Bartlett's Correction | 139.21201 |
| Akaike's Information Criterion | 101.21201 |
| Schwarz's Bayesian Criterion | 57.43477 |
| Tucker and Lewis's Reliability Coefficient | 0.54000 |

Squared Canonical Correlations

| Factor1 | Factor2 |
|------------|------------|
| 0.95761280 | 0.86804173 |

Eigenvalues of the Weighted Reduced Correlation
Matrix: Total = 29.1701845 Average = 3.24113161

| | Eigenvalue | Difference | Proportion | Cumulative |
|---|------------|------------|------------|------------|
| 1 | 22.5920286 | 16.0138755 | 0.7745 | 0.7745 |
| 2 | 6.5781531 | 5.3370482 | 0.2255 | 1.0000 |
| 3 | 1.2411049 | 0.7245865 | 0.0425 | 1.0425 |
| 4 | 0.5165184 | 0.4444988 | 0.0177 | 1.0603 |
| 5 | 0.0720196 | 0.0831900 | 0.0025 | 1.0627 |
| 6 | -0.0111704 | 0.3229722 | -0.0004 | 1.0623 |
| 7 | -0.3341426 | 0.3404424 | -0.0115 | 1.0509 |
| 8 | -0.6745851 | 0.1351570 | -0.0231 | 1.0278 |
| 9 | -0.8097420 | | -0.0278 | 1.0000 |

Factor Pattern

| | Factor1 | Factor2 |
|----------|---------|----------|
| progmatt | 0.42881 | 0.52973 |
| reason | 0.37446 | 0.73736 |
| verbal | 0.45175 | 0.79220 |
| headlng | 0.80639 | -0.11832 |
| headbrd | 0.66507 | -0.21258 |
| headcir | 0.95701 | -0.14400 |
| bizyg | 0.75642 | -0.13628 |
| height | 0.66779 | -0.10979 |
| weight | 0.71347 | -0.19215 |

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The FACTOR Procedure

Initial Factor Method: Maximum Likelihood

Variance Explained by Each Factor

| Factor | Weighted | Unweighted |
|---------|------------|------------|
| Factor1 | 22.5920286 | 4.06376784 |
| Factor2 | 6.5781531 | 1.59937394 |

Final Communalities Estimates and Variable Weights

Total Communalities: Weighted = 29.170182 Unweighted = 5.663142

| Variable | Communalities | Weight |
|----------|---------------|------------|
| progmatt | 0.46449409 | 1.8674146 |
| reason | 0.68392047 | 3.1637681 |
| verbal | 0.83165645 | 5.9402206 |
| headlng | 0.66427090 | 2.9749409 |
| headbrd | 0.48750360 | 1.9505690 |
| headcir | 0.93660411 | 15.7799995 |
| bizyg | 0.59073481 | 2.4440025 |
| height | 0.45800209 | 1.8461595 |
| weight | 0.54595524 | 2.2031098 |

The FACTOR Procedure
Rotation Method: Varimax

Orthogonal Transformation Matrix

| | 1 | 2 |
|---|----------|---------|
| 1 | 0.92969 | 0.36834 |
| 2 | -0.36834 | 0.92969 |

Rotated Factor Pattern

| | Factor1 | Factor2 |
|----------|---------|---------|
| progmatt | 0.20354 | 0.65044 |
| reason | 0.07653 | 0.82345 |
| verbal | 0.12819 | 0.90290 |
| headlng | 0.79328 | 0.18703 |
| headbrd | 0.69661 | 0.04734 |
| headcir | 0.94277 | 0.21862 |
| bizyg | 0.75343 | 0.15192 |
| height | 0.66128 | 0.14391 |
| weight | 0.73408 | 0.08415 |

Variance Explained by Each Factor

| Factor | Weighted | Unweighted |
|---------|------------|------------|
| Factor1 | 20.4194016 | 3.61090172 |
| Factor2 | 8.7507802 | 2.05224006 |

Final Communalities Estimates and Variable Weights

Total Communalities: Weighted = 29.170182 Unweighted = 5.663142

| Variable | Communalities | Weight |
|----------|---------------|------------|
| progmatt | 0.46449409 | 1.8674146 |
| reason | 0.68392047 | 3.1637681 |
| verbal | 0.83165645 | 5.9402206 |
| headlng | 0.66427090 | 2.9749409 |
| headbrd | 0.48750360 | 1.9505690 |
| headcir | 0.93660411 | 15.7799995 |
| bizyg | 0.59073481 | 2.4440025 |
| height | 0.45800209 | 1.8461595 |
| weight | 0.54595524 | 2.2031098 |