Psychology 360: Personality Research
Scale Construction

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Outline

Scale construction: A 10 steps program

1. Personality scales are not created in a theoretical vacuum. Perhaps the most important step in developing a new scale is a consideration of what is the construct of interest. What is it, what are manifestations of it, what is it not, and what should it not relate to.
2. Then, what is the population of interest? Are they young or old, highly literate, or somewhat challenged by literacy. Write items suitable for the population of interest.
3. Give the items to the participants. Make sure that they are engaged in the task.

Scale construction: A 10 steps program (continued)

4. To analyze the data, it is necessary to enter the data into a machine readable form.
   - This is a source of error. Double check for data entry errors.
   - Double entry (two different people enter the data and then the two files are automatically compared) is recommended.
   - Even better is automatic data entry (but then you need to check and double check the program).
   - my.data <- read.file() #go find the file on your computer
   - my.data <- read.file(myfile) #if you have the file name some
   - my.data <- read.clipboard() #if you have already copied the data to the clipboard
5. Run basic descriptive statistics to do one more check for errors. Graphically check as well.
   - describe(my.data)
   - pairs.panels(my.data)
6. Form the variance/covariance matrix from the items and examine the dimensionality of the resulting space.

Scale construction: A 10 steps program (continued)

7. Apply various data reduction techniques (factor analysis, principal components analysis, cluster analysis).
   - `fa`
   - `irt.fa` # if you have polytomous or dichotomous items
   - `principal`
   - `iclust`
8. Form composite scales of the selected items. Check these scales for various measures of internal consistency.
   - `make.keys`
   - `scoreItems`
   - `bestScales` (For empirical scale construction)
9. Discriminant validity requires that the scales not correlate with other, unrelated traits.
10. Convergent validity requires that the scale do correlate with other, alternative measures of the same trait.

Basic item development

As a demonstration of scale construction and validation, consider the following problem. N self report items are given to a number of people. This inventory has is composed of subsets of items that measure believed to measure different traits. In addition, each subject is rated by a friend on those same traits. There are several questions we can ask of these data:

1. Do the items form reliable scales?
2. What are the correlations of these scales?
3. Do the scales correlate with the peer ratings?
4. Can we empirically find a better structure of the items?
5. Do these revised scales show greater independence, reliability, and validity?

Item writing

To show the procedures, 12 students in a personality research course spent several weeks learning about each of four personality dimensions. Each student then wrote five items to assess each of four constructs.

1. Need for Achievement
2. Anxiety
3. Sociability
4. Impulsivity

As a group they examined all of the items and formed the best 80 items into one questionnaire with 20 items believed to measure each of the constructs. An additional four items were the simple stem: "I think I am ... ".They administered this questionnaire to approximately ten friends each whom they also rated on these four constructs. Thus, we have a data set of about 75 participants assessed on 91 items (the 84 self report items and the 4 peer ratings + Gender).

These four sets of items can be seen as samples from four domains.

The items (abbreviated)

Variable	Cntnt
NeedAch	NeedAch
Anxiety	Anxiety
Sociability	Sociability
Impulsivity	Impulsivity
Gender	Gender
q1	I love to seek out new challenges
q2	I get nervous very easily
q3	I like to meet new people in everyday situations
q4	I am thoughtful and deliberate when making decisions
q5	Personal satisfaction is the best reward of a job well done
q6	I dont handle stress well
q7	I can easily start conversations with people I dont know
q8	I say things that I regret later
q9	I am a good multi tasker
q10	I am easily bothered by negative reviews
q11	I tend to avoid social situations
q12	I weigh all the options carefully before making a choice
q13	I like to go the extra mile on a project or a job
q14	Measures of skill or intelligence make me nervous
q15	I tend to lead the conversation
q16	I tend to make decisions quickly
q17	I have high standards for the quality of my activity in everyday life
q18	I rarely feel tense
q19	I am good at maintaining a lively conversation
q20	I plan my activities in advance
q21	I am a perfectionist
q22	I feel stressed when I have a lot to do in a short amount of time
q23	I make friends easily
q24	I often change my plans at the last minute
q25	If I fail, I keep trying until I succeed
q26	I often feel anxious about future events

The items (continued)

Variable	Cntnt
q26	I often feel anxious about future events
q27	I tend to enjoy small groups of people
q28	I dislike planning ahead
q29	I seek the enjoyment of winning
q30	I often feel tense, nauseous, and/or faint before a big event
q31	I tend to talk a lot in large groups
q32	I indulge in my desires on a whim
q33	I find myself needing to achieve whatever I start
q34	I have a hard time forgetting negative events
q35	I have a large social network
q36	When working on a necessary task and a more promising option arises, I keep working
q37	I get bored if a task is not challenging
q38	I often have unwanted and/or disturbing thoughts
q39	Id rather spend time with others than spend time alone
q40	I act on sudden urges
q41	I always make sure anything attached to my name is top quality
q42	Even trivial problems greatly contribute to my stress level
q43	I am happier when Im around other people
q44	I often regret decisions because I acted too quickly
q45	I prefer challenging tasks to easy ones
q46	I often have difficulty sleeping
q47	I enjoy being alone
q48	I tend to act on my gut feelings
q49	The joy of success is worth the hard work it takes to get there
q50	Even in non stressful situations, I find things to worry about
q51	People are more likely to initiate a conversation with me than I am with them
q52	I often get sidetracked in the middle of an activity
q53	I only work as hard as I have to on tasks
q54	I feel tension in my body or face while in stressful situations
q55	Ill spend time talking to a friend even if I have something else that needs to be done
q56	I often and actively express my feelings to those around me

The items (continued)

Variable	Cntnt
q56	I often and actively express my feelings to those around me
q57	I always reach the goals I set for myself
q58	I prefer to work in relaxed environments where I can take my time
q59	I prefer large crowded parties to small intimate ones
q60	I stay on task until a project is completed
q61	I experience great joy when my efforts pay off and I perform well on a task
q62	A small unpleasant event can ruin my day
q63	A good night for me is reading a book
q64	I dislike changing established plans
q65	I tend to have trouble getting motivated in my tasks
q66	I worry about what others think of me
q67	I am always willing to attend a party
q68	I always think before I act
q69	I tend to procrastinate and waste more time than most of my peers
q70	I bounce back quickly from unpleasant situations
q71	I dont understand how people can spend hours in the library alone
q72	I always stick to plans
q73	I set long term and sizeable goals for myself
q74	I tend to dwell on obstacles in the near future
q75	I work better when there are people around
q76	I sometimes look back and dont know why I made a certain decision
q77	I always see projects through to the finish
q78	I tend to back away from tasks I think are too difficult
q79	When given the choice, I will work alone rather than in a group
q80	I often say the first thing that comes to my mind
q81	I believe that if something is worth doing, it is worth doing well
q82	I am more emotional than my friends
q83	I am a very sociable person
q84	I am an impulsive person

Initial data reading

The data, item labels, and scoring keys are saved on a web server. They may be accessed by the read.table(file.name) or `read.file` command. We then use the dim command to find out the dimensions of the data file as well as the names command to find out what the names are.

```
prq.data.name <-  "https://personality-project.org/courses/360/prq.data.csv"
prq.dictionary.name <- "https://personality-project.org/courses/360/prq.dictionary.csv"
prq.data<- read.file(prq.data.name)
prq.dictionary <- read.file(prq.dictionary.name)
dim(prq.data)
names(prq.data)
> dim(prq.data)
[1]75 91
 names(prq.data)
 [1] "Exp"         "Subject"     "NeedAch"     "Anxiety"     "Sociability" "Impulsivity"
 [7] "Gender"      "q1"          "q2"          "q3"          "q4"          "q5"
[13] "q6"          "q7"          "q8"          "q9"          "q10"         "q11"
[19] "q12"         "q13"         "q14"         "q15"         "q16"         "q17"
[25] "q18"         "q19"         "q20"         "q21"         "q22"         "q23"
[31] "q24"         "q25"         "q26"         "q27"         "q28"         "q29"
[37] "q30"         "q31"         "q32"         "q33"         "q34"         "q35"
[43] "q36"         "q37"         "q38"         "q39"         "q40"         "q41"
[49] "q42"         "q43"         "q44"         "q45"         "q46"         "q47"
[55] "q48"         "q49"         "q50"         "q51"         "q52"         "q53"
[61] "q54"         "q55"         "q56"         "q57"         "q58"         "q59"
[67] "q60"         "q61"         "q62"         "q63"         "q64"         "q65"
[73] "q66"         "q67"         "q68"         "q69"         "q70"         "q71"
```

Data checking

Always check the data first. Use the `describe` function.

```
> describe(prq)
```

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
Exp*	1	75	5.17	2.64	6	5.21	2.97	1	9	8	-0.19	-1.28	0.31
Subject	2	75	4.85	2.68	5	4.75	2.97	1	10	9	0.24	-1.05	0.31
NeedAch	3	75	6.39	1.92	7	6.48	1.48	2	10	8	-0.40	-0.64	0.22
Anxiety	4	75	5.24	2.28	5	5.21	2.97	1	10	9	0.09	-1.18	0.26
Sociability	5	75	6.15	2.13	7	6.31	1.48	1	9	8	-0.69	-0.60	0.25
Impulsivity	6	75	5.16	2.35	5	5.20	2.97	1	9	8	-0.13	-1.32	0.27
Gender	7	74	1.51	0.50	2	1.52	0.00	1	2	1	-0.05	-2.02	0.06
q1	8	75	4.27	1.15	4	4.34	1.48	1	6	5	-0.52	-0.08	0.13
q2	9	75	3.37	1.39	3	3.33	1.48	1	6	5	0.21	-0.73	0.16
q3	10	75	4.36	1.34	5	4.48	1.48	1	6	5	-0.57	-0.51	0.15
q4	11	75	4.04	1.33	4	4.08	1.48	1	6	5	-0.11	-0.75	0.15
q5	12	75	4.35	1.16	5	4.44	1.48	1	6	5	-0.74	0.03	0.13
q6	13	75	3.21	1.41	3	3.13	1.48	1	6	5	0.43	-0.85	0.16
q7	14	75	4.17	1.54	5	4.28	1.48	1	6	5	-0.44	-0.99	0.18
...													
q81	88	75	4.32	1.22	4	4.43	1.48	1	6	5	-0.57	0.13	0.14
q82	89	75	3.84	1.46	4	3.92	1.48	1	6	5	-0.39	-0.74	0.17
q83	90	75	4.08	1.33	4	4.10	1.48	2	6	4	-0.35	-1.06	0.15
q84	91	75	3.89	1.33	4	3.92	1.48	1	6	5	-0.32	-0.80	0.15

Data checking

In doing this, we discovered (on the first pass through the data) that one of the variables had a range of 46 rather than the 6 that was appropriate. Correcting the data, we can start over again.
Even with well meaning, careful data entry, mistakes will happen in data entry. It is recommended that data be entered twice and then compared using software that compares the two files line by line and entry by entry. In all cases, make sure to describe the data and check that the ranges are appropriate for the data.
Thus, the data were edited and the prior steps were done again until there were no incorrectly entered subjects. One error that makes data checking complicated is a blank field in Excel is read improperly. However, if we copy the data file to the clipboard and then use the `read.clipboard.tab` function, this solves that problem. Note that the describe output shows that some variables do not have as many subjects as others.

Score the scales

1. Forming scale scores as linear sums (or averages) of the items is easy to do in R.
2. One technique (not recommended) is to do a series of recodings, creating new variables for each scale.
3. A simpler technique, using the `scoreItems` function from the *psych* package does this for all scales defined in a matrix of keys (the keys matrix).
4. This is essentially a matrix of -1, 0, and 1s where 0 means don't include the item in the scale, and a 1 means to include it. -1 means to reverse key the item.
5. This is, however, a not very useful internal representation. item A more useful techniqus is to make up lists of the items and how to score them. Combine these into a `keys.list`

Making up the scoring keys

```
prq.keys <- list(
nach = cs(q1,  q5,  q9, q13, q17, q21, q25, q29, -q33, q37, q41, q45, q49, -q53, q57, q61, -q65, -q69, q73,
 anx = cs(q2,  q6, q10, q14, -q18, q22, q26, q30, q34, q38, q42, q46, q50, q54, -q58, q62, q66, -q70, q74,
 soc = cs( q3,  q7, -q11, q15, q19, q23, -q27, q31, q35, q39, q43, -q47, -q51, q55, q59, -q63, q67, q71, q7
 imp =cs(-q4,  q8, -q12, q16, -q20, q24, q28, q32, -q36, q40, q44, q48, q52, q56, -q60, q64, -q68, -q72, q7
 ,PeerNach ="NeedAch",  PeerAnx="Anxiety", PeerSoc = "Sociability", PeerImp = "Impulsivity", Gender="Gender
 )
```

By having the scoring key information in this form, we can always reproduce it.

We can also save it using `dput`

But the keys.list format is easiest to use.

Table: df2latex

A table from the psych package in R

Variable	Cntnt
q1	I love to seek out new challenges
q5	Personal satisfaction is the best reward of a job well
q9	I am a good multi tasker
q13	I like to go the extra mile on a project or a job
q17	I have high standards for the quality of my activity ir
q21	I am a perfectionist
q25	If I fail, I keep trying until I succeed
q29	I seek the enjoyment of winning
q33-	I find myself needing to achieve whatever I start
q37	I get bored if a task is not challenging
q41	I always make sure anything attached to my name is
q45	I prefer challenging tasks to easy ones
q49	The joy of success is worth the hard work it takes to
q53-	I only work as hard as I have to on tasks
q57	I always reach the goals I set for myself
q61	I experience great joy when my efforts pay off and I
q65-	I tend to have trouble getting motivated in my tasks
q69-	I tend to procrastinate and waste more time than mo
q73	I set long term and sizeable goals for myself

Anxiety items

A table from the psych package in R

Variable	Cntnt
q2	I get nervous very easily
q6	I dont handle stress well
q10	I am easily bothered by negative reviews
q14	Measures of skill or intelligence make me nervous
q18-	I rarely feel tense
q22	I feel stressed when I have a lot to do in a short amo
q26	I often feel anxious about future events
q30	I often feel tense, nauseous, and/or faint before a big
q34	I have a hard time forgetting negative events
q38	I often have unwanted and/or disturbing thoughts
q42	Even trivial problems greatly contribute to my stress
q46	I often have difficulty sleeping
q50	Even in non stressful situations, I find things to worry
q54	I feel tension in my body or face while in stressful sit
q58-	I prefer to work in relaxed environments where I can
q62	A small unpleasant event can ruin my day
q66	I worry about what others think of me
q70-	I bounce back quickly from unpleasant situations
q74	I tend to dwell on obstacles in the near future
q78	I tend to back away from tasks I think are too difficu

Table: df2latex

A table from the psych package in R

Variable	Cntnt
q3	I like to meet new people in everyday situations
q7	I can easily start conversations with people I dont kn
q11	I tend to avoid social situations
q15	I tend to lead the conversation
q19	I am good at maintaining a lively conversation
q23	I make friends easily
q27-	I tend to enjoy small groups of people
q31	I tend to talk a lot in large groups
q35	I have a large social network
q39	Id rather spend time with others than spend time alo
q43	I am happier when Im around other people
q47-	I enjoy being alone
q51-	People are more likely to initiate a conversation with
q55	Ill spend time talking to a friend even if I have somet
q59	I prefer large crowded parties to small intimate ones
q63-	A good night for me is reading a book
q67	I am always willing to attend a party
q71	I dont understand how people can spend hours in the
q75	I work better when there are people around

Table: df2latex

A table from the psych package in R

Variable	Cntnt
q4-	I am thoughtful and deliberate when making decision
q8	I say things that I regret later
q12-	I weigh all the options carefully before making a choi
q16	I tend to make decisions quickly
q20-	I plan my activities in advance
q24	I often change my plans at the last minute
q28	I dislike planning ahead
q32	I indulge in my desires on a whim
q36-	When working on a necessary task and a more promi
q40	I act on sudden urges
q44	I often regret decisions because I acted too quickly
q48	I tend to act on my gut feelings
q52	I often get sidetracked in the middle of an activity
q56	I often and actively express my feelings to those arou
q60-	I stay on task until a project is completed
q64	I dislike changing established plans
q68-	I always think before I act
q72-	I always stick to plans
q76	I sometimes look back and dont know why I made a

Score the items

We use the `scoreItems` function.

We first do this just for the items. The item.scores is a list of multiple values:

1. scores – the actual scores for each subject
2. missing – where there any missing values for any subject?
3. alpha – coefficient alpha for each scale
4. av.r – the average r within each scale
5. n.items – how many items in each scale?
6. item.cor – the correlation of each item with each scale
7. cor – the correlation matrix of the scales (based upon the correlations of the items - with SAPA data this will differ from correlating the scales)
8. corrected – the raw correlations of the scales (below the diagonal), the alpha reliabilities (on the diagonal), and the intercorrelations corrected for unreliability (above the diagonal).

Using scoreItems

```
 Call: scoreItems(keys = prq.keys, items = prq.data)

(Unstandardized) Alpha:
      nach  anx soc  imp PeerNach PeerAnx PeerSoc PeerImp Gender
alpha 0.81 0.85 0.9 0.84        1       1       1       1      1

Standard errors of unstandardized Alpha:
       nach   anx   soc   imp PeerNach PeerAnx PeerSoc PeerImp Gender
ASE   0.038 0.033 0.024 0.034      NaN     NaN     NaN     NaN    NaN

Average item correlation:
          nach  anx  soc imp PeerNach PeerAnx PeerSoc PeerImp Gender
average.r 0.17 0.21 0.31 0.2      NaN     NaN     NaN     NaN    NaN

Median item correlation:
    nach      anx      soc      imp PeerNach  PeerAnx  PeerSoc  PeerImp   Gende
    0.22     0.23     0.31     0.24       NA       NA       NA       NA       N

 Guttman 6* reliability:
         nach  anx  soc  imp PeerNach PeerAnx PeerSoc PeerImp Gender
Lambda.6 0.97 0.97 0.98 0.98     0.93    0.88     0.9    0.86   0.88

Signal/Noise based upon av.r :
```

Show more of the output

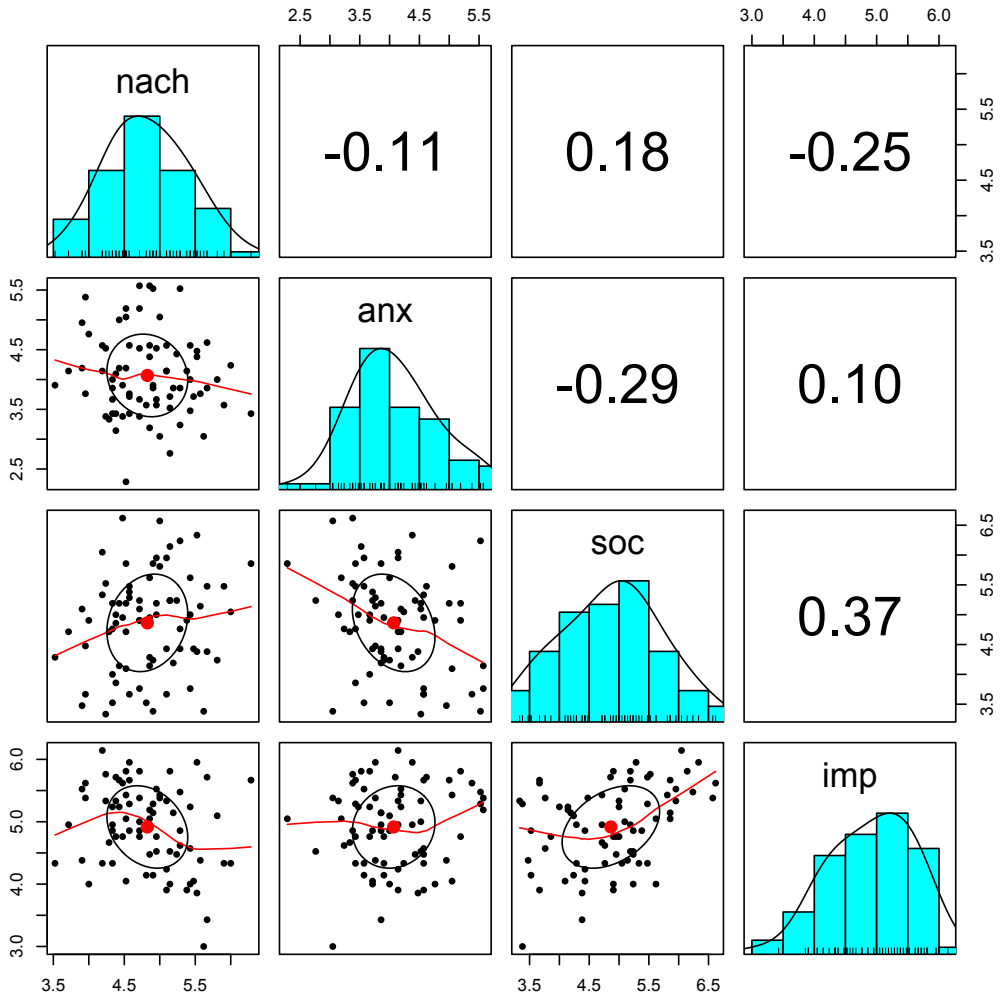
```
> item.scores
```

```
Scale intercorrelations corrected for attenuation
 raw correlations below the diagonal, alpha on the diagonal
 corrected correlations above the diagonal:
           nach   anx     soc    imp PeerNach PeerAnx PeerSoc PeerImp  Gender
nach      0.814 -0.13  0.2066 -0.303   0.2607  -0.020  -0.192  -0.295 -0.0584
anx      -0.105  0.85 -0.3274  0.124   0.1565   0.642  -0.161   0.143  0.1603
soc       0.177 -0.29  0.9022  0.430  -0.0049  -0.223   0.604   0.226 -0.0192
imp      -0.251  0.10  0.3743  0.842  -0.3589   0.095   0.347   0.568  0.0730
PeerNach  0.235  0.14 -0.0047 -0.329   1.0000   0.207  -0.077  -0.304 -0.0011
PeerAnx  -0.018  0.59 -0.2118  0.087   0.2068   1.000  -0.102  -0.030  0.3733
PeerSoc  -0.173 -0.15  0.5738  0.319  -0.0767  -0.102   1.000   0.293  0.0919
PeerImp  -0.266  0.13  0.2149  0.521  -0.3041  -0.030   0.293   1.000  0.0545
Gender   -0.053  0.15 -0.0183  0.067  -0.0011   0.373   0.092   0.054  1.0000
```

```
 In order to see the item by scale loadings and frequency counts of the data
 print with the short option = FALSE
```

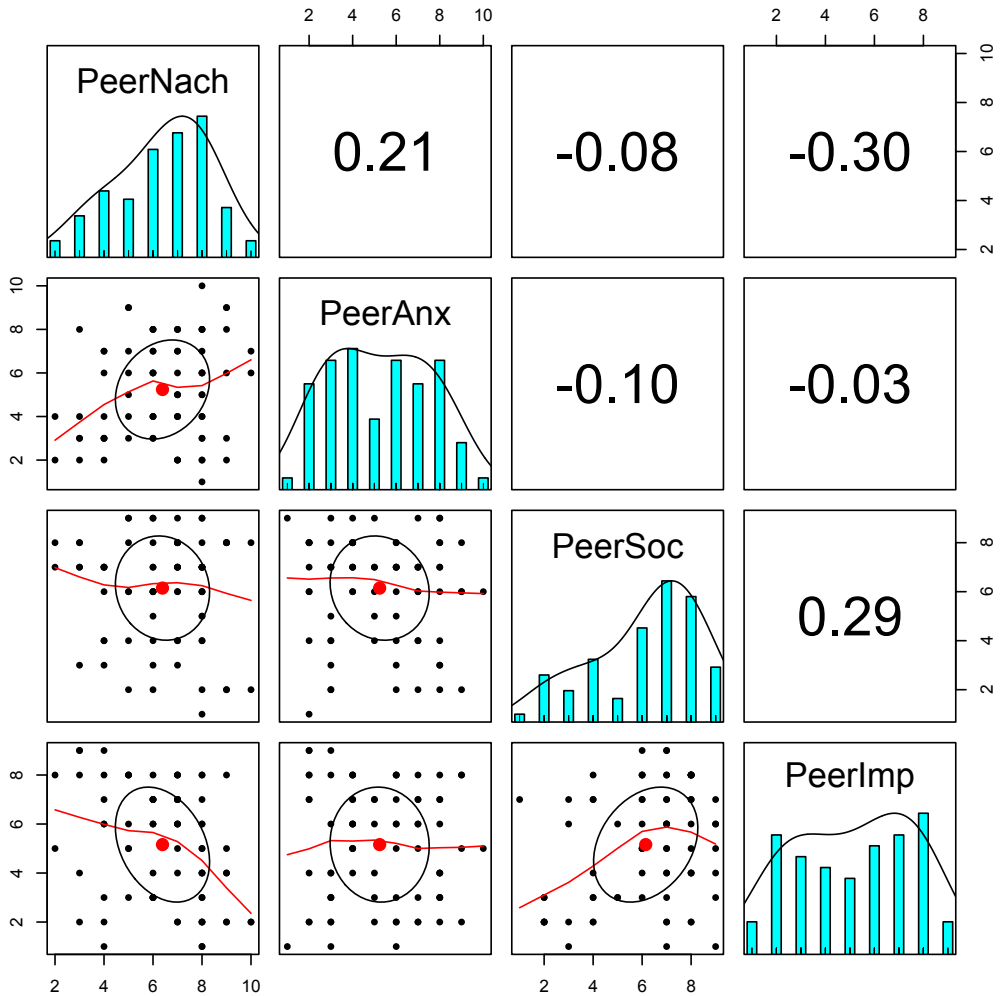
Display the four self report dimensions

pairs.panels(prq.scores$scores[,1:4]) # note that scores is an object in prq.scores



Show the peer rating structure

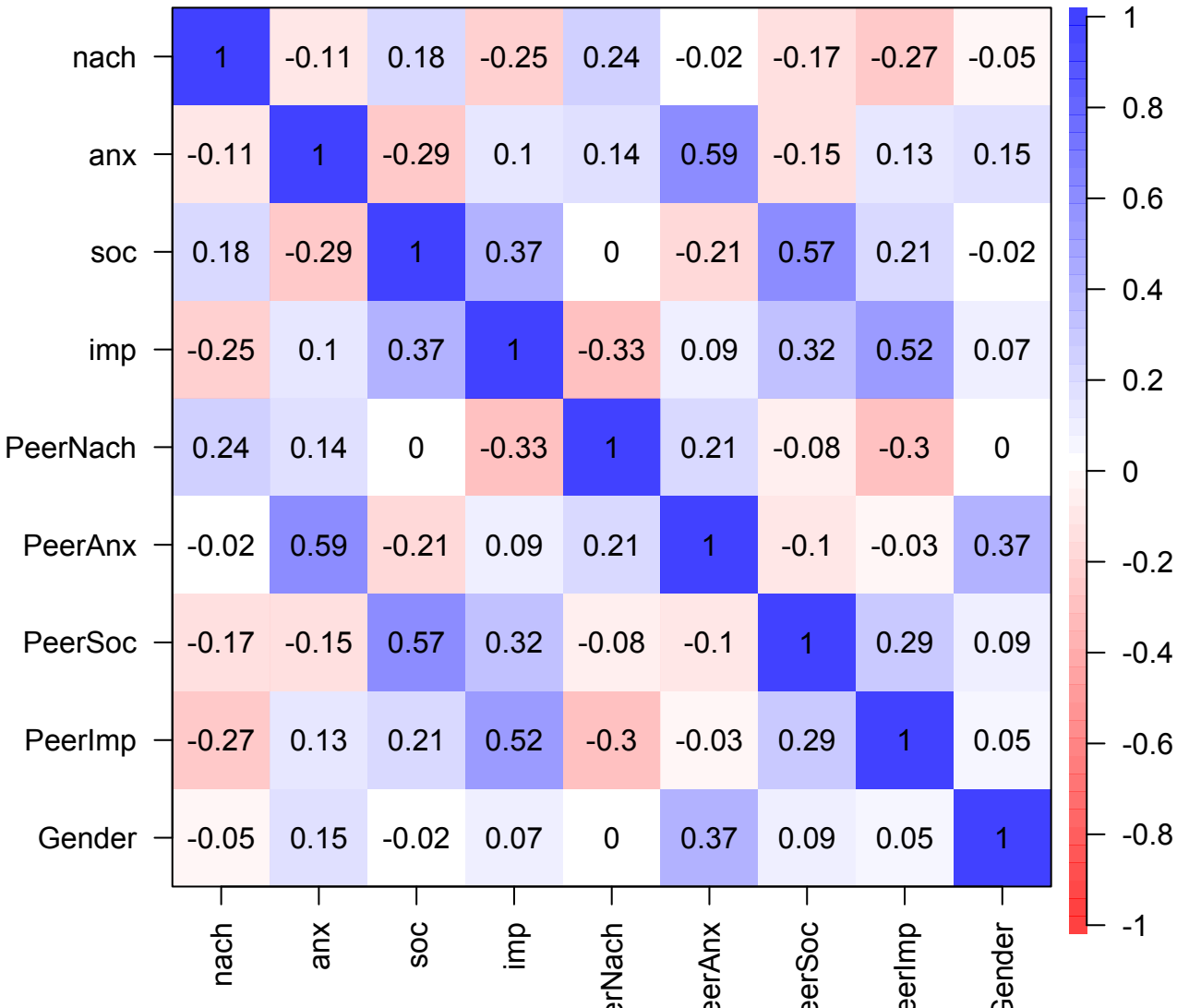
```
pairs.panels(prq.scores$scores[,5:8])
```



The Multi-Trait- Multi- Method Matrix

1. Correlations within method combine trait and method variance
   - What is the structure of NASI within self report
   - What is the structure of NASI within peer report
2. Correlations across method show trait variance
   - Do the self report dimensions match the peer ratings?
   - Note the correlations of gender differ between self and peer report. What could account for this difference?

Show the MMTM matrix graphically – cor.ci(prq.scores$scores)



Factor Analysis

The items analysed were meant to represent four constructs. Given the previous analysis, they probably do. But what if we did not know how many separate dimensions were in the data? Is it possible to find out? Three alternative procedure address this question.

1. Principal components analysis
2. Factor analysis
3. Cluster analysis

All three of these procedures are attempting to approximate the nvar * nvar correlation matrix R with a matrix of lesser rank, one that is nvar * nf. That is, can we find a Factor (Component or Cluster) such that

$$R \approx FF' + U^2 \tag{1}$$

or

$$R \approx CC' \tag{2}$$

Factor analysis of PRQ

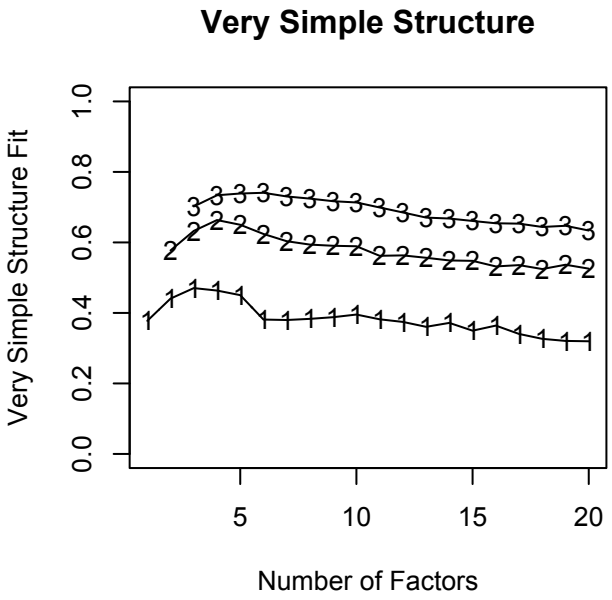
1. We need more people than items to make the matrix invertible
2. Can be solved in either case by using minimum residuals (OLS)
3. Can be solved by the `fa` function using minres option
4. How many factors to extract is a perpetual problem.
   - nfactors(prq)
   - Use VSS 2 (complexity 1) or 3 (complexity 2)
   - Use MAPS 9
   - Empirical BIC 3 factors
5. Theory says 4

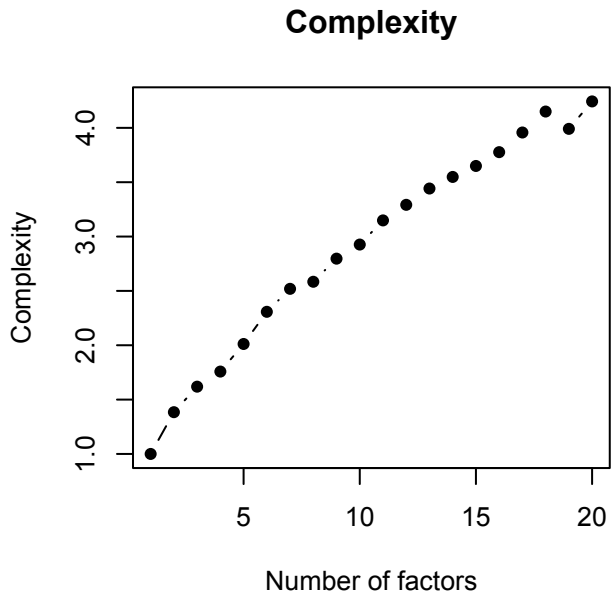
R code

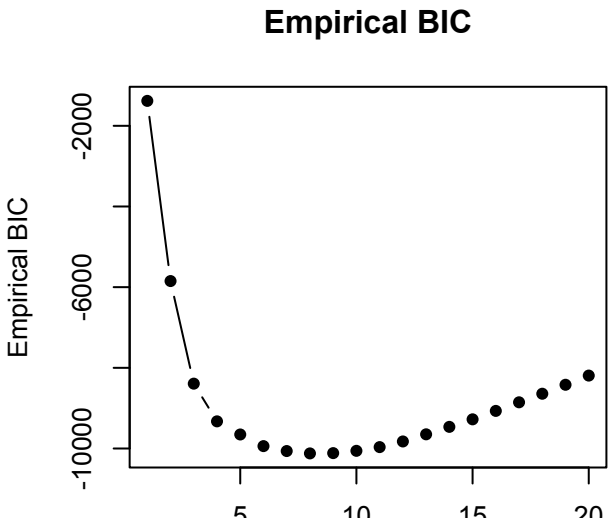
```
nfactors(prq.data[8:91])
```

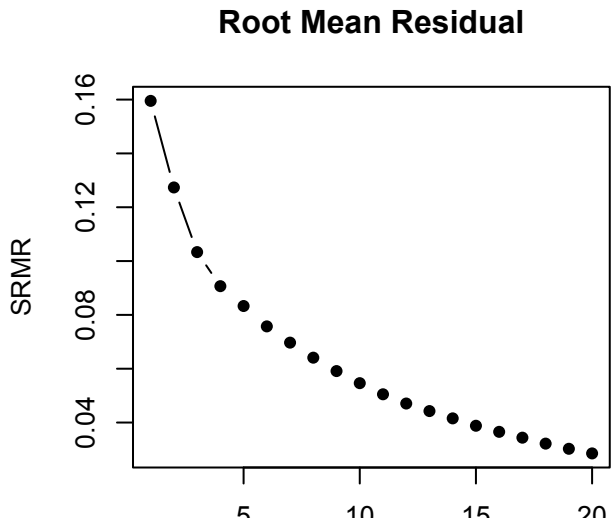
```
Number of factors
Call: vss(x = x, n = n, rotate = rotate, diagonal = diagonal, fm = fm,
    n.obs = n.obs, plot = FALSE, title = title, use = use, cor = cor)
VSS complexity 1 achieves a maximimum of 0.47  with  3  factors
VSS complexity 2 achieves a maximimum of 0.66  with  4  factors
The Velicer MAP achieves a minimum of 0.02  with  12  factors
Empirical BIC achieves a minimum of  -10121.68  with  8  factors
Sample Size adjusted BIC achieves a minimum of  5408.41  with  20  factors
```

VSS of prq


Very Simple Structure
Very Simple Structure Fit
Number of Factors
0.0
0.2
0.4
0.6
0.8
1.0
5
10
15
20


Complexity
Complexity
Number of factors
1.0
2.0
3.0
4.0
5
10
15
20


Empirical BIC
Empirical BIC
-10000
-6000
-2000
5
10
15
20


Root Mean Residual
SRMR
0.04
0.08
0.12
0.16
5
10
15
20

Find a 4 factor as well as a 4 component solution – very similar

```
prq <- prq.data[8:91]
f4 <- fa(prq,4)
p4 <- principal(prq,4)
 factor.congruence(f4,p4)
```

```
factor.congruence(f4,p4)
      RC1   RC2   RC4   RC3
MR1  0.99  0.15  0.20 -0.15
MR2  0.10  0.99 -0.07  0.01
MR4  0.18 -0.03  1.00  0.05
MR3 -0.19 -0.05 -0.01  1.00
```

Summary of the 4 factor solution

summary(f4)

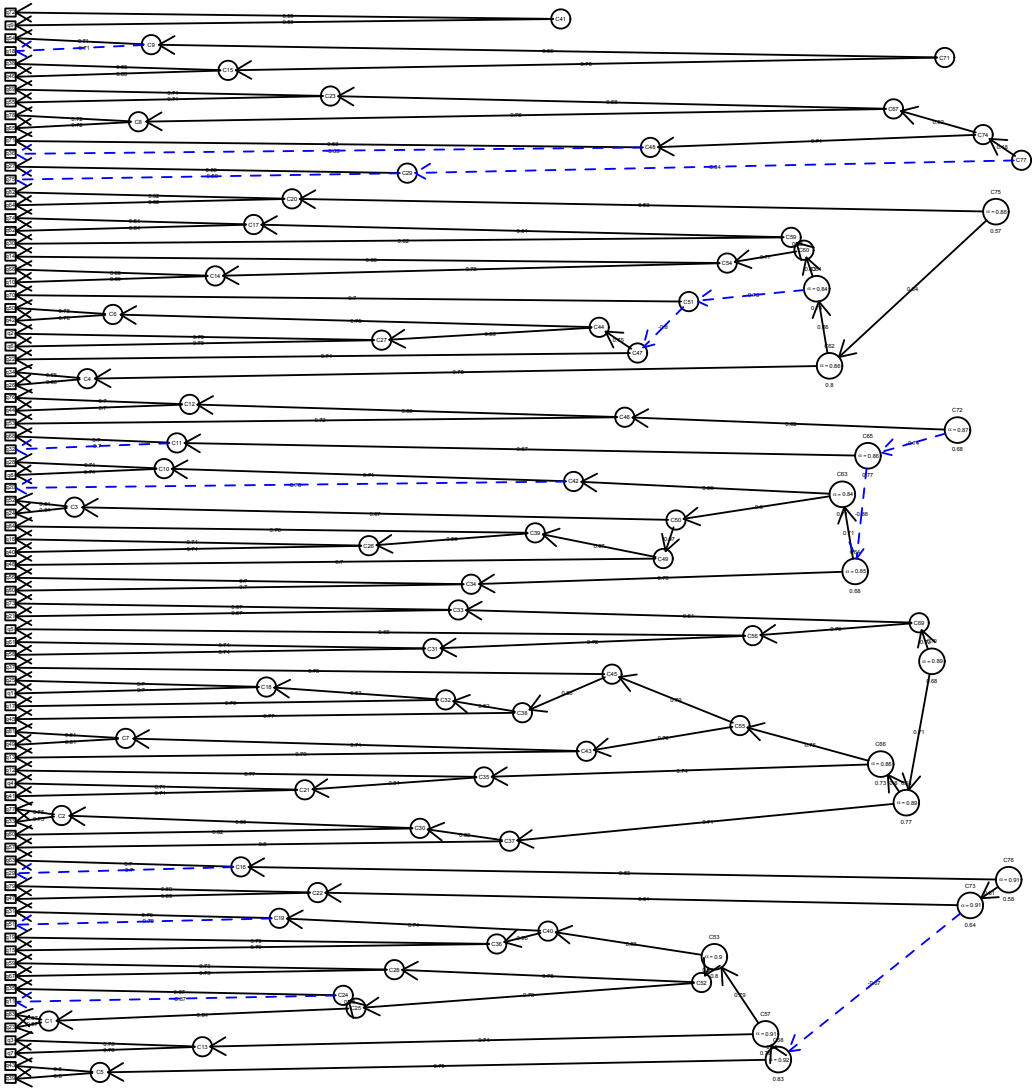
```
Factor analysis with Call: fa(r = prq, nfactors = 4)

Test of the hypothesis that 4 factors are sufficient.
The degrees of freedom for the model is 3156  and the objective function was  280.09
The number of observations was  75  with Chi Square =  11903.94  with prob <  0

The root mean square of the residuals (RMSA) is  0.09
The df corrected root mean square of the residuals is  0.1

Tucker Lewis Index of factoring reliability =  0
RMSEA index =  0.192  and the 10 % confidence intervals are  0.19 0.197
BIC =  -1722.05
 With factor correlations of
      MR1   MR2   MR4   MR3
MR1  1.00  0.15  0.18 -0.17
MR2  0.15  1.00 -0.03 -0.04
MR4  0.18 -0.03  1.00  0.01
MR3 -0.17 -0.04  0.01  1.00
```

Also try a cluster analysis

```
 ic <-  iclust(prq)
 summary(ic)
ICLUST (Item Cluster Analysis)Call: iclust(r.mat = prq)
ICLUST

Purified Alpha:
 C76  C70  C72  C75  C77  C71  C41
0.91 0.89 0.87 0.86 0.72 0.69 0.47

 Guttman Lambda6*
 C76  C70  C72  C75  C77  C71  C41
0.99 0.99 0.98 0.98 0.96 0.96 0.94

Original Beta:
 C76  C70  C72  C75  C77  C71  C41
0.58 0.68 0.68 0.57 0.45 0.58 0.47

Cluster size:
C76 C70 C72 C75 C77 C71 C41
 18  20  15  16   9   4   2

Purified scale intercorrelations
 reliabilities on diagonal
 correlations corrected for attenuation above diagonal:
      C76    C70    C72    C75    C77    C71   C41
C76  0.91 -0.318 -0.467  0.339 -0.271  0.270 -0.29
C70 -0.29  0.891 -0.042  0.013 -0.539  0.130  0.42
C72 -0.42 -0.037  0.875 -0.051  0.418  0.356 -0.37
C75  0.30  0.011 -0.044  0.859  0.134  0.437  0.13
C77 -0.22 -0.431  0.331  0.105  0.716 -0.064 -0.32
C71  0.21  0.102  0.277  0.337 -0.045  0.691 -0.35
C41 -0.19  0.272 -0.240  0.082 -0.184 -0.198  0.47
```

The cluster solution

ICLUST



Compare the solutions

factor.congruence(list(f4,p4,ic))

```
    factor.congruence(list(f4,p4,ic))
      MR1   MR2   MR4   MR3   RC1   RC2   RC4   RC3   C76   C70   C72   C75   C77   C71   C41
MR1  1.00  0.06  0.12 -0.11  0.99  0.15  0.20 -0.15 -0.93  0.30  0.52 -0.32  0.38 -0.43  0.39
MR2  0.06  1.00 -0.05  0.00  0.10  0.99 -0.07  0.01 -0.23  0.97 -0.09  0.01 -0.71  0.22  0.49
MR4  0.12 -0.05  1.00  0.02  0.18 -0.03  1.00  0.05 -0.28 -0.04  0.90 -0.01  0.40  0.58 -0.53
MR3 -0.11  0.00  0.02  1.00 -0.19 -0.05 -0.01  1.00  0.32 -0.04 -0.05  0.97  0.21  0.48  0.06
RC1  0.99  0.10  0.18 -0.19  1.00  0.19  0.26 -0.23 -0.97  0.34  0.57 -0.39  0.34 -0.41  0.36
RC2  0.15  0.99 -0.03 -0.05  0.19  1.00 -0.05 -0.04 -0.32  0.98 -0.03 -0.05 -0.68  0.16  0.52
RC4  0.20 -0.07  1.00 -0.01  0.26 -0.05  1.00  0.02 -0.35 -0.04  0.93 -0.05  0.45  0.52 -0.51
RC3 -0.15  0.01  0.05  1.00 -0.23 -0.04  0.02  1.00  0.35 -0.04 -0.05  0.98  0.20  0.52  0.03
C76 -0.93 -0.23 -0.28  0.32 -0.97 -0.32 -0.35  0.35  1.00 -0.44 -0.61  0.50 -0.22  0.32 -0.32
C70  0.30  0.97 -0.04 -0.04  0.34  0.98 -0.04 -0.04 -0.44  1.00  0.02 -0.09 -0.57  0.07  0.56
C72  0.52 -0.09  0.90 -0.05  0.57 -0.03  0.93 -0.05 -0.61  0.02  1.00 -0.16  0.52  0.26 -0.30
C75 -0.32  0.01 -0.01  0.97 -0.39 -0.05 -0.05  0.98  0.50 -0.09 -0.16  1.00  0.07  0.56 -0.01
C77  0.38 -0.71  0.40  0.21  0.34 -0.68  0.45  0.20 -0.22 -0.57  0.52  0.07  1.00 -0.02 -0.40
C71 -0.43  0.22  0.58  0.48 -0.41  0.16  0.52  0.52  0.32  0.07  0.26  0.56 -0.02  1.00 -0.33
C41  0.39  0.49 -0.53  0.06  0.36  0.52 -0.51  0.03 -0.32  0.56 -0.30 -0.01 -0.40 -0.33  1.00

>
```

Combine the factor scores with the empirical scores

```
scores.df <- data.frame(f4$scores,prq.scores$scores)
lowerCor(scores.df)
```

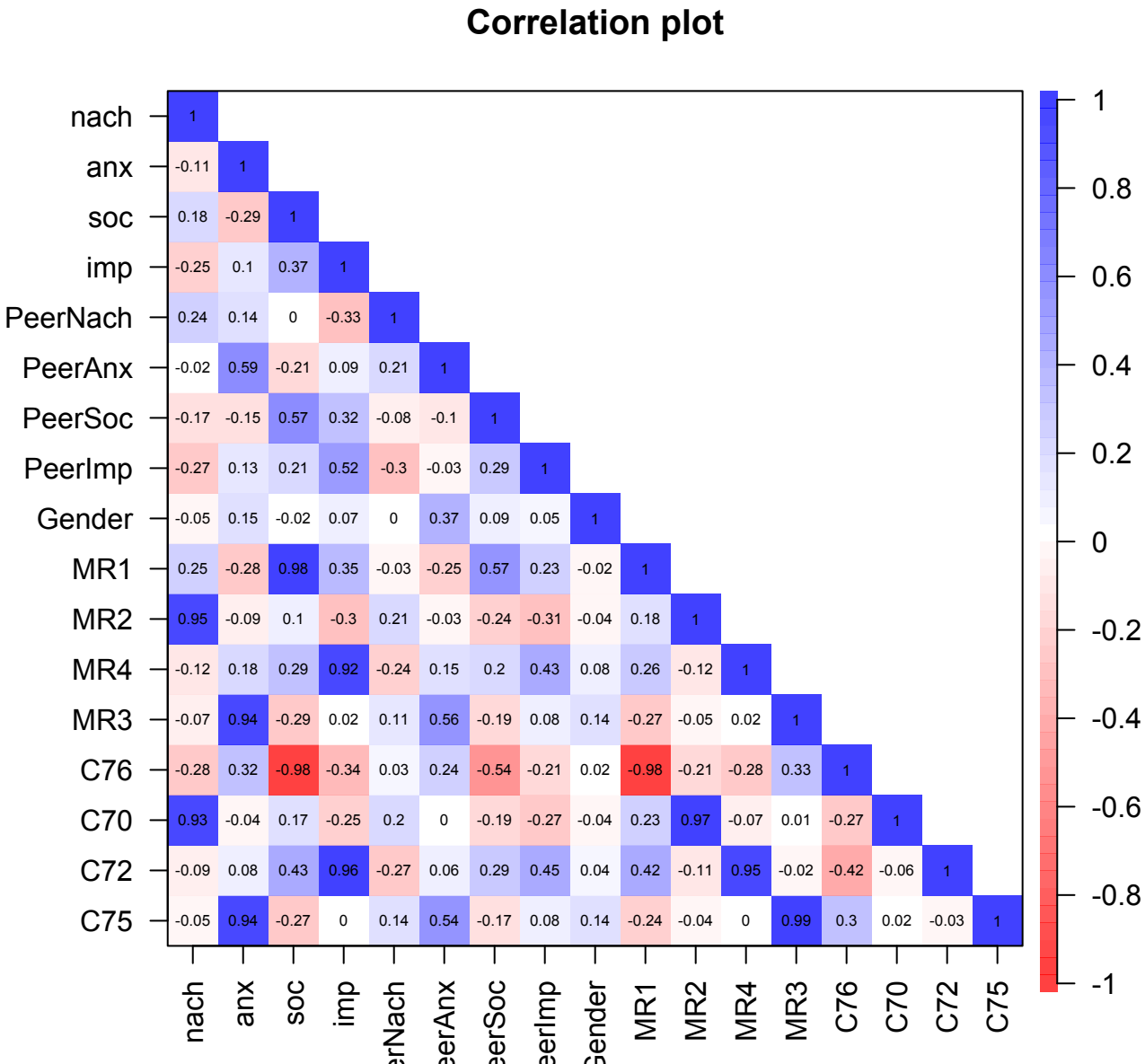
```
          MR1   MR2   MR4   MR3   nach  anx   soc   imp   PrNch PrAnx PerSc PrImp
MR1        1.00
MR2        0.16  1.00
MR4        0.20 -0.02  1.00
MR3       -0.20 -0.02  0.02  1.00
nach       0.23  0.92 -0.09 -0.13  1.00
anx       -0.27 -0.02  0.18  0.92 -0.11  1.00
soc        0.94  0.09  0.27 -0.27  0.18 -0.29  1.00
imp        0.35 -0.26  0.89  0.02 -0.25  0.10  0.37  1.00
PeerNach  -0.05  0.19 -0.22  0.06  0.24  0.14  0.00 -0.33  1.00
PeerAnx   -0.25  0.01  0.16  0.54 -0.02  0.59 -0.21  0.09  0.21  1.00
PeerSoc    0.54 -0.19  0.18 -0.12 -0.17 -0.15  0.57  0.32 -0.08 -0.10  1.00
PeerImp    0.22 -0.25  0.42  0.11 -0.27  0.13  0.21  0.52 -0.30 -0.03  0.29  1.0
Gender    -0.05 -0.04  0.10  0.13 -0.05  0.15 -0.02  0.07  0.00  0.37  0.09  0.0
```

Compare original, factors and clusters

```
fkeys <-keys2list( factor2cluster(f4))
 ckeys <- keys2list(cluster2keys(ic))
all.keys <- c(prq.keys,fkeys,ckeys)
 all.scores <- scoreItems(all.keys,prq.data)
lowerMat(all.scores$cor)
```

```
          nach  anx   soc   imp   PrNch PrAnx PerSc PrImp Gendr MR1   MR2   MR4   MR3   C76   C70   C72   C
nach       1.00
anx       -0.11  1.00
soc        0.18 -0.29  1.00
imp       -0.25  0.10  0.37  1.00
PeerNach   0.24  0.14  0.00 -0.33  1.00
PeerAnx   -0.02  0.59 -0.21  0.09  0.21  1.00
PeerSoc   -0.17 -0.15  0.57  0.32 -0.08 -0.10  1.00
PeerImp   -0.27  0.13  0.21  0.52 -0.30 -0.03  0.29  1.00
Gender    -0.05  0.15 -0.02  0.07  0.00  0.37  0.09  0.05  1.00
MR1        0.25 -0.28  0.98  0.35 -0.03 -0.25  0.57  0.23 -0.02  1.00
MR2        0.95 -0.09  0.10 -0.30  0.21 -0.03 -0.24 -0.31 -0.04  0.18  1.00
MR4       -0.12  0.18  0.29  0.92 -0.24  0.15  0.20  0.43  0.08  0.26 -0.12  1.00
MR3       -0.07  0.94 -0.29  0.02  0.11  0.56 -0.19  0.08  0.14 -0.27 -0.05  0.02  1.00
C76       -0.28  0.32 -0.98 -0.34  0.03  0.24 -0.54 -0.21  0.02 -0.98 -0.21 -0.28  0.33  1.00
C70        0.93 -0.04  0.17 -0.25  0.20  0.00 -0.19 -0.27 -0.04  0.23  0.97 -0.07  0.01 -0.27  1.00
C72       -0.09  0.08  0.43  0.96 -0.27  0.06  0.29  0.45  0.04  0.42 -0.11  0.95 -0.02 -0.42 -0.06  1.00
C75       -0.05  0.94 -0.27  0.00  0.14  0.54 -0.17  0.08  0.14 -0.24 -0.04  0.00  0.99  0.30  0.02 -0.03
C77       -0.57  0.13  0.36  0.44 -0.19  0.01  0.37  0.32  0.04  0.27 -0.59  0.34  0.13 -0.23 -0.43  0.35
C71        0.05  0.59 -0.22  0.24  0.03  0.42 -0.20  0.11  0.10 -0.24  0.09  0.51  0.36  0.21  0.10  0.27
C41        0.34 -0.02  0.15 -0.30  0.06 -0.25  0.11 -0.04 -0.18  0.26  0.28 -0.34  0.04 -0.19  0.28 -0.23
```

Correlated rational keying, peer ratings, factors and clusters



Factor 1: Sociability

Variable	MR1	MR2	MR4	MR3	com	h2	Content
q35	0.79	-0.01	0.05	-0.12	1.05	0.68	I have a large social network
q11	-0.78	-0.05	0.03	0.08	1.03	0.64	I tend to avoid social situations
q3	0.76	0.10	-0.17	0.16	1.22	0.58	I like to meet new people in everyday situations
q83	0.76	0.22	0.03	-0.13	1.22	0.73	I am a very sociable person
q39	0.72	-0.04	0.00	0.15	1.09	0.49	Id rather spend time with others than spend time alone
q23	0.71	0.11	0.08	-0.09	1.10	0.59	I make friends easily
q43	0.61	0.30	0.14	0.08	1.62	0.55	I am happier when Im around other people
q51	-0.59	-0.07	-0.15	0.13	1.25	0.46	People are more likely to initiate a conversation with me
q67	0.55	0.05	0.26	-0.07	1.49	0.44	I am always willing to attend a party
q56	0.54	-0.01	0.17	0.22	1.55	0.36	I often and actively express my feelings to those around
q59	0.53	-0.21	0.06	-0.08	1.39	0.32	I prefer large crowded parties to small intimate ones
q19	0.52	0.19	0.15	-0.14	1.62	0.44	I am good at maintaining a lively conversation
q7	0.50	0.09	-0.08	-0.02	1.12	0.27	I can easily start conversations with people I dont know
q79	-0.49	0.36	0.09	0.00	1.92	0.30	When given the choice, I will work alone rather than in
q47	-0.46	0.03	-0.14	0.08	1.26	0.26	I enjoy being alone
q71	0.41	-0.29	0.05	-0.10	1.96	0.24	I dont understand how people can spend hours in the lil
q15	0.40	-0.09	-0.06	-0.26	1.91	0.25	I tend to lead the conversation
q63	-0.38	-0.05	-0.04	0.24	1.74	0.25	A good night for me is reading a book
q9	0.27	0.27	-0.20	-0.03	2.84	0.20	I am a good multi tasker

Factor 2: Achievement Motivation

A table from the psych package in R

Variable	MR1	MR2	MR4	MR3	com	h2	Content
q81	0.13	0.74	0.12	0.03	1.12	0.61	I believe that if something is worth doing, it is worth do
q17	0.12	0.66	-0.14	0.14	1.25	0.50	I have high standards for the quality of my activity in ev
q33	0.16	0.63	0.09	0.08	1.22	0.47	I find myself needing to achieve whatever I start
q13	0.11	0.62	-0.10	0.01	1.11	0.43	I like to go the extra mile on a project or a job
q41	0.07	0.61	-0.03	-0.03	1.04	0.39	I always make sure anything attached to my name is to
q77	0.06	0.59	-0.05	0.13	1.14	0.37	I always see projects through to the finish
q4	0.03	0.58	-0.35	-0.10	1.71	0.49	I am thoughtful and deliberate when making decisions
q60	0.05	0.56	-0.06	0.05	1.05	0.33	I stay on task until a project is completed
q1	0.20	0.55	0.08	-0.15	1.48	0.42	I love to seek out new challenges
q61	0.04	0.54	-0.09	-0.05	1.09	0.32	I experience great joy when my efforts pay off and I per
q49	0.21	0.54	0.04	0.05	1.33	0.37	The joy of success is worth the hard work it takes to ge
q25	0.26	0.54	-0.07	-0.04	1.50	0.41	If I fail, I keep trying until I succeed
q73	-0.14	0.51	0.15	-0.03	1.34	0.27	I set long term and sizeable goals for myself
q78	0.19	-0.50	-0.03	0.38	2.20	0.39	I tend to back away from tasks I think are too difficult
q45	0.06	0.47	0.02	-0.11	1.14	0.25	I prefer challenging tasks to easy ones
q27	-0.29	0.46	0.13	0.01	1.89	0.25	I tend to enjoy small groups of people
q58	-0.01	0.43	0.18	0.08	1.42	0.22	I prefer to work in relaxed environments where I can tak
q69	0.29	-0.43	0.24	0.15	2.72	0.33	I tend to procrastinate and waste more time than most
q12	-0.16	0.41	-0.19	0.05	1.81	0.23	I weigh all the options carefully before making a choice
q5	-0.08	0.41	0.13	0.18	1.72	0.21	Personal satisfaction is the best reward of a job well do
q57	0.24	0.40	-0.12	-0.03	1.88	0.26	I always reach the goals I set for myself
q65	0.09	-0.39	0.10	0.32	2.21	0.27	I tend to have trouble getting motivated in my tasks
q37	0.08	0.36	0.20	-0.16	2.11	0.22	I get bored if a task is not challenging
q21	-0.09	0.33	-0.10	0.24	2.22	0.18	I am a perfectionist
q53	0.11	-0.27	0.19	0.19	3.13	0.16	I only work as hard as I have to on tasks
q75	0.16	-0.25	0.05	-0.05	1.89	0.08	I work better when there are people around
q29	0.18	0.21	0.10	-0.11	2.97	0.12	I seek the enjoyment of winning

Factor 3: Impulsivity

Variable	MR1	MR2	MR4	MR3	com	h2	Content
q24	0.12	0.04	0.71	-0.01	1.07	0.54	I often change my plans at the last minute
q40	-0.02	0.06	0.70	-0.12	1.08	0.50	I act on sudden urges
q52	0.02	-0.13	0.67	0.11	1.14	0.49	I often get sidetracked in the middle of an activity
q38	-0.35	0.10	0.60	0.15	1.82	0.45	I often have unwanted and/or disturbing thoughts
q8	0.09	-0.16	0.60	0.08	1.23	0.42	I say things that I regret later
q28	0.03	-0.18	0.56	0.08	1.26	0.36	I dislike planning ahead
q84	0.21	0.03	0.55	-0.08	1.34	0.41	I am an impulsive person
q44	0.21	-0.16	0.54	0.27	2.03	0.45	I often regret decisions because I acted too quickly
q32	0.15	0.14	0.50	0.11	1.45	0.33	I indulge in my desires on a whim
q68	-0.09	0.24	-0.49	0.04	1.56	0.32	I always think before I act
q76	0.20	0.07	0.48	0.08	1.42	0.32	I sometimes look back and dont know why I made a cer
q72	0.24	0.08	-0.48	0.24	2.08	0.29	I always stick to plans
q48	0.05	0.24	0.48	-0.19	1.88	0.33	I tend to act on my gut feelings
q16	0.34	0.11	0.45	-0.23	2.59	0.47	I tend to make decisions quickly
q20	-0.06	0.35	-0.41	0.17	2.36	0.33	I plan my activities in advance
q46	-0.30	0.16	0.38	-0.02	2.29	0.20	I often have difficulty sleeping
q80	0.30	-0.22	0.35	-0.07	2.77	0.29	I often say the first thing that comes to my mind
q54	-0.24	0.21	0.31	0.21	3.60	0.21	I feel tension in my body or face while in stressful situat
q36	-0.09	0.20	-0.22	-0.02	2.39	0.10	When working on a necessary task and a more promisin

Factor 4 Anxiety

Variable	MR1	MR2	MR4	MR3	com	h2	Content
q6	-0.13	-0.10	0.04	0.67	1.13	0.51	I dont handle stress well
q50	-0.01	0.02	0.01	0.63	1.00	0.40	Even in non stressful situations, I find things to worry a
q42	-0.16	0.02	0.06	0.63	1.15	0.45	Even trivial problems greatly contribute to my stress lev
q66	0.20	-0.07	-0.06	0.62	1.25	0.39	I worry about what others think of me
q2	-0.17	-0.15	0.00	0.60	1.30	0.47	I get nervous very easily
q10	0.02	-0.03	0.05	0.57	1.02	0.33	I am easily bothered by negative reviews
q62	0.02	0.19	-0.04	0.56	1.24	0.34	A small unpleasant event can ruin my day
q22	-0.03	0.26	-0.16	0.55	1.63	0.39	I feel stressed when I have a lot to do in a short amoun
q34	-0.11	0.26	-0.01	0.52	1.59	0.35	I have a hard time forgetting negative events
q26	-0.14	0.27	0.26	0.50	2.31	0.40	I often feel anxious about future events
q64	0.12	-0.02	-0.42	0.45	2.13	0.36	I dislike changing established plans
q31	0.33	0.11	0.26	-0.45	2.63	0.48	I tend to talk a lot in large groups
q82	0.30	-0.09	-0.08	0.45	1.94	0.24	I am more emotional than my friends
q30	-0.13	0.02	0.25	0.44	1.79	0.28	I often feel tense, nauseous, and/or faint before a big ev
q70	0.23	0.28	0.13	-0.41	2.66	0.39	I bounce back quickly from unpleasant situations
q18	0.25	-0.29	-0.28	-0.41	3.38	0.37	I rarely feel tense
q74	0.16	0.27	0.14	0.41	2.37	0.27	I tend to dwell on obstacles in the near future
q55	0.35	-0.16	0.28	0.36	3.29	0.34	Ill spend time talking to a friend even if I have somethir
q14	-0.20	-0.04	0.12	0.27	2.33	0.14	Measures of skill or intelligence make me nervous

Cluster 1

Table: Soc

Variable	C76	C70	C72	C75	Cntnt
q83	-0.83	0.37	0.30	-0.27	I am a very sociable person
q35	-0.81	0.19	0.36	-0.27	I have a large social network
q11	0.77	-0.24	-0.30	0.25	I tend to avoid social situations
q51	0.74	-0.20	-0.34	0.23	People are more likely to initiate a conversation with me than I am with t
q23	-0.71	0.28	0.36	-0.23	I make friends easily
q67	-0.68	0.20	0.42	-0.17	I am always willing to attend a party
q39	-0.67	0.14	0.27	0.01	Id rather spend time with others than spend time alone
q3	-0.67	0.27	0.15	-0.02	I like to meet new people in everyday situations
q43	-0.67	0.46	0.33	-0.08	I am happier when Im around other people
q19	-0.65	0.28	0.36	-0.19	I am good at maintaining a lively conversation
q31	-0.61	0.16	0.36	-0.44	I tend to talk a lot in large groups
q59	-0.60	-0.06	0.29	-0.13	I prefer large crowded parties to small intimate ones
q47	0.58	-0.09	-0.29	0.15	I enjoy being alone
q63	0.56	-0.16	-0.15	0.30	A good night for me is reading a book
q7	-0.53	0.21	0.14	-0.14	I can easily start conversations with people I dont know
q15	-0.49	0.01	0.11	-0.31	I tend to lead the conversation
q79	0.45	0.20	-0.15	0.09	When given the choice, I will work alone rather than in a group
q29	-0.33	0.31	0.12	-0.17	I seek the enjoyment of winning

Cluster 2

Variable	C76	C70	C72	C75	Cntnt
q81	-0.29	0.75	0.11	-0.01	I believe that if something is worth doing, it is worth doing well
q17	-0.13	0.71	-0.09	0.14	I have high standards for the quality of my activity in everyday life
q33	-0.28	0.70	0.14	0.03	I find myself needing to achieve whatever I start
q25	-0.32	0.64	0.03	-0.11	If I fail, I keep trying until I succeed
q4	-0.12	0.63	-0.38	-0.13	I am thoughtful and deliberate when making decisions
q13	-0.20	0.62	-0.10	0.01	I like to go the extra mile on a project or a job
q41	-0.20	0.61	-0.07	-0.06	I always make sure anything attached to my name is top quality
q77	-0.18	0.61	-0.06	0.12	I always see projects through to the finish
q1	-0.39	0.61	0.10	-0.14	I love to seek out new challenges
q60	-0.18	0.61	-0.07	0.06	I stay on task until a project is completed
q49	-0.29	0.60	0.09	0.03	The joy of success is worth the hard work it takes to get there
q61	-0.17	0.60	-0.12	-0.07	I experience great joy when my efforts pay off and I perform well on a tasl
q73	-0.06	0.54	0.01	-0.01	I set long term and sizeable goals for myself
q45	-0.12	0.52	0.07	-0.08	I prefer challenging tasks to easy ones
q57	-0.28	0.51	-0.01	-0.06	I always reach the goals I set for myself
q12	0.16	0.46	-0.34	0.02	I weigh all the options carefully before making a choice
q58	-0.11	0.44	0.10	0.07	I prefer to work in relaxed environments where I can take my time
q37	-0.21	0.42	0.22	-0.16	I get bored if a task is not challenging

Cluster 3

Table: Impulsivity

Variable	C76	C70	C72	C75	Cntnt
q40	-0.18	0.05	0.72	-0.08	I act on sudden urges
q24	-0.28	0.08	0.71	-0.06	I often change my plans at the last minute
q8	-0.18	-0.12	0.68	0.05	I say things that I regret later
q84	-0.33	0.05	0.67	-0.13	I am an impulsive person
q28	-0.02	-0.14	0.64	0.06	I dislike planning ahead
q32	-0.23	0.14	0.63	0.07	I indulge in my desires on a whim
q52	-0.12	-0.17	0.62	0.08	I often get sidetracked in the middle of an activity
q44	-0.26	-0.11	0.61	0.21	I often regret decisions because I acted too quickly
q16	-0.53	0.17	0.59	-0.24	I tend to make decisions quickly
q76	-0.31	0.08	0.57	0.04	I sometimes look back and dont know why I made a certain decision
q80	-0.35	-0.16	0.56	-0.11	I often say the first thing that comes to my mind
q68	0.20	0.28	-0.55	0.02	I always think before I act
q56	-0.46	0.12	0.48	0.10	I often and actively express my feelings to those around me
q20	0.08	0.29	-0.47	0.20	I plan my activities in advance
q48	-0.27	0.23	0.47	-0.16	I tend to act on my gut feelings

Cluster 4

Table:

Variable	C76	C70	C72	C75	Cntnt
q42	0.28	-0.07	-0.06	0.70	Even trivial problems greatly contribute to my stress level
q6	0.34	-0.15	-0.03	0.69	I dont handle stress well
q50	0.15	0.00	0.00	0.68	Even in non stressful situations, I find things to worry about
q2	0.35	-0.19	-0.10	0.65	I get nervous very easily
q10	0.17	-0.03	0.04	0.62	I am easily bothered by negative reviews
q66	0.03	-0.01	-0.02	0.60	I worry about what others think of me
q62	0.13	0.17	-0.06	0.59	A small unpleasant event can ruin my day
q34	0.18	0.22	-0.09	0.59	I have a hard time forgetting negative events
q22	0.19	0.22	-0.20	0.58	I feel stressed when I have a lot to do in a short amount of time
q70	-0.40	0.35	0.20	-0.56	I bounce back quickly from unpleasant situations
q26	0.16	0.20	0.17	0.55	I often feel anxious about future events
q30	0.20	-0.05	0.20	0.53	I often feel tense, nauseous, and/or faint before a big event
q74	-0.12	0.25	0.12	0.44	I tend to dwell on obstacles in the near future
q82	-0.09	-0.04	0.13	0.44	I am more emotional than my friends
q64	0.18	0.03	-0.29	0.43	I dislike changing established plans
q14	0.21	-0.10	-0.01	0.35	Measures of skill or intelligence make me nervous

Cluster 4:6

Table: df2latex

Variable	C77	C71	C41	Cntnt
q69	0.72	-0.09	-0.22	I tend to procrastinate and waste more time than most of my peers
q65	0.67	0.06	-0.08	I tend to have trouble getting motivated in my tasks
q78	0.62	0.07	-0.05	I tend to back away from tasks I think are too difficult
q36	-0.57	-0.12	0.14	When working on a necessary task and a more promising option arises, I keep work
q55	0.55	0.01	-0.23	Ill spend time talking to a friend even if I have something else that needs to be do
q53	0.50	0.01	-0.18	I only work as hard as I have to on tasks
q71	0.44	-0.22	0.01	I dont understand how people can spend hours in the library alone
q27	-0.42	0.23	0.07	I tend to enjoy small groups of people
q75	0.40	0.05	0.00	I work better when there are people around
q38	0.03	0.75	-0.13	I often have unwanted and/or disturbing thoughts
q18	0.04	-0.74	0.15	I rarely feel tense
q54	0.02	0.71	-0.16	I feel tension in my body or face while in stressful situations
q46	-0.14	0.62	-0.15	I often have difficulty sleeping
q72	-0.07	-0.18	0.79	I always stick to plans
q9	-0.23	-0.15	0.77	I am a good multi tasker

Empirical scale construction

1. Identify those items that most correlate with the criteria
   - Form item composites based upon those items
2. `best.scales` will do this
   - bs <- bestScales(prq.data,criteria = c("NeedAch" , "Anxiety" , "Sociability" ,"Impulsivity", "Gender"),dictionary=prq.dictionary)

Empirical 1

```
Call = bestScales(x = prq.data, criteria = c("NeedAch", "Anxiety", "Sociability",
    "Impulsivity", "Gender"), dictionary = prq.dictionary)
The items most correlated with the criteria yield r's of
            correlation n.items
NeedAch            0.60      10
Anxiety            0.69      10
Sociability        0.64      10
Impulsivity        0.64      10
Gender             0.54      10

The best items, their correlations and content  are
NeedAch
    NeedAch Item                                                        Content
q60    0.36  q60                        I stay on task until a project is completed
q68    0.33  q68                                          I always think before I act
q13    0.32  q13                  I like to go the extra mile on a project or a job
q32   -0.31  q32                                  I indulge in my desires on a whim
q69   -0.30  q69  I tend to procrastinate and waste more time than most of my peers
q65   -0.29  q65               I tend to have trouble getting motivated in my tasks
q6     0.29   q6                                          I dont handle stress well
q80   -0.28  q80                  I often say the first thing that comes to my mind
q22    0.26  q22  I feel stressed when I have a lot to do in a short amount of time
q53   -0.25  q53                           I only work as hard as I have to on tasks
```

Empirical 2

```
Anxiety
    Anxiety Item                                                    Content
q42    0.54  q42      Even trivial problems greatly contribute to my stress level
q6     0.51   q6                                        I dont handle stress well
q18   -0.47  q18                                              I rarely feel tense
q62    0.46  q62                        A small unpleasant event can ruin my day
q63    0.35  q63                           A good night for me is reading a book
q2     0.35   q2                                        I get nervous very easily
q50    0.32  q50  Even in non stressful situations, I find things to worry about
q54    0.31  q54 I feel tension in my body or face while in stressful situations
q21    0.31  q21                                           I am a perfectionist
q44    0.30  q44            I often regret decisions because I acted too quickly
```

Empirical 3

```
Sociability
    Sociability Item                                                                  Content
q35        0.51  q35                                                I have a large social network
q39        0.46  q39                                  Id rather spend time with others than spend time alone
q3         0.45   q3                                       I like to meet new people in everyday situations
q7         0.44   q7                                 I can easily start conversations with people I dont know
q51       -0.44  q51 People are more likely to initiate a conversation with me than I am with them
q83        0.42  q83                                                    I am a very sociable person
q11       -0.41  q11                                              I tend to avoid social situations
q73       -0.40  q73                                 I set long term and sizeable goals for myself
q31        0.38  q31                                          I tend to talk a lot in large groups
q19        0.36  q19                                I am good at maintaining a lively conversation
```

Empirical 4

```
$Impulsivity
    Impulsivity Item                                                    Content
q84        0.47  q84                                        I am an impulsive person
q4        -0.46   q4                    I am thoughtful and deliberate when making decisions
q69        0.45  q69  I tend to procrastinate and waste more time than most of my peers
q32        0.41  q32                                  I indulge in my desires on a whim
q52        0.37  q52                    I often get sidetracked in the middle of an activity
q40        0.35  q40                                                I act on sudden urges
q12       -0.33  q12          I weigh all the options carefully before making a choice
q16        0.33  q16                                I tend to make decisions quickly
q20       -0.32  q20                                 I plan my activities in advance
q68       -0.30  q68                                     I always think before I act
```

Gender

```
Gender
    Gender Item                                                                  Content
q57  -0.30  q57                                                I always reach the goals I set for myself
q27   0.30  q27                                                   I tend to enjoy small groups of people
q5    0.25   q5                                       Personal satisfaction is the best reward of a job well done
q77  -0.23  q77                                                I always see projects through to the finish
q54   0.23  q54                                 I feel tension in my body or face while in stressful situations
q6    0.23   q6                                                                I dont handle stress well
q55   0.21  q55 Ill spend time talking to a friend even if I have something else that needs to be done
q42   0.21  q42                                       Even trivial problems greatly contribute to my stress level
q72  -0.21  q72                                                                I always stick to plans
q71  -0.20  q71                                 I dont understand how people can spend hours in the library alone
```

Multiple ways to construct scales

1. Rational/Theoretical
   - Learn Theory
   - Write good items
2. Homogeneous keying
   - Write good items
   - Factor/Cluster analyze
3. Empirical Keys
   - Write good items
   - Select those items that correlate with the criteria

Reliability of various ways of scoring

```
  mixed.key <- c(bs$key.list,prq.keys)
 mixed <- scoreItems(mixed.key,prq.data)
mixed
```

```
> mixed
Call: scoreItems(keys = mixed.key, items = prq.data)

(Unstandardized) Alpha:
      NeedAch Anxiety Sociability Impulsivity Gender nach  anx  soc  imp PeerNach PeerAnx PeerSoc PeerImp
alpha    0.66    0.77        0.86        0.79   0.51 0.81 0.85 0.86 0.84        1       1       1       1

Standard errors of unstandardized Alpha:
      NeedAch Anxiety Sociability Impulsivity Gender  nach   anx  soc   imp PeerNach PeerAnx PeerSoc Peerl
ASE     0.073   0.056        0.04       0.052  0.095 0.038 0.033 0.03 0.034      NaN     NaN     NaN     N

Average item correlation:
          NeedAch Anxiety Sociability Impulsivity Gender nach  anx  soc imp PeerNach PeerAnx PeerSoc Peerl
average.r    0.16    0.25        0.39        0.28  0.096 0.17 0.21 0.23 0.2      NaN     NaN     NaN     N

Median item correlation:
    NeedAch     Anxiety Sociability Impulsivity      Gender        nach         anx         soc          in
      0.162       0.226       0.436       0.302       0.094       0.222       0.230       0.265       0.24

 Guttman 6* reliability:
         NeedAch Anxiety Sociability Impulsivity Gender nach  anx  soc  imp PeerNach PeerAnx PeerSoc Peerl
Lambda.6    0.95    0.96        0.97        0.97   0.92 0.97 0.97 0.98 0.98     0.93    0.88     0.9    0.

Signal/Noise based upon av.r :
             NeedAch Anxiety Sociability Impulsivity Gender nach anx soc imp PeerNach PeerAnx PeerSoc Peer
Signal/Noise     1.9     3.3         6.4         3.9    1.1  4.4 5.5 6.4 5.3      NaN     NaN     NaN
```

Show the MMTM matrix graphically – cor.ci(mixed$scores)

```
lowerCor(mixed$scores)
            NdAch Anxty Scblt Impls Gendr nach  anx   soc   imp   PrNch PrAnx PerSc PrImp Gendr
NeedAch      1.00
Anxiety      0.19  1.00
Sociability -0.18 -0.32  1.00
Impulsivity -0.65 -0.03  0.27  1.00
Gender       0.07  0.70 -0.34  0.14  1.00
nach         0.56 -0.04  0.24 -0.30 -0.18  1.00
anx          0.16  0.89 -0.29  0.03  0.57 -0.11  1.00
soc         -0.26 -0.32  0.91  0.34 -0.39  0.16 -0.27  1.00
imp         -0.66  0.07  0.32  0.94  0.19 -0.25  0.10  0.38  1.00
PeerNach     0.60  0.14 -0.01 -0.35  0.03  0.24  0.14  0.00 -0.33  1.00
PeerAnx      0.22  0.69 -0.22  0.01  0.62 -0.02  0.59 -0.20  0.09  0.21  1.00
PeerSoc     -0.37 -0.25  0.64  0.30 -0.21 -0.17 -0.15  0.57  0.32 -0.08 -0.10  1.00
PeerImp     -0.42  0.02  0.17  0.64  0.13 -0.27  0.13  0.21  0.52 -0.30 -0.03  0.29  1.00
Gender       0.01  0.19  0.02  0.11  0.51 -0.05  0.15 -0.01  0.07  0.00  0.37  0.09  0.05  1.00
```

10 steps: Reprise

1. Specify your theory of relevant constructs
2. Define the population of interest
3. Give items to engaged subjects
4. Enter the data (carefully)
5. Descriptives to double check data entry and subject engagement
6. Find the variance/covariance matrix
7. Reduce its dimensionality through FA, PC, or clustering
8. Score composites (classical or IRT based)
9. Discriminant validity versus other constructs
10. Convergent validity with similar constructs and different methods

Methods of scale construction

1. Empirical
   - MMPI
   - Strong Vocational Interest Blank
2. Rational
   - California Psychological Inventory
3. Theoretical
   - Measures of Need Achievement (e.g., Jackson PI)
4. Homegeneous keying
   - Eysenck Personality Inventory
   - NEO
   - BFI
   - TIPI

Empirical

1. Ask items that discriminate known groups
   - People in general versus specific group
   - Choose items that are maximally independent and that have highest validities
2. Example:
   - MMPI
   - Strong-Campbell
   - sex and ethnic differences in personality and music
3. Problem:
   - What is the meaning of the scale?
   - Need to develop new scale for every new group

Early examples of SAPA analysis

1. Development of SAPA reported by Revelle, Wilt & Rosenthal (2010)
2. Work on music preference by Mellissa Liebert as an honors thesis
3. Other work on Honesty, (Trust Evans & Revelle, 2008), RWA

Sex differences at item level

Item	effect size
Get overwhelmed by emotions.	0.59
Sympathize with others' feelings.	0.45
Worry about things.	0.43
Feel others' emotions.	0.39
Get stressed out easily.	0.51
Have a soft heart.	0.38
Panic easily	0.50
Inquire about others' well-being.	0.41
Get upset by unpleasant thoughts that come into my mind.	0.38
Get upset easily.	0.37
Am indifferent to the feelings of others.	-0.33
Am not interested in other people's problems.	-0.33
Feel little concern for others.	-0.35
Am not easily bothered by things	-0.35
Love to help others.	0.34
Am not really interested in others.	-0.32
Think of others first.	0.30
Take offense easily.	0.29
Take time out for others.	0.33

Sex differences and music preference

effect size	Item
0.9	Broadway Musicals (e.g. Rent, Cats, Phantom of the Opera)
0.68	Top 40/Pop Vocal Music (e.g. Kelly Clarkson, Madonna, The Black Eyed Peas)
0.65	Broadway, Movie and TV Soundtrack Music in General
0.59	Contemporary Rhythm and Blues (e. g. Whitney Houston, Usher, Alicia Keys)
0.59	Modern Country Music (e.g. Garth Brooks, Dixie Chicks, Tim McGraw)
0.37	Country Music in General
0.37	Movie Soundtracks (e.g. Starwars, Good Will Hunting, Garden State)
0.36	Top 40 Music/Pop in General
0.32	Pop Rock (e.g. Maroon 5, Counting Crows, John Mayer)
0.31	Modern Religious Music (e.g. 4Him, Casting Crowns)
0.3	Soul Rock (e.g. Stevie Wonder, Earth Wind and Fire)
-0.3	Acid Rock (e.g. Pink Floyd, The Doors, Jefferson Airplane)
-0.4	Heavy Metal (e.g. Metallica, Marilyn Manson, System of a Down)

Ethnic differences and music preference

effect size	Item
1.26	Acid Rock (e.g. Pink Floyd, The Doors, Jefferson Airplane)
1	Alternative (e.g. Pearl Jam, Incubus, Radiohead)
0.97	Electronic Music in General
0.91	Rock Music In General
0.87	Jam Bands (e.g. The Grateful Dead, Phish, String Cheese Incident)
0.87	Classic Rock (e.g. The Beatles, The Rolling Stones, Led Zeppelin)
0.85	Country Rock (e.g. The Allman Brothers, Lynyrd Skynyrd)
0.61	Electronic Dance Music (e.g. DJ Tiesto, Paul Van Dyk, Keoki)
0.59	Folk Music in General (e.g. Bob Dylan, Iron and Wine, Simon and Garfunkel)
0.57	Pop Rock (e.g. Maroon 5, Counting Crows, John Mayer)
0.56	Country Music in General
0.51	Bluegrass (e.g. Alison Krauss, Lester Flatt, Nickel Creek)
-0.56	Contemporary Rhythm and Blues (e. g. Whitney Houston, Usher, Alicia Keys)
-0.6	Blues in General (e.g. Ray Charles, Stevie Ray Vaughn, B.B. King)
-0.63	Instrumental Hip-Hop (e.g. DJ Hi-Tek, RJD2, Prefuse 73)
-0.64	Gospel Soul (e.g. Aretha Franklin, Solomon Burke)
-0.67	Soul in General (e.g. Otis Redding, Marvin Gaye)
-0.84	Religious Music in General
-1.04	Soul Rock (e.g. Stevie Wonder, Earth Wind and Fire)
-1.11	Rhythm and Blues in General
-1.43	Religious Gospel (e.g. Andre Crouch, Gospel Quartet)

Rational Keying

1. Ask items with direct content relevance
2. Example: California Psychological Inventory
3. Problems
   - Not all items predict in obvious way
   - Need evidence for validity
   - Easy to fake

Theoretical Keying

1. Ask items with theoretical relevance
2. Example: Jackson Personality Research Form
3. Problems:
   - Theoretical circularity
   - Need evidence for validity

Homogeneous Keying

1. Select items to represent single domain
2. Exclude items based upon internal consistency
3. Examples:
   - 16PF
   - EPI/EPQ,
   - NEO/NEO-PIR
4. Problems
   - Garbage In, Garbage Out
   - Need evidence for validity

Methods of Homogeneous keying

1. Cluster analysis (e.g. `iclust`)
2. Principal Components analysis (e.g., `pca`)
3. Factor analysis (e.g., `fa`)

The Hase and Goldberg and Goldberg studies

1. Hase and Goldberg: a direct comparison of different techniques
   - Differential validity of scale construction
   - Factor analytic
   - Empirical Group discrimination
   - Intuitive theoretical
   - Intuitive rational
   - Stylistic-psychometric
   - Random
2. 200 University Freshman women
3. CPI items and 13 criteria

Hase and Goldberg: 13 criteria

1. Sorority Membership
2. An experimental measure of conformity
3. Peer ratings of
   - Dominance
   - Sociability
   - Responsibility
   - Psychological Mindedness
   - Femininity
4. Peer ratings of how well known the person is
5. Average number of dates per month
6. College Grade Point Average
7. College Achievement relative to ability
8. College Major
9. College Droput

Does it make a difference?

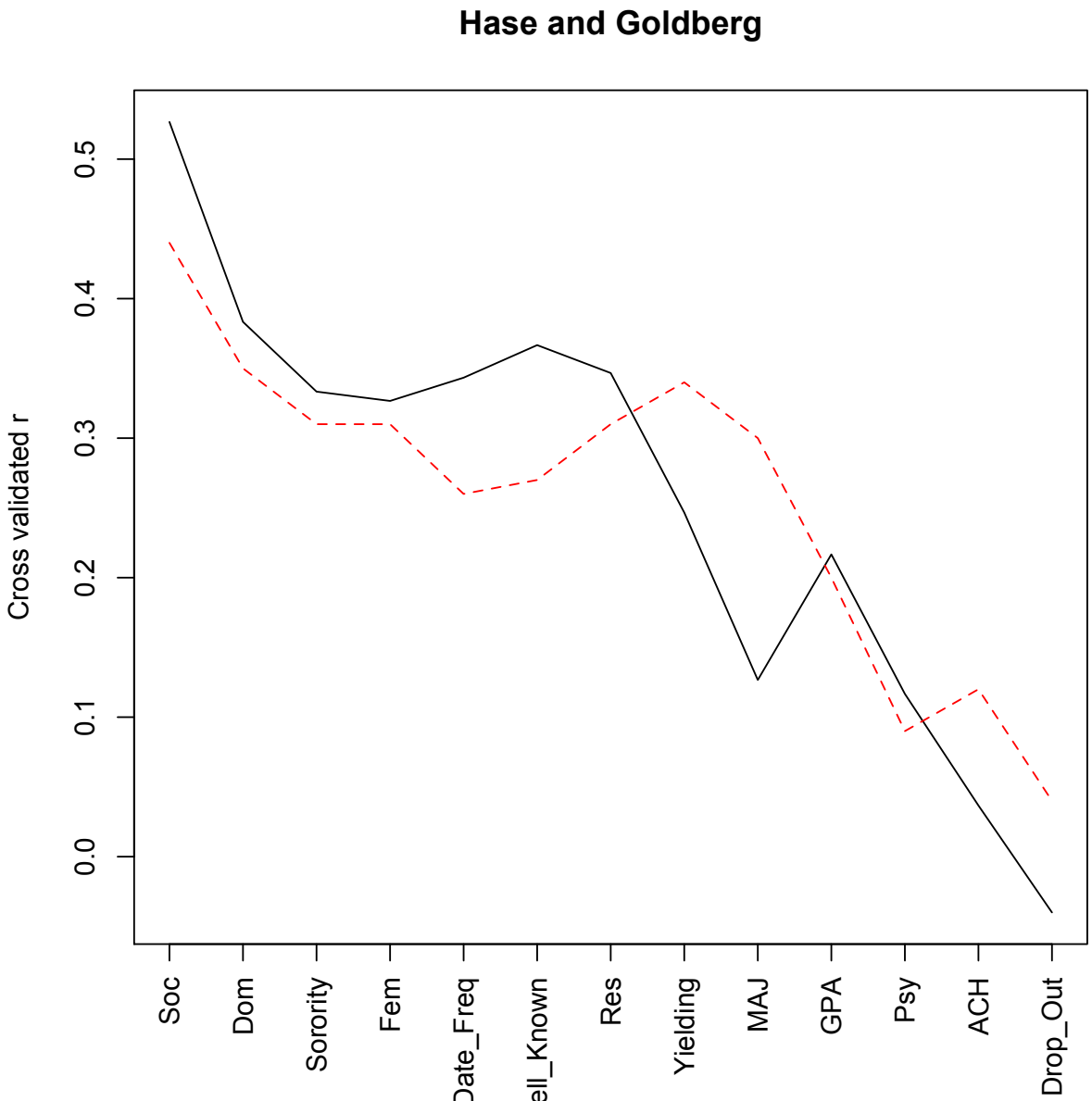
1. Hase and Goldberg (Hase & Goldberg, 1967) No
2. Goldberg (1972) YES

Hase and Goldberg; mean values)

Original Hase and Goldberg showed no difference between methods, except that stylistic and random were much worse.

	var	n	mean	sd	median	trimmed	mad	min	max	range	se
Factor	1	13	0.25	0.18	0.27	0.25	0.13	-0.05	0.57	0.62	0.05
Theoretical	2	13	0.25	0.16	0.26	0.25	0.18	0.01	0.52	0.51	0.04
Rational	3	13	0.26	0.16	0.32	0.27	0.09	-0.08	0.49	0.57	0.04
Empirical	4	13	0.26	0.11	0.30	0.26	0.06	0.04	0.44	0.40	0.03
Stylistic	5	13	0.13	0.12	0.11	0.13	0.12	-0.07	0.35	0.42	0.03
Random	6	13	0.10	0.12	0.11	0.10	0.13	-0.08	0.30	0.38	0.03

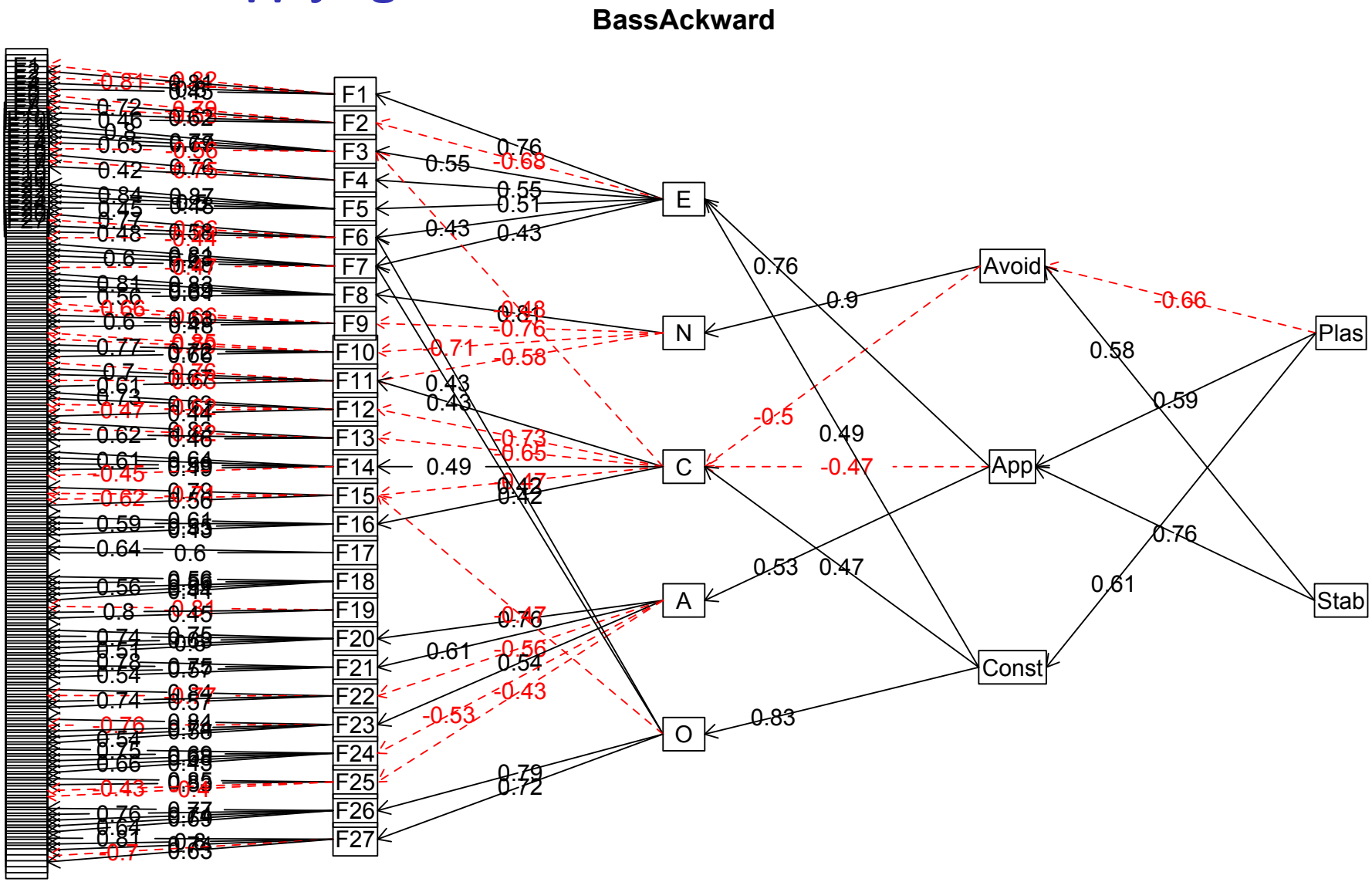
Prediction depends upon criteria: Goldberg: 72



Another factorial versus empirical example

1. Sapa Personality Inventory best 135 item (Condon (2018)
   - From 1800 IPIP items, found that 696 were most common
   - Factor structure of these 696 showed 135 very clear items
   - 5/27 factors, but not hiearchically organized
2. 4,000 subjects on spi 135 in the *psych* package
3. 135 items plus 10 criteria variables

Applying the 'Bass Ackward' function



Score the Big 5 and predict the criteria

R code

```
spi.scales <- scoreItems(spi.keys[1:5],spi)

 cor2(spi[1:10],spi.scales$scores)
```

```
          Agree Consc Neuro Extra  Open
age        0.18  0.19 -0.17 -0.02  0.13
sex        0.17  0.09  0.24  0.06 -0.15
health     0.11  0.23 -0.34  0.21  0.07
p1edu      0.02 -0.02 -0.05  0.06  0.07
p2edu      0.02 -0.04 -0.04  0.08  0.07
education  0.13  0.12 -0.17 -0.01  0.15
wellness   0.11  0.12 -0.02  0.11  0.01
exer       0.07  0.19 -0.18  0.13  0.10
smoke     -0.09 -0.11  0.06  0.06  0.09
ER        -0.03 -0.01  0.12  0.02 -0.02
```

What about multiple R

R code

```
summary(setCor(1:10,11:15,data=spi.scores.df,plot=FALSE))
```

```
 summary(setCor(1:10,11:15,data=spi.scores.df,plot=FALSE))

Multiple Regression from raw data
setCor(y = 1:10, x = 11:15, data = spi.scores.df, plot = FALSE)

Multiple Regression from matrix input

Beta weights
        age    sex  health  p1edu  p2edu education wellness    exer  smoke     ER
Agree  0.16  0.162  0.0063  0.015  0.014     0.116   0.0631 -0.0053 -0.083 -0.025
Consc  0.13  0.103  0.1715 -0.034 -0.049     0.065   0.1053  0.1613 -0.082  0.016
Neuro -0.14  0.286 -0.2721 -0.036 -0.033    -0.147   0.0302 -0.1247  0.058  0.131
Extra -0.11  0.086  0.1436  0.047  0.061    -0.086   0.0918  0.0876  0.084  0.050
Open   0.12 -0.122  0.0126  0.058  0.057     0.142   0.0031  0.0675  0.090 -0.012

Multiple R
      age       sex    health     p1edu     p2edu education  wellness      exer     smoke        ER
    0.306     0.360     0.405     0.098     0.109     0.264     0.170     0.267     0.181     0.133

Multiple R2
      age       sex    health     p1edu     p2edu education  wellness      exer     smoke        ER
   0.0939    0.1296    0.1642    0.0096    0.0118    0.0699    0.0288    0.0711    0.0329    0.0176

Cohen's set correlation R2
[1] 0.4

Squared Canonical Correlations
[1] 0.2394 0.1332 0.0620 0.0298 0.0079
```

Compare with best scales

R code

```
bs <- bestScales(spi[11:145],spi[1:10],dictionary=spi.dictionary,n.iter=20)
```

```
Call = bestScales(x = spi[11:145], criteria = spi[1:10], dictionary = spi.dictionary,
    n.iter = 20)
          derivation.mean derivation.sd validation.m validation.sd final.valid
age                  0.37         0.014        0.360         0.021        0.35
sex                  0.36         0.014        0.354         0.021        0.35
health               0.44         0.016        0.432         0.017        0.43
p1edu                0.15         0.030        0.124         0.026          NA
p2edu                0.17         0.027        0.098         0.024          NA
education            0.32         0.022        0.285         0.026        0.18
wellness             0.25         0.014        0.213         0.026        0.22
exer                 0.32         0.018        0.283         0.023        0.30
smoke                0.28         0.016        0.255         0.024        0.27
ER                   0.17         0.025        0.127         0.025        0.12

Repeat from setCor:
Multiple R
      age       sex    health     p1edu     p2edu education  wellness      exer     smoke        ER
    0.306     0.360     0.405     0.098     0.109     0.264     0.170     0.267     0.181     0.133
```

What are the items?

Criterion = age

	Freq	mean.r	sd.r	item_id	item	item_scale	resp_type
q_4296	20	-0.23	0.01	q_4296	Tell a lot of lies.	EPQ:P	reg
q_4249	20	-0.21	0.02	q_4249	Would call myself a nervous person.	EPQ:N	reg
q_501	20	-0.21	0.01	q_501	Cheat to get ahead.	IPIP	reg
q_1024	18	-0.21	0.01	q_1024	Hang around doing nothing.	IPIP	reg
q_803	19	0.20	0.02	q_803	Express myself easily.	IPIP	reg
q_1081	18	-0.20	0.01	q_1081	Have difficulty expressing my feelings.	IPIP	reg

Criterion = sex

	Freq	mean.r	sd.r	item_id	item	item_scale	resp_typ
q_1505	20	0.29	0.01	q_1505	Panic easily.	IPIP	re
q_979	20	0.29	0.01	q_979	Get overwhelmed by emotions.	IPIP	re
q_793	20	0.25	0.01	q_793	Experience my emotions intensely.	IPIP	re
q_174	20	-0.24	0.01	q_174	Am not easily affected by my emotions.	IPIP	re
q_1989	18	0.21	0.01	q_1989	Worry about things.	IPIP	re
q_851	19	0.21	0.01	q_851	Feel sympathy for those who are worse off than myself.	IPIP	re
q_1763	18	0.21	0.02	q_1763	Sympathize with others feelings.	IPIP	re
q_4252	18	0.20	0.01	q_4252	Am a worrier.	EPQ:N	re

Criterion = health

	Freq	mean.r	sd.r	item_id	item	item_scale	resp_type
q_820	20	0.35	0.02	q_820	Feel comfortable with myself.	IPIP	reg
q_2765	20	0.35	0.01	q_2765	Am happy with my life.	IPIP	reg
q_811	20	-0.34	0.01	q_811	Feel a sense of worthlessness or hopelessness.	IPIP	reg
q_578	20	-0.34	0.02	q_578	Dislike myself.	IPIP	reg
q_1371	20	0.32	0.02	q_1371	Love life.	IPIP	reg
q_56	20	0.28	0.01	q_56	Am able to control my cravings.	IPIP	reg
q_1505	20	-0.27	0.01	q_1505	Panic easily.	IPIP	reg
q_808	18	-0.26	0.02	q_808	Fear for the worst.	IPIP	reg

Validating SAPA using peer ratings (Zola, Condon & Revelle, 2021)

1. From 158,000 SAPA subjects
2. 1,554 peer reports on 921 targets
3. Asked a short form for peer ratings
4. Item by rating correlations in `zola`

The peer rating items from Zola et al. (2021)

```
$Agreeableness
        item_id                                    item
q_3837-  q_3837     Is indifferent to others feelings.
q_3838   q_3838                   Likes to help others.
q_3853-  q_3853 Tells people when they are frustrated.
q_3854   q_3854                  Is patient and polite.
$Conscientiousness
        item_id                               item
q_3845-  q_3845      Neglects their work/duties.
q_3846   q_3846                       Works hard.
q_3851-  q_3851                   Is disorganized.
q_3852   q_3852 Likes things to be  just right.
$Stability
        item_id                               item
q_3833-  q_3833          Is moody, easily upset.
q_3834   q_3834 Is composed, not easily annoyed.
q_3835-  q_3835       Is fearful, panics easily.
q_3836   q_3836        Faces danger confidently.
$Extraversion
        item_id                           item
q_3831-  q_3831 Prefers to let others lead.
q_3832   q_3832 Is assertive, takes charge.
q_3839-  q_3839 Keeps others at a distance.
q_3840   q_3840   Enjoys being with people.
$IntellectOpenness
        item_id                                  item
q_3847-  q_3847   Cant handle a lot of information.
q_3848   q_3848         Understands things quickly.
q_3849-  q_3849 Is disinterested in abstract ideas.
q_3850   q_3850  Believes in the importance of art.
$HonestyHumility
        item_id                              item
```

Multi-Trait, Multi-Method correlations

R code

```
scores <- psych::scoreOverlap(zola.keys[c(1:5,33:37)],zola)
lowerMat(scores$cor)
```

Table: The Zola et al. (2021) MTMM correlations

Variable	Agrbl	Cnscn	Nrtcs	Extrv	Opnnn	Agrbl	Cnscn	Stblt	Extrv	IntlO
Agreeableness	**1.00**									
Conscientiousness	0.28	**1.00**								
Neuroticism	-0.12	-0.18	**1.00**							
Extraversion	0.25	0.12	-0.25	**1.00**						
Openness	0.08	0.05	-0.09	0.13	**1.00**					
Agreeableness	**0.47**	0.10	-0.01	0.00	-0.09	**1.00**				
Conscientiousness	0.15	**0.55**	-0.12	-0.01	-0.04	0.18	**1.00**			
Stability	0.13	0.16	**-0.58**	0.05	0.07	0.25	0.25	**1.00**		
Extraversion	0.23	0.28	-0.27	**0.49**	0.11	0.07	0.23	0.22	**1.00**	
IntellectOpenness	0.14	0.08	-0.15	0.09	**0.30**	0.19	0.24	0.27	0.15	**1.00**

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