SNAG: Correlations

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Variables

Because correlations require observations with the same vector length, this was done for participants who have all tasks completed.

Dependent variables:

Names of variables and brief description

- SBSOD (Santa Barbara Sense of Direction scale)
- SOT (estimated angle [SOT_Angle] and angular error [SOT_Error]; if anything, just SOT_Angle is the measure we care about)
- MRM (Money Road Map)
- DSP_Wayfinding (proportion correct)
- DSP_SI (solution index strict coding)
- MAZE_Wayfinding (proportion correct)
- MAZE_Moves (number of moves during exploration)
- LOOP_MeanPositionErr (averge meters across 3 radii)
- LOOP_PositionPSTD (average PSTD for position error across 3 radii)
- LOOP_MeanDegrees (average degrees across 3 radii)
- LOOP_DegreesPSTD (average PSTD for degrees traveled across 3 radii)

Data

```
#Load data
corr_dat <- read.csv("Correlations_ALL.csv")

#Remove SubjectID column
corr_dat <- corr_dat[,c(2:13)]

#Show first 10 rows/subjects
head(corr_dat, 10)
```

```
##      SBSOD SOT_Angle SOT_Error      MRM DSP_Wayfinding     DSP_SI
## 1 3.333333  176.4167 33.583333 100.00000           0.65 0.15384615
## 2 4.200000  170.0833 30.250000 100.00000           0.60 0.25000000
## 3 5.400000  198.4167 74.750000  80.00000           0.75 0.00000000
## 4 4.066667  182.7500 24.750000 100.00000           0.65 0.23076923
```

```
## 5   6.000000  180.4167 31.083333  75.00000            0.60 0.08333333
## 6   6.400000  209.5000 35.500000  94.11765            1.00 0.20000000
## 7   6.533333  194.7500 10.250000 100.00000            0.75 0.20000000
## 8   4.333333  194.3333  9.166667 100.00000            0.65 0.15384615
## 9   5.600000  182.5833 17.750000 100.00000            0.75 0.40000000
## 10  4.400000  179.6667 24.666667  92.85714            0.45 0.33333333
##     MAZE_Wayfinding MAZE_Moves LOOP_MeanPositionErr LOOP_PositionPSTD
## 1          0.000000        269             1.370606         0.8371334
## 2          8.333333        266             1.171936         0.7405337
## 3         20.833333        288             1.438188         0.9525353
## 4         12.500000        299             1.989072         0.9758353
## 5          4.166667        266             1.555377         1.0987158
## 6         62.500000        273             2.062230         1.1552127
## 7         12.500000        315             1.230118         0.7726145
## 8          8.333333        269             2.328188         0.8999634
## 9         29.166667        274             1.243972         0.6625947
## 10         4.166667        288             2.879014         0.8607178
##     LOOP_MeanDegrees LOOP_DegreePSTD
## 1          396.5134        35.59109
## 2          332.6236        33.17871
## 3          350.5439        37.01638
## 4          416.8381        68.13490
## 5          347.5976        69.32251
## 6          420.3662        58.15037
## 7          344.9175        44.90391
## 8          332.4740        83.55519
## 9          341.1140        41.96415
## 10         258.1615        70.45680
```

Correlation matrix with p-values

```
#Save correlation matrix into variable
res <- rcorr(as.matrix(corr_dat), type = "pearson")
res
```

```
##                        SBSOD SOT_Angle SOT_Error   MRM DSP_Wayfinding DSP_SI
## SBSOD                   1.00      0.26     -0.17  0.34           0.03   0.06
## SOT_Angle               0.26      1.00     -0.49  0.09           0.10  -0.11
## SOT_Error              -0.17     -0.49      1.00 -0.40          -0.15   0.09
## MRM                     0.34      0.09     -0.40  1.00          -0.10   0.05
## DSP_Wayfinding          0.03      0.10     -0.15 -0.10           1.00  -0.24
## DSP_SI                  0.06     -0.11      0.09  0.05          -0.24   1.00
## MAZE_Wayfinding         0.04      0.05      0.03  0.01           0.49   0.22
## MAZE_Moves             -0.17     -0.07      0.00 -0.02           0.07  -0.08
## LOOP_MeanPositionErr   -0.26     -0.29      0.21 -0.41          -0.03   0.04
## LOOP_PositionPSTD       0.00     -0.02      0.31 -0.30          -0.02  -0.08
## LOOP_MeanDegrees        0.01     -0.20      0.22  0.02          -0.03  -0.05
## LOOP_DegreePSTD        -0.02      0.04      0.06 -0.20          -0.02  -0.17
##                      MAZE_Wayfinding MAZE_Moves LOOP_MeanPositionErr
## SBSOD                           0.04      -0.17                -0.26
## SOT_Angle                       0.05      -0.07                -0.29
## SOT_Error                       0.03       0.00                 0.21
## MRM                             0.01      -0.02                -0.41
```

```
## DSP_Wayfinding               0.49      0.07              -0.03
## DSP_SI                        0.22     -0.08               0.04
## MAZE_Wayfinding               1.00      0.34               0.05
## MAZE_Moves                    0.34      1.00              -0.01
## LOOP_MeanPositionErr          0.05     -0.01               1.00
## LOOP_PositionPSTD             0.03      0.15               0.36
## LOOP_MeanDegrees             -0.10     -0.07               0.11
## LOOP_DegreePSTD              -0.11      0.08               0.39
##                  LOOP_PositionPSTD LOOP_MeanDegrees LOOP_DegreePSTD
## SBSOD                         0.00             0.01           -0.02
## SOT_Angle                    -0.02            -0.20            0.04
## SOT_Error                     0.31             0.22            0.06
## MRM                          -0.30             0.02           -0.20
## DSP_Wayfinding               -0.02            -0.03           -0.02
## DSP_SI                       -0.08            -0.05           -0.17
## MAZE_Wayfinding               0.03            -0.10           -0.11
## MAZE_Moves                    0.15            -0.07            0.08
## LOOP_MeanPositionErr          0.36             0.11            0.39
## LOOP_PositionPSTD             1.00             0.09            0.65
## LOOP_MeanDegrees              0.09             1.00            0.29
## LOOP_DegreePSTD               0.65             0.29            1.00
##
## n= 41
##
##
## P
##                  SBSOD  SOT_Angle SOT_Error MRM    DSP_Wayfinding
## SBSOD                   0.0956    0.2918    0.0281 0.8379
## SOT_Angle        0.0956           0.0010    0.5923 0.5142
## SOT_Error        0.2918 0.0010              0.0092 0.3537
## MRM              0.0281 0.5923    0.0092           0.5405
## DSP_Wayfinding   0.8379 0.5142    0.3537    0.5405
## DSP_SI           0.7162 0.4943    0.5733    0.7371 0.1342
## MAZE_Wayfinding  0.8063 0.7727    0.8722    0.9409 0.0010
## MAZE_Moves       0.3006 0.6786    0.9812    0.9087 0.6836
## LOOP_MeanPositionErr 0.0960 0.0670 0.1794   0.0085 0.8410
## LOOP_PositionPSTD 0.9822 0.8834   0.0514    0.0574 0.8863
## LOOP_MeanDegrees  0.9490 0.2160   0.1632    0.8950 0.8350
## LOOP_DegreePSTD   0.9119 0.8078   0.7185    0.2078 0.8886
##                  DSP_SI MAZE_Wayfinding MAZE_Moves
## SBSOD            0.7162 0.8063          0.3006
## SOT_Angle        0.4943 0.7727          0.6786
## SOT_Error        0.5733 0.8722          0.9812
## MRM              0.7371 0.9409          0.9087
## DSP_Wayfinding   0.1342 0.0010          0.6836
## DSP_SI                  0.1713          0.6389
## MAZE_Wayfinding  0.1713                 0.0290
## MAZE_Moves       0.6389 0.0290
## LOOP_MeanPositionErr 0.7831 0.7498      0.9660
## LOOP_PositionPSTD 0.6142 0.8523         0.3622
## LOOP_MeanDegrees  0.7433 0.5459         0.6415
## LOOP_DegreePSTD   0.2894 0.4889         0.6368
##                  LOOP_MeanPositionErr LOOP_PositionPSTD
## SBSOD            0.0960               0.9822
```

```
## SOT_Angle              0.0670                   0.8834
## SOT_Error              0.1794                   0.0514
## MRM                    0.0085                   0.0574
## DSP_Wayfinding         0.8410                   0.8863
## DSP_SI                 0.7831                   0.6142
## MAZE_Wayfinding        0.7498                   0.8523
## MAZE_Moves             0.9660                   0.3622
## LOOP_MeanPositionErr                            0.0194
## LOOP_PositionPSTD      0.0194
## LOOP_MeanDegrees       0.5112                   0.5839
## LOOP_DegreePSTD        0.0109                   0.0000
##                        LOOP_MeanDegrees LOOP_DegreePSTD
## SBSOD                  0.9490                   0.9119
## SOT_Angle              0.2160                   0.8078
## SOT_Error              0.1632                   0.7185
## MRM                    0.8950                   0.2078
## DSP_Wayfinding         0.8350                   0.8886
## DSP_SI                 0.7433                   0.2894
## MAZE_Wayfinding        0.5459                   0.4889
## MAZE_Moves             0.6415                   0.6368
## LOOP_MeanPositionErr 0.5112                     0.0109
## LOOP_PositionPSTD      0.5839                   0.0000
## LOOP_MeanDegrees                                0.0627
## LOOP_DegreePSTD        0.0627
```

Table

Formatting a correlation matrix into a table with 4 columns containing :

- Column 1 : row names (variable 1 for the correlation test)

- Column 2 : column names (variable 2 for the correlation test)

- Column 3 : the correlation coefficients

- Column 4 : the p-values of the correlations

```r
#Create function to combine coefficients and p-values

#Code modified from Reference [1] and [2]

#coeff_mat: matrix of the correlation coefficients
#p_mat : matrix of the correlation p-values

CorMat <- function(coeff_mat, p_mat) {

  #Save upper half triangle of coefficients
  #This is because the other half is redundant
  up_half <- upper.tri(coeff_mat)

  #Save into dataframe
  data.frame(

    #Variable 1
    Var1 = rownames(coeff_mat)[row(coeff_mat)[up_half]],
    #Variable 2
```

```r
    Var2 = rownames(coeff_mat)[col(coeff_mat)[up_half]],
    #Correlation coefficient
    Corr  =(coeff_mat)[up_half],
    #p-value
    p_value = p_mat[up_half]
    )
}

#Pearson correlation
res2 <- rcorr(as.matrix(corr_dat), type="pearson")

#Use function to place into table

#res2$r = correlation coefficient
#res2$P = associated p-value
CorMat(res2$r, res2$P)
```

```
##                  Var1             Var2         Corr      p_value
## 1              SBSOD        SOT_Angle  0.263770767 9.563712e-02
## 2              SBSOD        SOT_Error -0.168658749 2.918280e-01
## 3          SOT_Angle        SOT_Error -0.494369157 1.018526e-03
## 4              SBSOD              MRM  0.343019202 2.812320e-02
## 5          SOT_Angle              MRM  0.086136315 5.923167e-01
## 6          SOT_Error              MRM -0.401691924 9.235629e-03
## 7              SBSOD   DSP_Wayfinding  0.032965705 8.378759e-01
## 8          SOT_Angle   DSP_Wayfinding  0.104837981 5.141870e-01
## 9          SOT_Error   DSP_Wayfinding -0.148636267 3.536827e-01
## 10               MRM   DSP_Wayfinding -0.098401485 5.404848e-01
## 11             SBSOD           DSP_SI  0.058529368 7.162368e-01
## 12         SOT_Angle           DSP_SI -0.109824807 4.942615e-01
## 13         SOT_Error           DSP_SI  0.090578142 5.732941e-01
## 14               MRM           DSP_SI  0.054059111 7.371061e-01
## 15    DSP_Wayfinding           DSP_SI -0.237874042 1.342309e-01
## 16             SBSOD  MAZE_Wayfinding  0.039505760 8.062760e-01
## 17         SOT_Angle  MAZE_Wayfinding  0.046530094 7.726727e-01
## 18         SOT_Error  MAZE_Wayfinding  0.025922672 8.721881e-01
## 19               MRM  MAZE_Wayfinding  0.011938209 9.409464e-01
## 20    DSP_Wayfinding  MAZE_Wayfinding  0.494226307 1.022495e-03
## 21            DSP_SI  MAZE_Wayfinding  0.217821637 1.712813e-01
## 22             SBSOD       MAZE_Moves -0.165656040 3.006286e-01
## 23         SOT_Angle       MAZE_Moves -0.066697417 6.786351e-01
## 24         SOT_Error       MAZE_Moves -0.003798538 9.811953e-01
## 25               MRM       MAZE_Moves -0.018489419 9.086524e-01
## 26    DSP_Wayfinding       MAZE_Moves  0.065619856 6.835542e-01
## 27            DSP_SI       MAZE_Moves -0.075507548 6.389245e-01
## 28   MAZE_Wayfinding       MAZE_Moves  0.341227693 2.900984e-02
## 29             SBSOD LOOP_MeanPositionErr -0.263513495 9.597306e-02
## 30         SOT_Angle LOOP_MeanPositionErr -0.288827174 6.703277e-02
## 31         SOT_Error LOOP_MeanPositionErr  0.213857946 1.794002e-01
## 32               MRM LOOP_MeanPositionErr -0.405941657 8.454177e-03
## 33    DSP_Wayfinding LOOP_MeanPositionErr -0.032312093 8.410487e-01
## 34            DSP_SI LOOP_MeanPositionErr  0.044341955 7.830997e-01
## 35   MAZE_Wayfinding LOOP_MeanPositionErr  0.051367419 7.497637e-01
## 36        MAZE_Moves LOOP_MeanPositionErr -0.006878604 9.659543e-01
```

```
## 37               SBSOD    LOOP_PositionPSTD  0.003588921 9.822328e-01
## 38           SOT_Angle    LOOP_PositionPSTD -0.023630030 8.834105e-01
## 39           SOT_Error    LOOP_PositionPSTD  0.306297958 5.144967e-02
## 40                 MRM    LOOP_PositionPSTD -0.299217710 5.737083e-02
## 41       DSP_Wayfinding    LOOP_PositionPSTD -0.023047564 8.862654e-01
## 42              DSP_SI    LOOP_PositionPSTD -0.081105266 6.141921e-01
## 43      MAZE_Wayfinding    LOOP_PositionPSTD  0.029999024 8.522966e-01
## 44          MAZE_Moves    LOOP_PositionPSTD  0.146064389 3.621661e-01
## 45 LOOP_MeanPositionErr    LOOP_PositionPSTD  0.363815291 1.937290e-02
## 46               SBSOD     LOOP_MeanDegrees  0.010309374 9.489922e-01
## 47           SOT_Angle     LOOP_MeanDegrees -0.197436384 2.159621e-01
## 48           SOT_Error     LOOP_MeanDegrees  0.221908150 1.631911e-01
## 49                 MRM     LOOP_MeanDegrees  0.021257347 8.950485e-01
## 50       DSP_Wayfinding     LOOP_MeanDegrees -0.033551509 8.350344e-01
## 51              DSP_SI     LOOP_MeanDegrees -0.052743899 7.432825e-01
## 52      MAZE_Wayfinding     LOOP_MeanDegrees -0.097104093 5.458628e-01
## 53          MAZE_Moves     LOOP_MeanDegrees -0.074924274 6.415245e-01
## 54 LOOP_MeanPositionErr     LOOP_MeanDegrees  0.105585664 5.111741e-01
## 55    LOOP_PositionPSTD     LOOP_MeanDegrees  0.088090442 5.839137e-01
## 56               SBSOD     LOOP_DegreePSTD -0.017820876 9.119422e-01
## 57           SOT_Angle     LOOP_DegreePSTD  0.039178855 8.078487e-01
## 58           SOT_Error     LOOP_DegreePSTD  0.058038704 7.185179e-01
## 59                 MRM     LOOP_DegreePSTD -0.200935995 2.077690e-01
## 60       DSP_Wayfinding     LOOP_DegreePSTD -0.022564442 8.886344e-01
## 61              DSP_SI     LOOP_DegreePSTD -0.169491196 2.894180e-01
## 62      MAZE_Wayfinding     LOOP_DegreePSTD -0.111177900 4.889244e-01
## 63          MAZE_Moves     LOOP_DegreePSTD  0.075989905 6.367775e-01
## 64 LOOP_MeanPositionErr     LOOP_DegreePSTD  0.393534924 1.091006e-02
## 65    LOOP_PositionPSTD     LOOP_DegreePSTD  0.649551570 4.328181e-06
## 66     LOOP_MeanDegrees     LOOP_DegreePSTD  0.293282301 6.274341e-02
```

Visualize correlation matrix

Scatter and chart

```r
#Scatter plot, histogram, and correlation value
chart.Correlation(corr_dat, histogram=TRUE, pch=19)
```
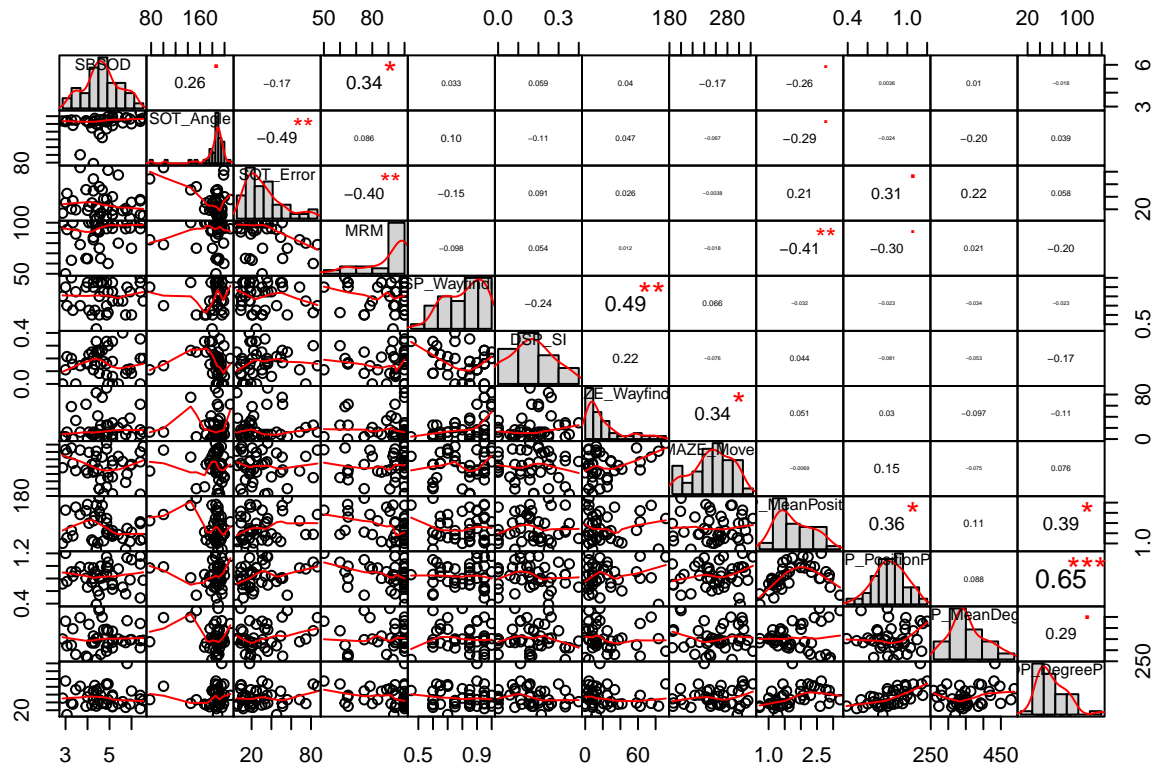
In the above plot:

- The distribution of each variable is shown on the diagonal.

- On the bottom of the diagonal : the bivariate scatter plots with a fitted line are displayed

- On the top of the diagonal : the value of the correlation plus the significance level as stars

- Each significance level is associated to a symbol : p-values(0, 0.001, 0.01, 0.05, 0.1, 1) <=> symbols(***, **, *, ., ' ')

In the pointing task (SOT), angle and error are negatively correlated. The more accurate subjects are at selecting the correct able, the less errors they make.

From the distribtion of the historgram, most subjects tend to score high on the SOT angle and on the MRM.

We can see that the wayfinding measures from DSP and MAZE are significantly positively correlated, indicating that performance in successfully and accurately completing trials are related in both tasks.

Variability in position error and degrees traveled are also significantly correlated.

Correlation

```
#Display only "upper" triangular portion to cut redundancy

corrplot(res2$r, type = "upper", order = "hclust",
         tl.col = "black", tl.srt = 45)
```
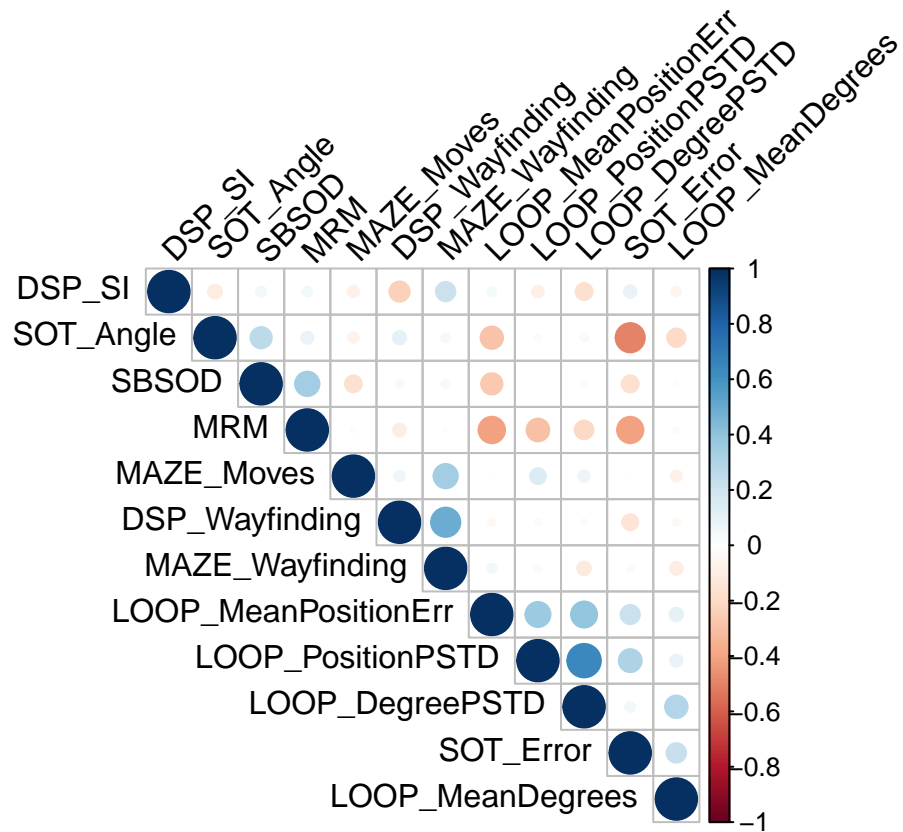
```r
#Show correlation coefficient numbers
corrplot(res2$r, method="number", number.cex=0.5)
```

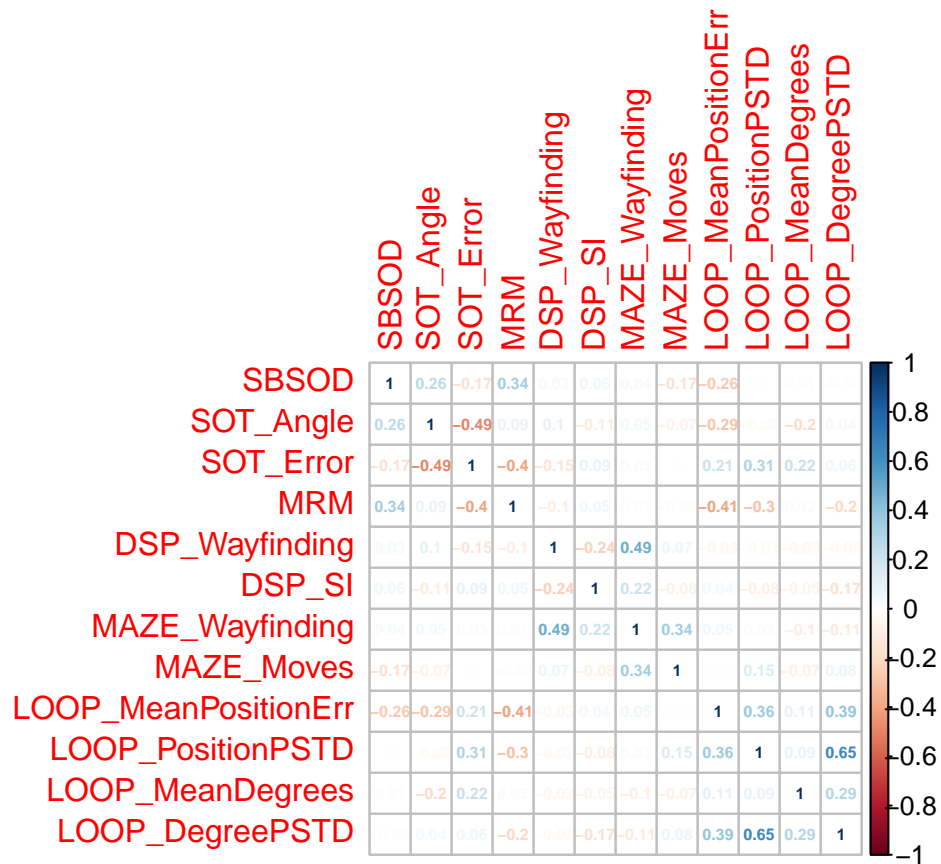|	SBSOD	SOT_Angle	SOT_Error	MRM	DSP_Wayfinding	DSP_SI	MAZE_Wayfinding	MAZE_Moves	LOOP_MeanPositionErr	LOOP_PositionPSTD	LOOP_MeanDegrees	LOOP_DegreePSTD
SBSOD	1	0.26	-0.17	0.34	0.03	0.06	0.04	-0.17	-0.26			
SOT_Angle	0.26	1	-0.49	0.09	0.1	-0.11	0.05	-0.07	-0.29		-0.2	
SOT_Error	-0.17	-0.49	1	-0.4	-0.15	0.09			0.21	0.31	0.22	0.06
MRM	0.34	0.09	-0.4	1	-0.1	0.05			-0.41	-0.3		-0.2
DSP_Wayfinding	0.03	0.1	-0.15	-0.1	1	-0.24	0.49	0.07				
DSP_SI	0.06	-0.11	0.09	0.05	-0.24	1	0.22	-0.08	-0.04	-0.08	-0.04	-0.17
MAZE_Wayfinding	0.04	0.05			0.49	0.22	1	0.34	0.05		-0.1	-0.11
MAZE_Moves	-0.17	-0.07			0.07	-0.08	0.34	1		0.15	-0.07	0.08
LOOP_MeanPositionErr	-0.26	-0.29	0.21	-0.41		-0.04	0.05		1	0.36	0.11	0.39
LOOP_PositionPSTD			0.31	-0.3		-0.08		0.15	0.36	1	0.09	0.65
LOOP_MeanDegrees		-0.2	0.22			-0.04	-0.1	-0.07	0.11	0.09	1	0.29
LOOP_DegreePSTD		0.04	0.06	-0.2		-0.17	-0.11	0.08	0.39	0.65	0.29	1

```
#Significance at p = 0.05

#Insignificant correlations are left blank
corrplot(res2$r, type="upper", order="hclust",
         p.mat = res2$P, sig.level = 0.05, insig = "blank")
```
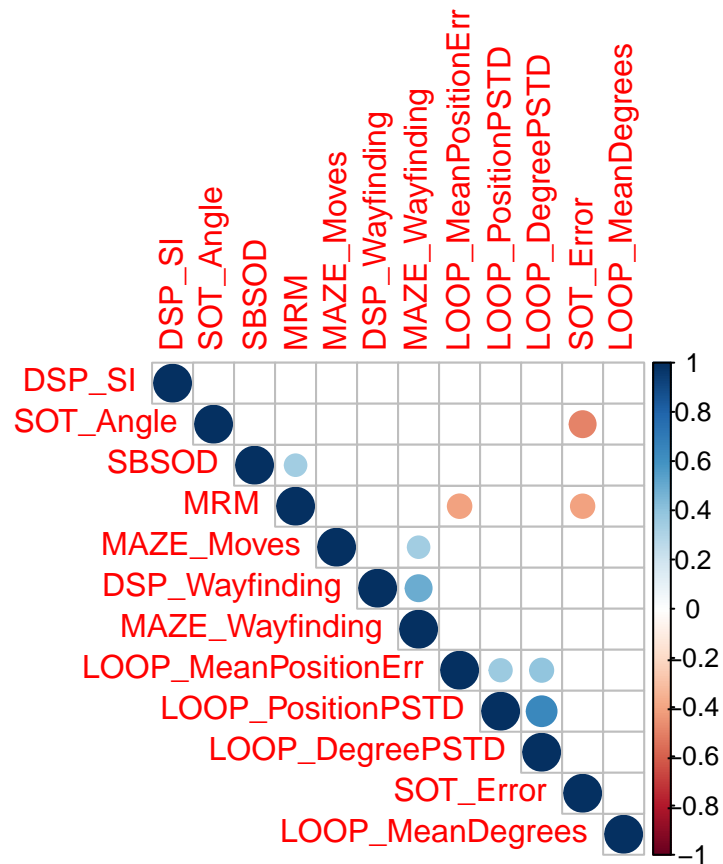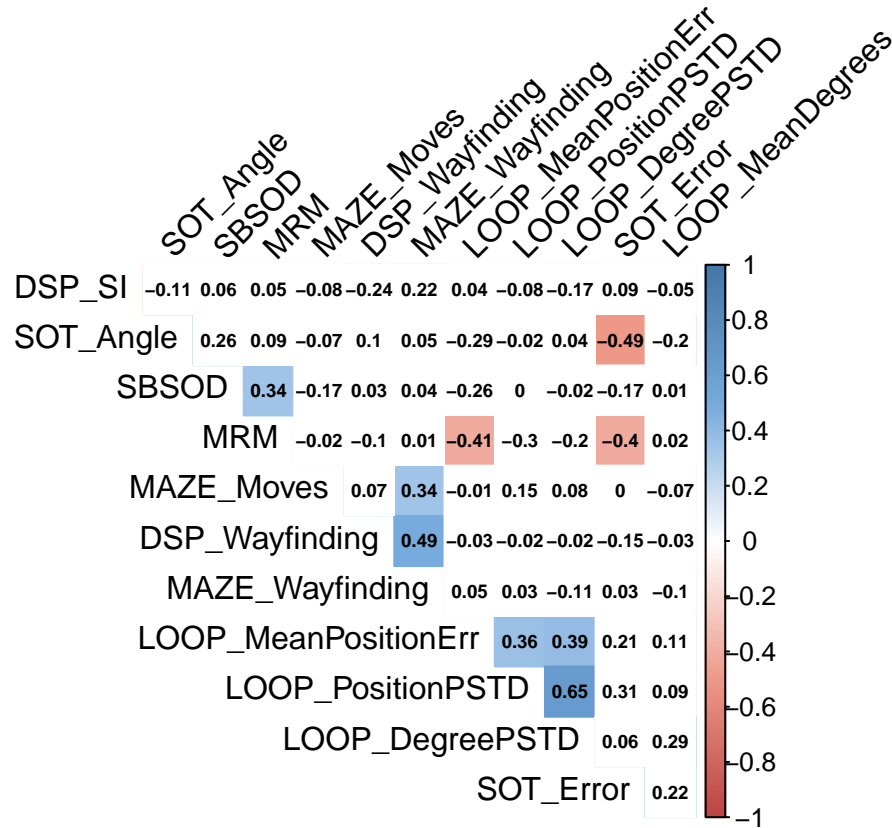
```
#Numbers are correlation coefficients
#Colored squares are those that meet significance (alpha = 0.05)

#Color palette and code taken from Reference [1] and [2]
col <- colorRampPalette(c("#BB4444", "#EE9988", "#FFFFFF", "#77AADD", "#4477AA"))

corrplot(res2$r, method="color", col=col(200),
        type="upper", order="hclust",
        #Add coefficient of correlation
        addCoef.col = "black",
        #Text label color and rotation
        tl.col="black", tl.srt=45,
        # Combine with significance
        p.mat = res2$P, sig.level = 0.05, insig = "blank", number.cex=0.6,
        #Hide correlation coefficient on the principal diagonal
        diag=FALSE
        )
```

	SOT_Angle	SBSOD	MRM	MAZE_Moves	DSP_Wayfinding	MAZE_Wayfinding	LOOP_MeanPositionErr	LOOP_PositionPSTD	LOOP_DegreePSTD	SOT_Error	LOOP_MeanDegrees
DSP_SI	-0.11	0.06	0.05	-0.08	-0.24	0.22	0.04	-0.08	-0.17	0.09	-0.05
SOT_Angle		0.26	0.09	-0.07	0.1	0.05	-0.29	-0.02	0.04	-0.49	-0.2
SBSOD			0.34	-0.17	0.03	0.04	-0.26	0	-0.02	-0.17	0.01
MRM				-0.02	-0.1	0.01	-0.41	-0.3	-0.2	-0.4	0.02
MAZE_Moves					0.07	0.34	-0.01	0.15	0.08	0	-0.07
DSP_Wayfinding						0.49	-0.03	-0.02	-0.02	-0.15	-0.03
MAZE_Wayfinding							0.05	0.03	-0.11	0.03	-0.1
LOOP_MeanPositionErr								0.36	0.39	0.21	0.11
LOOP_PositionPSTD									0.65	0.31	0.09
LOOP_DegreePSTD										0.06	0.29
SOT_Error											0.22

Positive correlations are displayed in blue and negative correlations in red color. Color intensity and the size of the circle are proportional to the correlation coefficients. On the right side of the correlogram, the legend color shows the correlation coefficients and the corresponding colors.

Overall, the DSP and MAZE wayfinding success measures are the most interesting (but expected) association. In general, there are no other major associations of interest or concern.

References

1. Correlation matrix : A quick start guide to analyze, format and visualize a correlation matrix using R softwards. http://www.sthda.com/english/wiki/correlation-matrix-a-quick-start-guide-to-analyze-format-and-visualize-a-correlation-matrix-using-r-software

2. Visualize correlation matrix using correlogram. http://www.sthda.com/english/wiki/visualize-correlation-matrix-using-correlogram