Multiple Factor Analysis (MFA) with FactoMineR on the sensory description of the wines
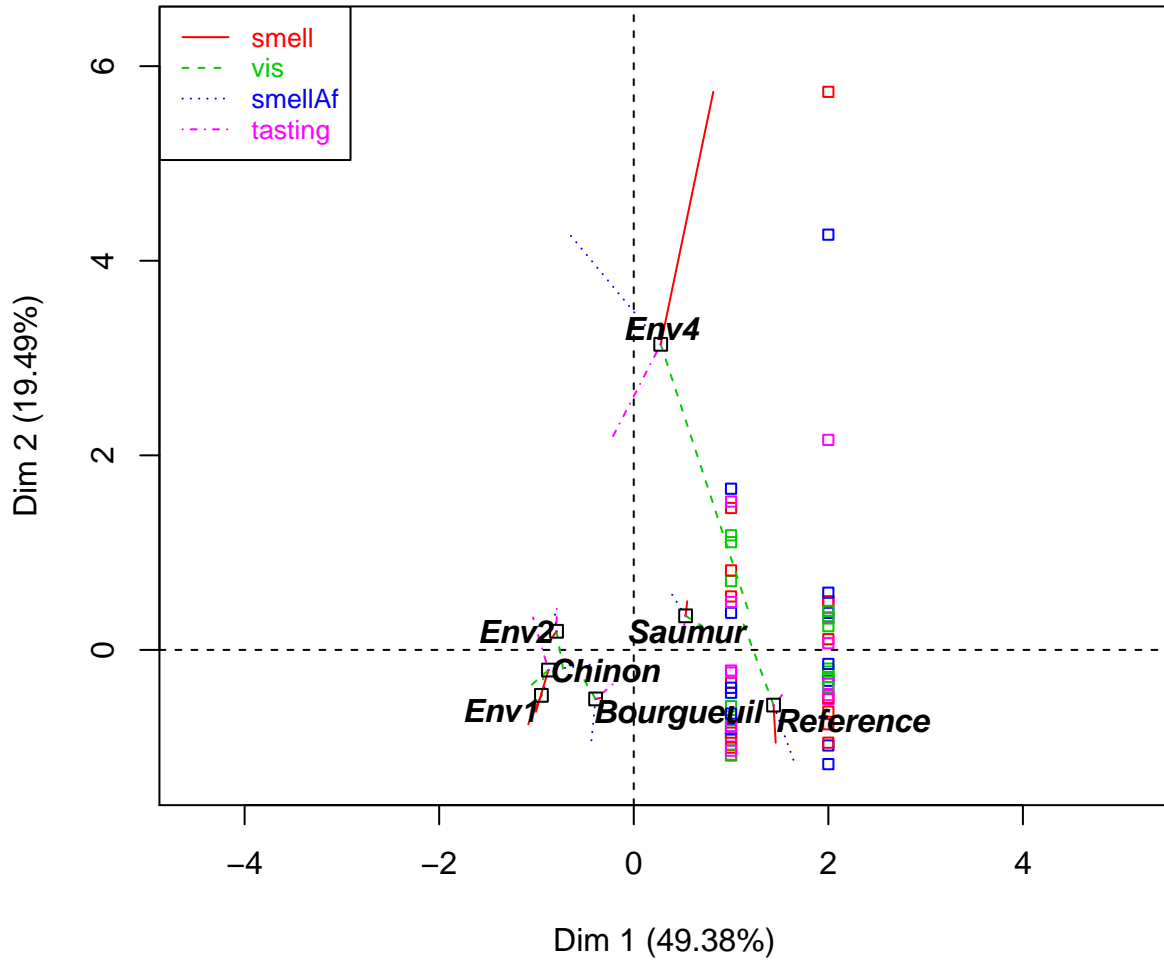
Francois Husson

Loading FactoMineR and data

```
library(FactoMineR)
data(wine)
```
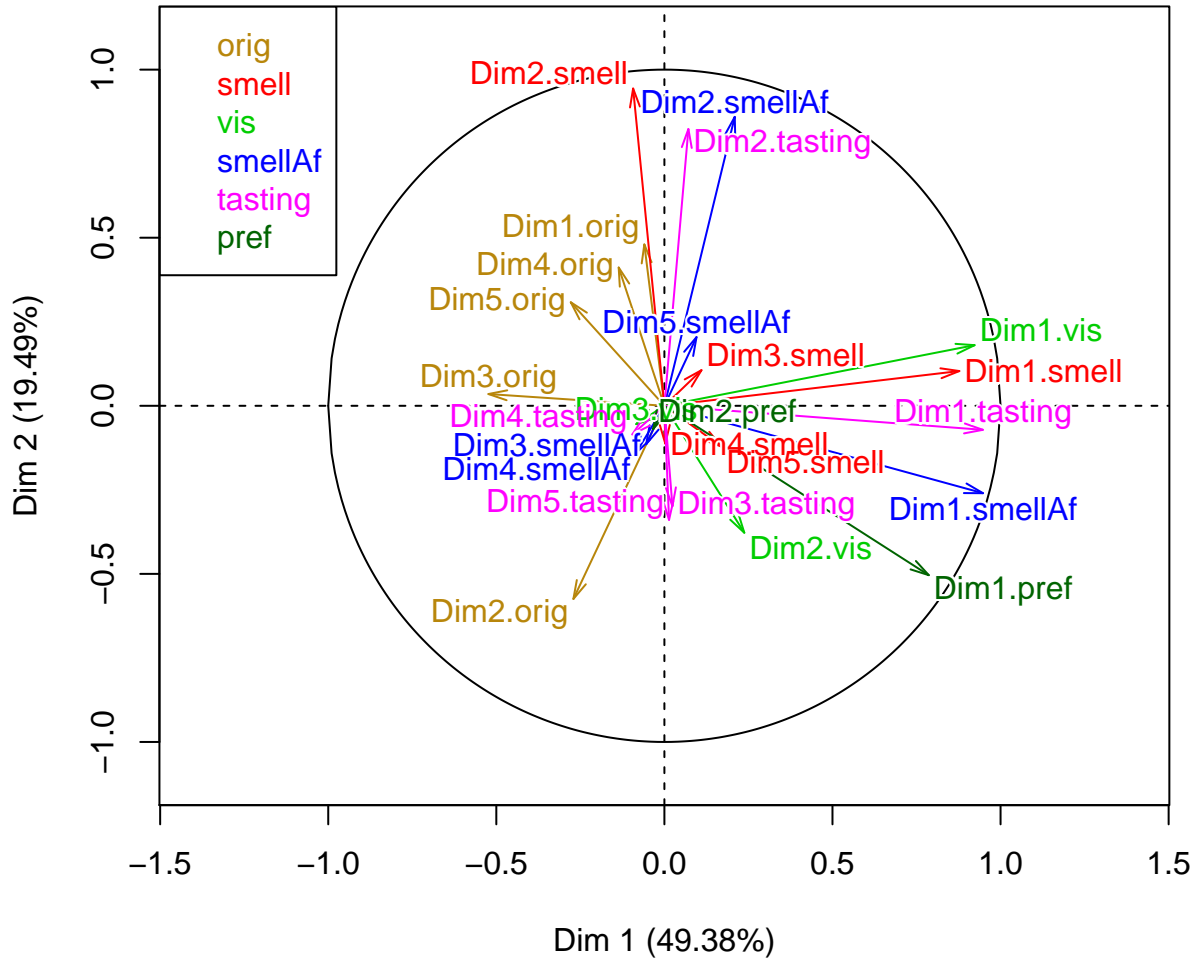
MFA

```
res <- MFA(wine, group=c(2,5,3,10,9,2), type=c("n",rep("s",5)),
    ncp=5, name.group=c("orig","smell","vis","smellAf","tasting","pref"),
    num.group.sup=c(1,6))
```
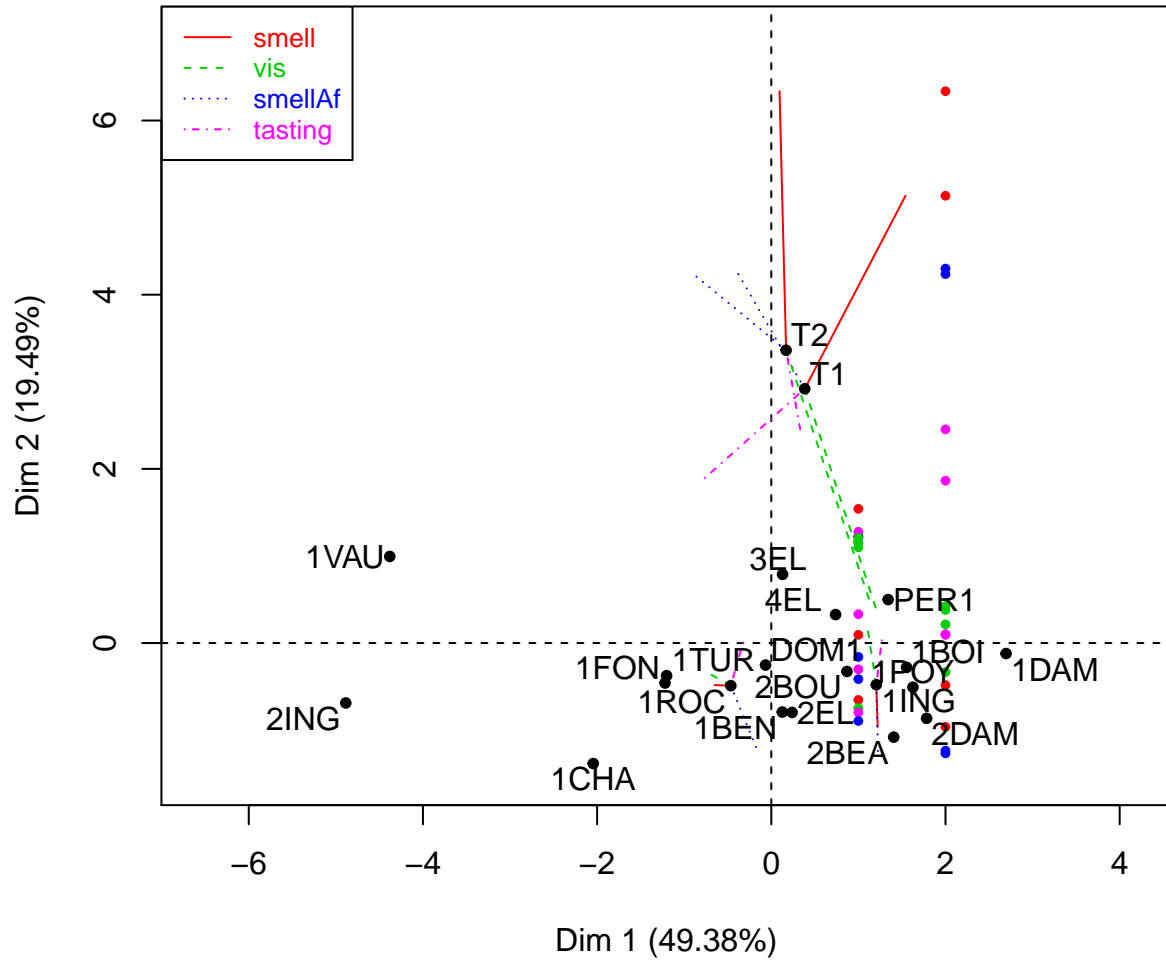
Individual factor map

Legend:
- smell (red, solid)
- vis (green, dashed)
- smellAf (blue, dotted)
- tasting (magenta, dash-dot)

Dim 2 (19.49%)

Dim 1 (49.38%)

Env4

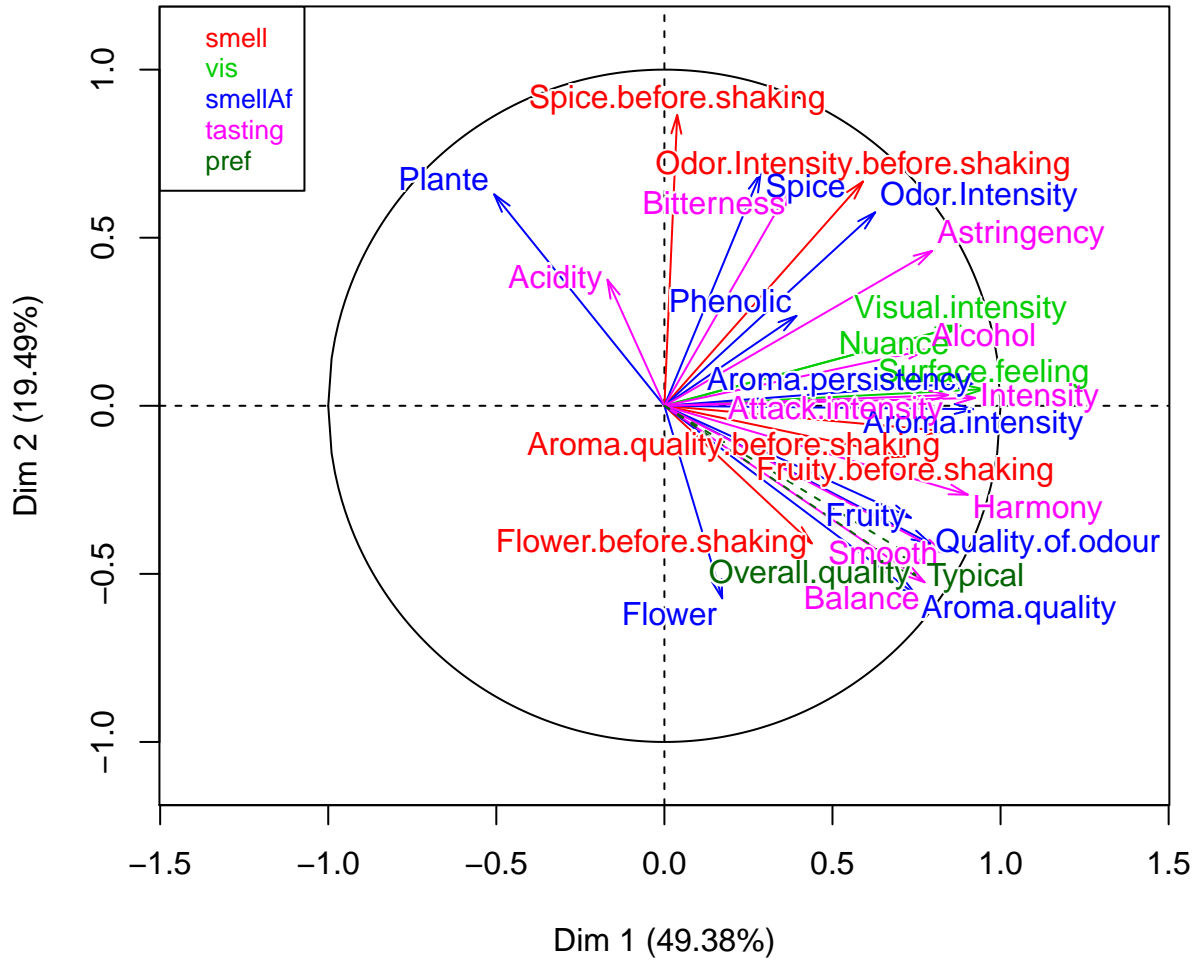Env2   Saumur

Chinon

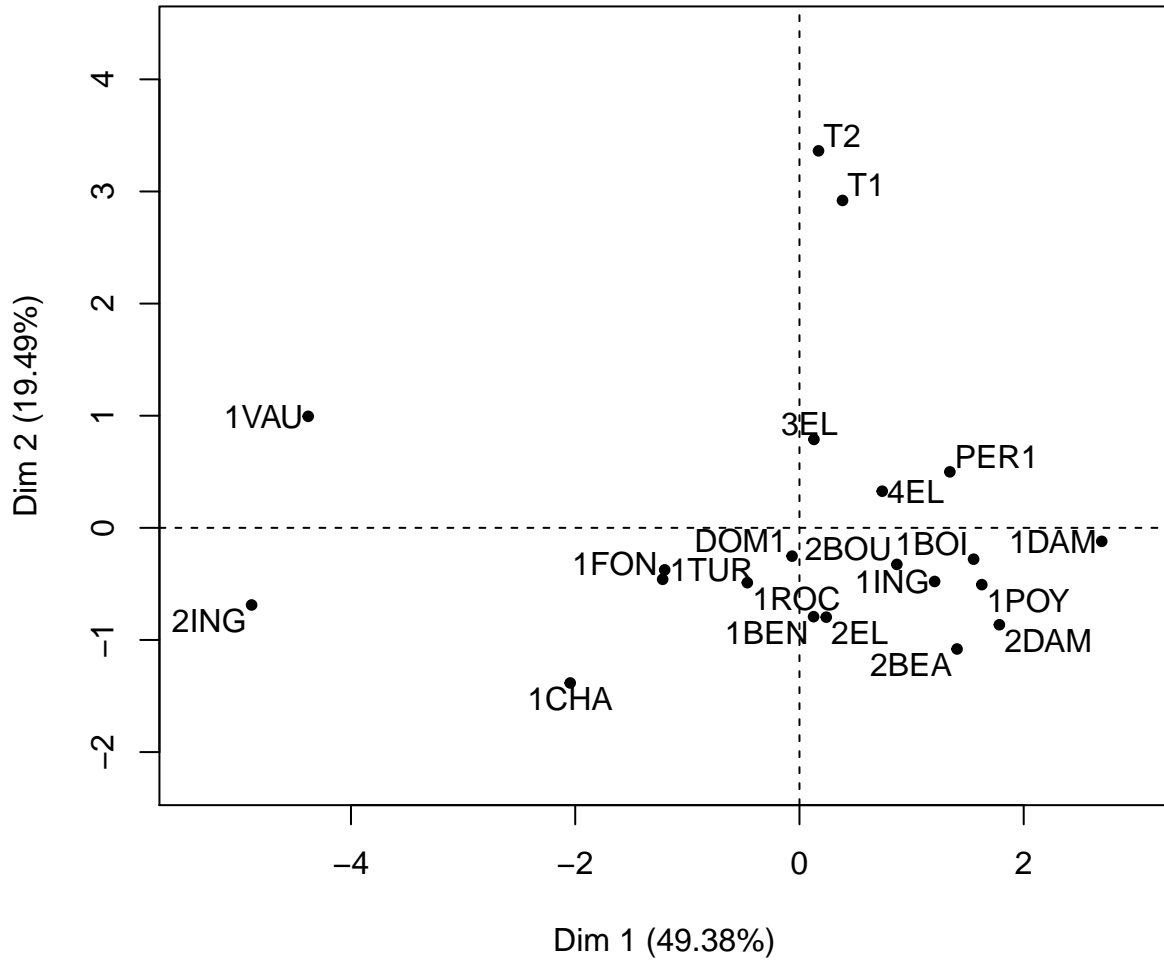Env1   Bourgueuil   Reference
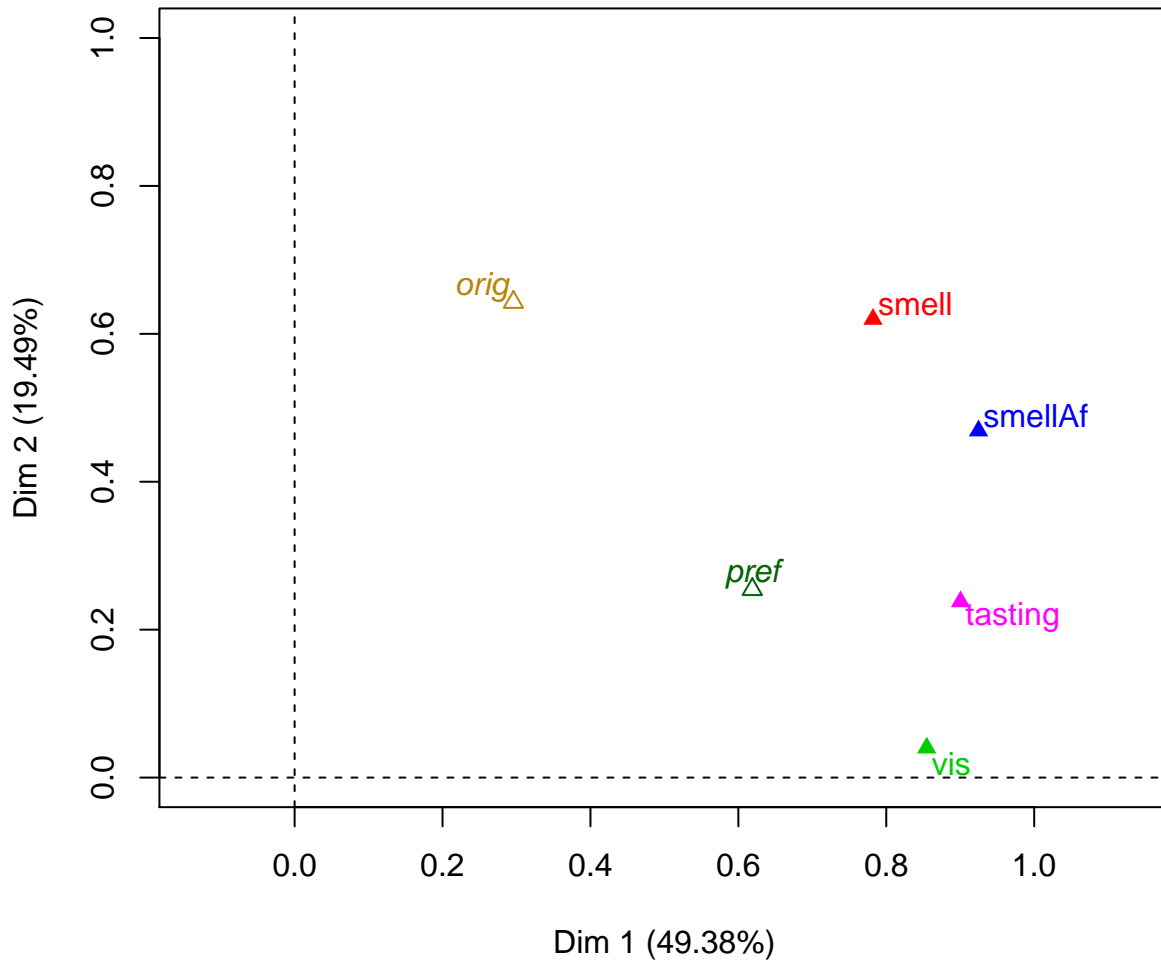
2

Partial axes

3

Individual factor map

Correlation circle

Individual factor map

Groups representation

A summary of the main results with the summary.MFA function

The `summary` function gives the main results of the MFA.

```
summary(res)
```

We just want the results on the first 2 dimensions (by default, the function returns the first 3 dimensions).

```
summary(res, ncp=2)
```

```
##
## Call:
## MFA(base = wine, group = c(2, 5, 3, 10, 9, 2), type = c("n",
##      rep("s", 5)), ncp = 5, name.group = c("orig", "smell", "vis",
##      "smellAf", "tasting", "pref"), num.group.sup = c(1, 6))
##
##
```

```
## Eigenvalues
##                        Dim.1   Dim.2   Dim.3   Dim.4   Dim.5   Dim.6
## Variance              3.462   1.367   0.615   0.372   0.270   0.202
## % of var.            49.378  19.494   8.778   5.309   3.857   2.887
## Cumulative % of var. 49.378  68.873  77.651  82.960  86.816  89.703
##                        Dim.7   Dim.8   Dim.9  Dim.10  Dim.11  Dim.12
## Variance              0.176   0.126   0.105   0.079   0.074   0.060
## % of var.             2.506   1.796   1.502   1.124   1.054   0.861
## Cumulative % of var. 92.209  94.005  95.506  96.630  97.684  98.545
##                       Dim.13  Dim.14  Dim.15  Dim.16  Dim.17  Dim.18
## Variance              0.029   0.022   0.019   0.011   0.009   0.006
## % of var.             0.409   0.313   0.273   0.156   0.131   0.091
## Cumulative % of var. 98.954  99.268  99.541  99.697  99.827  99.918
##                       Dim.19  Dim.20
## Variance              0.003   0.002
## % of var.             0.047   0.035
## Cumulative % of var. 99.965 100.000
##
## Groups
##                         Dim.1    ctr   cos2    Dim.2    ctr
## smell                |  0.782 22.591  0.380 |  0.620 45.346
## vis                  |  0.855 24.688  0.728 |  0.040  2.937
## smellAf              |  0.925 26.712  0.625 |  0.469 34.309
## tasting              |  0.900 26.009  0.722 |  0.238 17.408
##                        cos2
## smell                  0.239 |
## vis                    0.002 |
## smellAf                0.161 |
## tasting                0.050 |
##
## Supplementary groups
##                       Dim.1  cos2   Dim.2  cos2
## orig                 | 0.296 0.033 | 0.643 0.156 |
## pref                 | 0.619 0.380 | 0.254 0.064 |
##
## Individuals (the 10 first)
##                         Dim.1    ctr   cos2    Dim.2    ctr
## 2EL                  |  0.239  0.078  0.016 | -0.797  2.211
## 1CHA                 | -2.045  5.751  0.419 | -1.383  6.667
## 1FON                 | -1.220  2.048  0.367 | -0.459  0.734
## 1VAU                 | -4.381 26.404  0.874 |  0.995  3.446
## 1DAM                 |  2.696  9.996  0.754 | -0.120  0.050
## 2BOU                 |  0.869  1.038  0.219 | -0.326  0.371
## 1BOI                 |  1.553  3.318  0.617 | -0.280  0.272
## 3EL                  |  0.129  0.023  0.003 |  0.789  2.167
## DOM1                 | -0.066  0.006  0.002 | -0.253  0.222
## 1TUR                 | -1.202  1.987  0.310 | -0.375  0.489
##                        cos2
## 2EL                    0.182 |
## 1CHA                   0.192 |
## 1FON                   0.052 |
## 1VAU                   0.045 |
## 1DAM                   0.002 |
## 2BOU                   0.031 |
```

```
## 1BOI                          0.020 |
## 3EL                           0.115 |
## DOM1                          0.027 |
## 1TUR                          0.030 |
##
## Continuous variables (the 10 first)
##                               Dim.1    ctr    cos2    Dim.2    ctr
## Odor.Intensity.before.shaking |  0.591  4.497  0.349 |  0.667 14.530
## Aroma.quality.before.shaking  |  0.835  8.989  0.698 | -0.075  0.186
## Fruity.before.shaking         |  0.716  6.606  0.513 | -0.151  0.741
## Flower.before.shaking         |  0.439  2.480  0.192 | -0.409  5.469
## Spice.before.shaking          |  0.038  0.019  0.001 |  0.865 24.420
## Visual.intensity              |  0.881  7.912  0.776 |  0.238  1.466
## Nuance                        |  0.862  7.577  0.744 |  0.234  1.408
## Surface.feeling               |  0.950  9.198  0.903 |  0.049  0.063
## Odor.Intensity                |  0.627  2.416  0.393 |  0.576  5.155
## Quality.of.odour              |  0.791  3.844  0.626 | -0.410  2.612
##                                 cos2
## Odor.Intensity.before.shaking  0.445 |
## Aroma.quality.before.shaking   0.006 |
## Fruity.before.shaking          0.023 |
## Flower.before.shaking          0.168 |
## Spice.before.shaking           0.748 |
## Visual.intensity               0.057 |
## Nuance                         0.055 |
## Surface.feeling                0.002 |
## Odor.Intensity                 0.331 |
## Quality.of.odour               0.168 |
##
## Supplementary continuous variables
##                               Dim.1   cos2    Dim.2   cos2
## Overall.quality               |  0.747  0.558 | -0.504  0.254 |
## Typical                       |  0.766  0.586 | -0.466  0.217 |
##
## Supplementary categories
##                               Dim.1   cos2  v.test    Dim.2   cos2
## Saumur                        |  0.533  0.483  1.343 |  0.350  0.209
## Bourgueil                     | -0.392  0.176 -0.596 | -0.504  0.291
## Chinon                        | -0.877  0.537 -1.022 | -0.207  0.030
## Reference                     |  1.437  0.823  2.442 | -0.567  0.128
## Env1                          | -0.949  0.614 -1.613 | -0.467  0.149
## Env2                          | -0.794  0.554 -1.067 |  0.191  0.032
## Env4                          |  0.277  0.008  0.216 |  3.141  0.971
##                                 v.test
## Saumur                          1.405 |
## Bourgueil                      -1.219 |
## Chinon                         -0.384 |
## Reference                      -1.534 |
## Env1                           -1.263 |
## Env2                            0.409 |
## Env4                            3.899 |
```
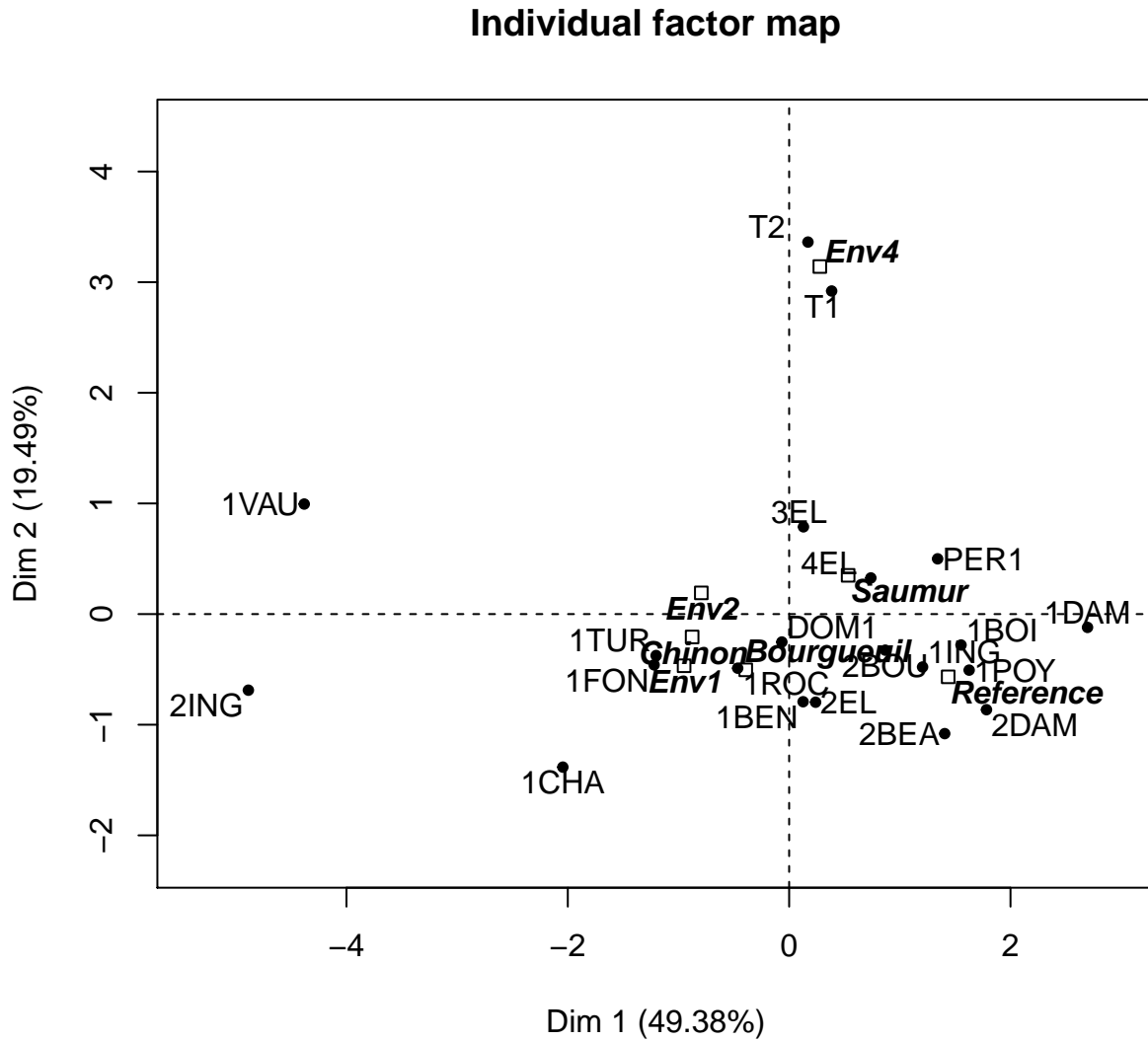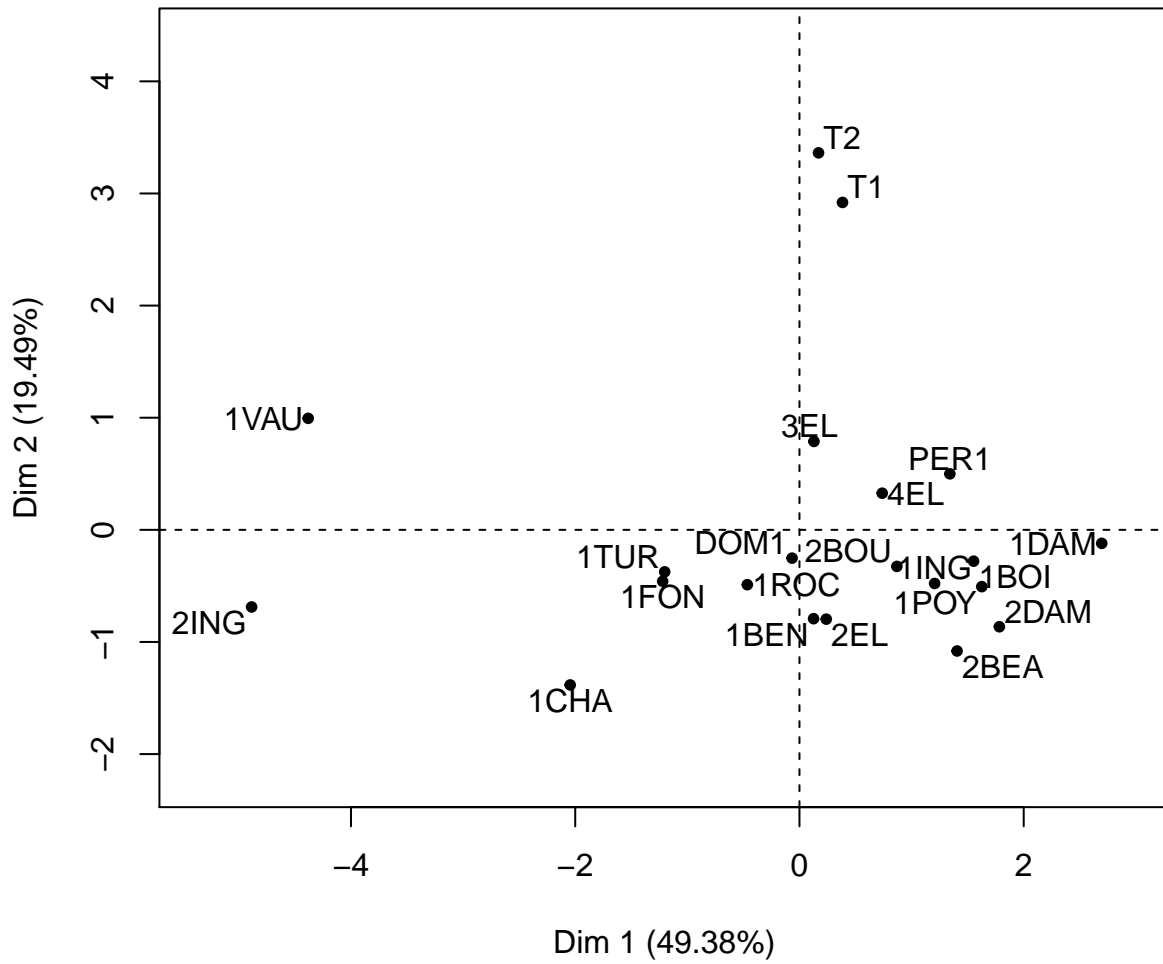
Graph of the individuals and the categories
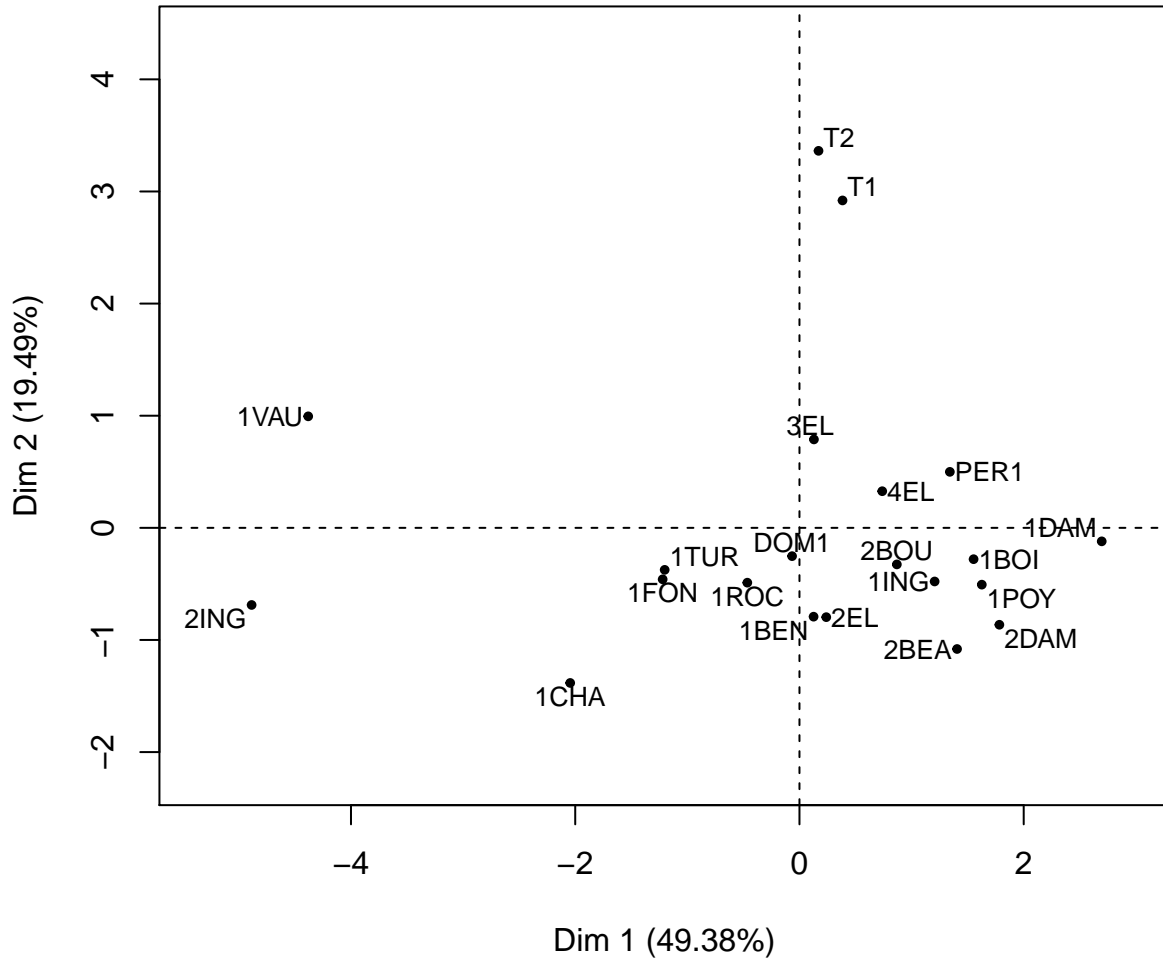
```
plot(res)
```

Individual factor map


```
plot(res, invisible="quali")
```

Individual factor map

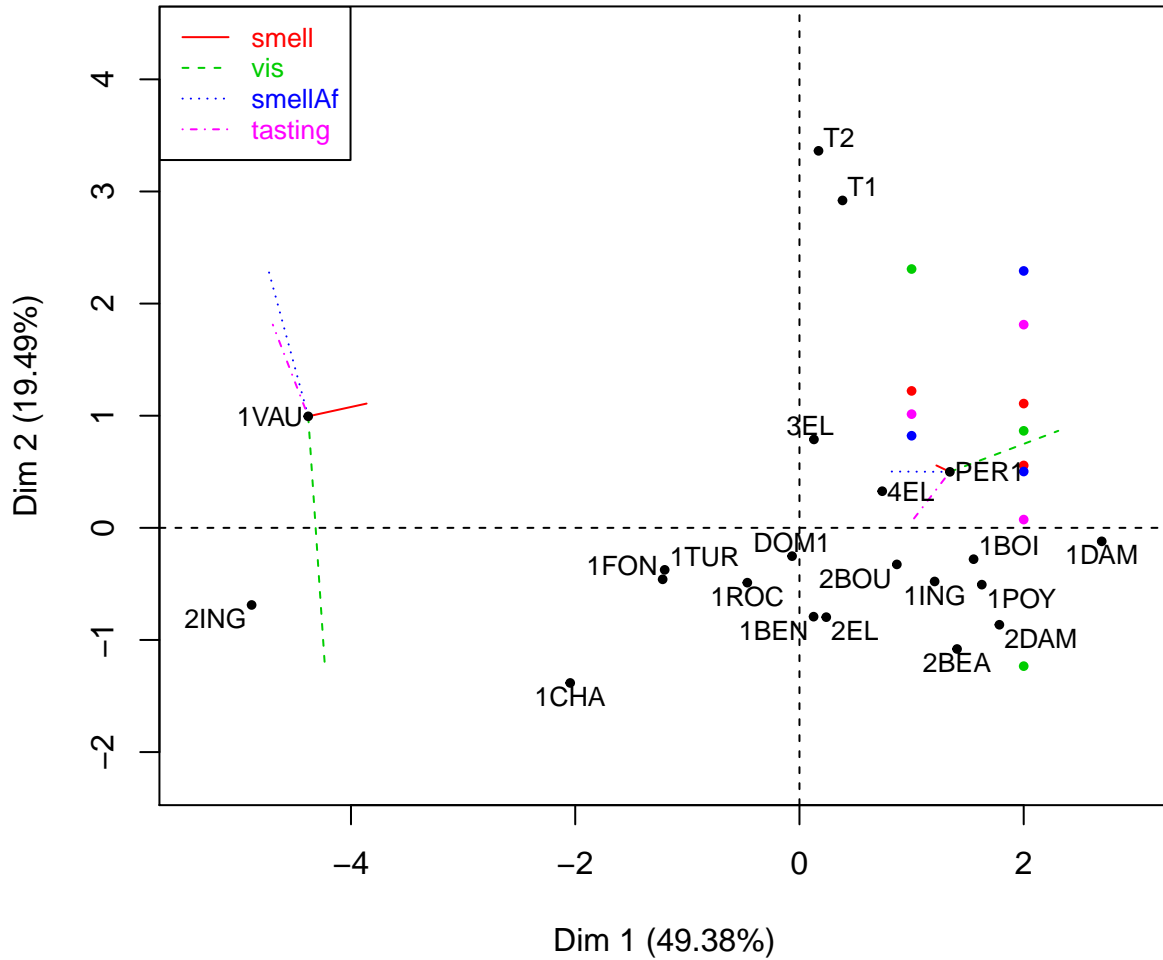```
plot(res, invisible="quali", cex=0.8)
```

# Individual factor map



```
plot(res, invisible="quali", cex=0.8, partial=c("1VAU","PER1"))
```
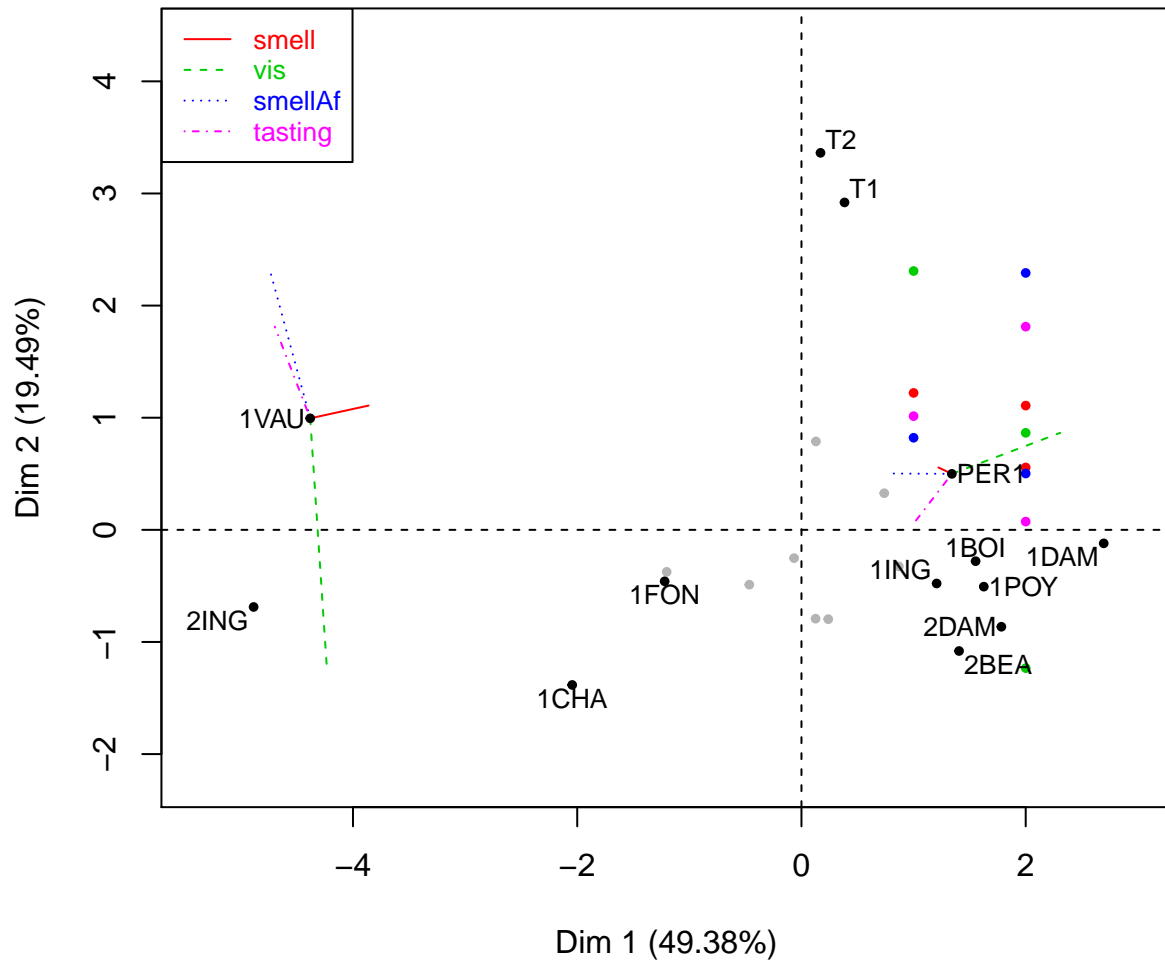
## Individual factor map



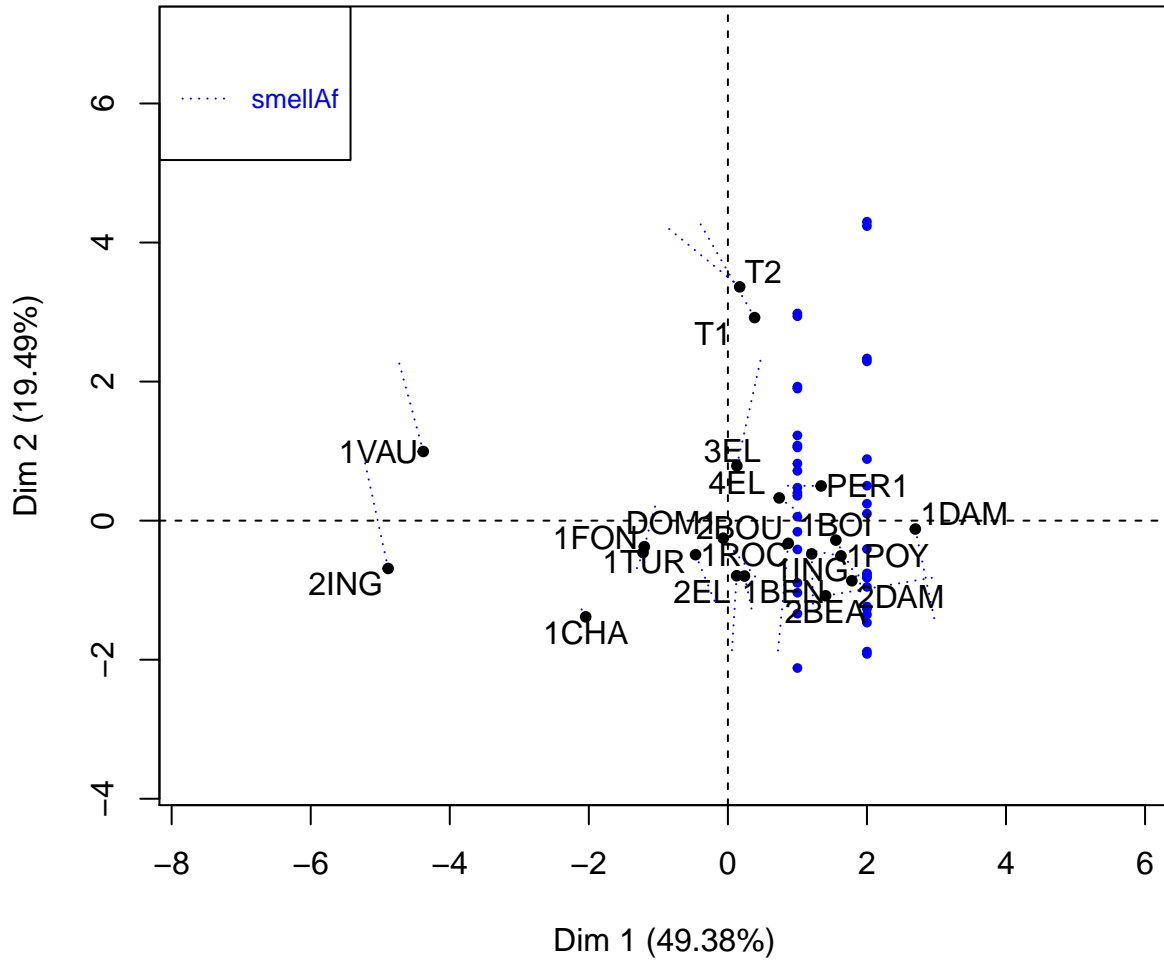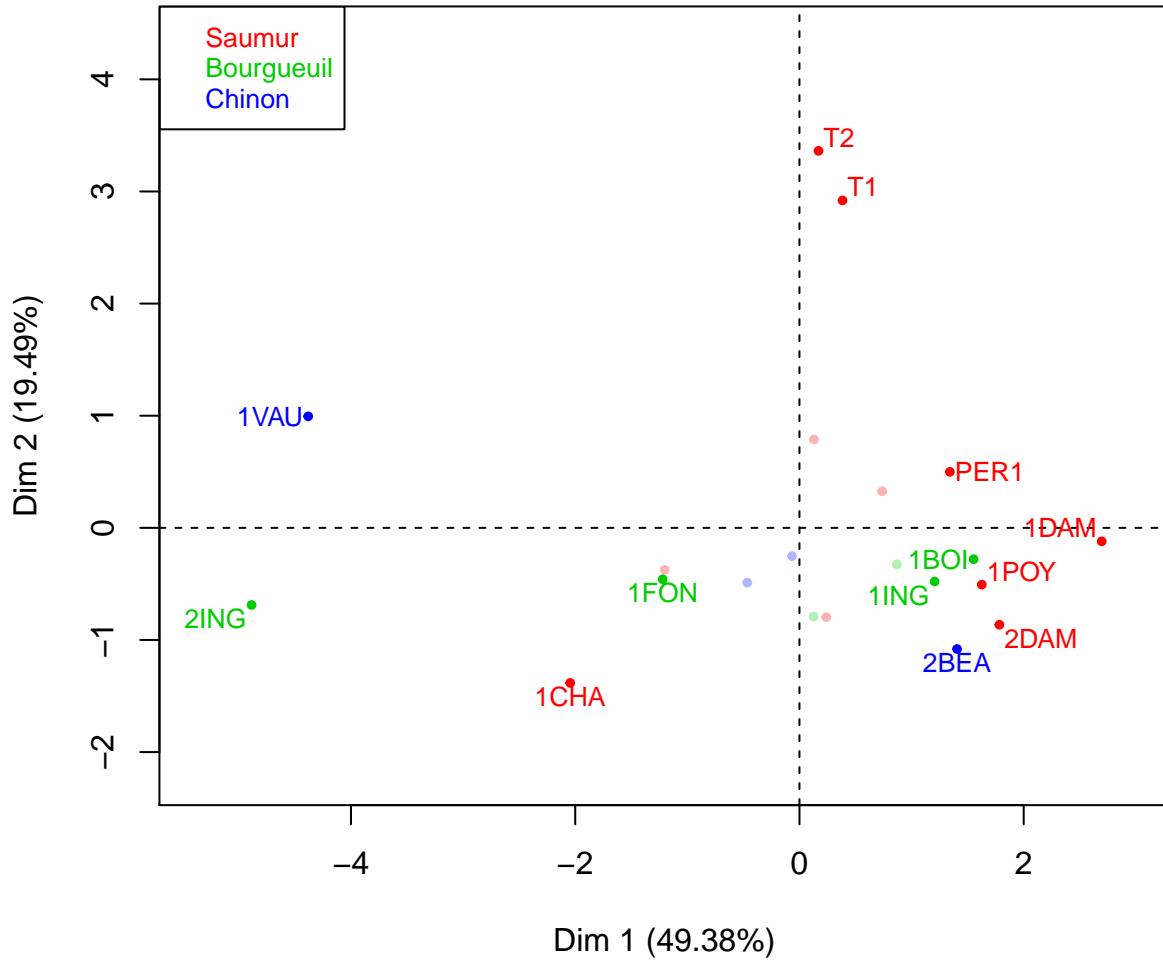## Selection in the graph of the individuals and categories

```
plot(res, invisible="quali", cex=0.8, partial=c("1VAU","PER1"), select="cos2 0.4")
```

Individual factor map


```
plot(res, ,invisible="quali", partial="all",
     palette=palette(c("black","transparent","transparent","blue","transparent")))
```

Individual factor map


```
plot(res, invisible="quali", habillage=1, cex=0.8, select="cos2 0.4")
```
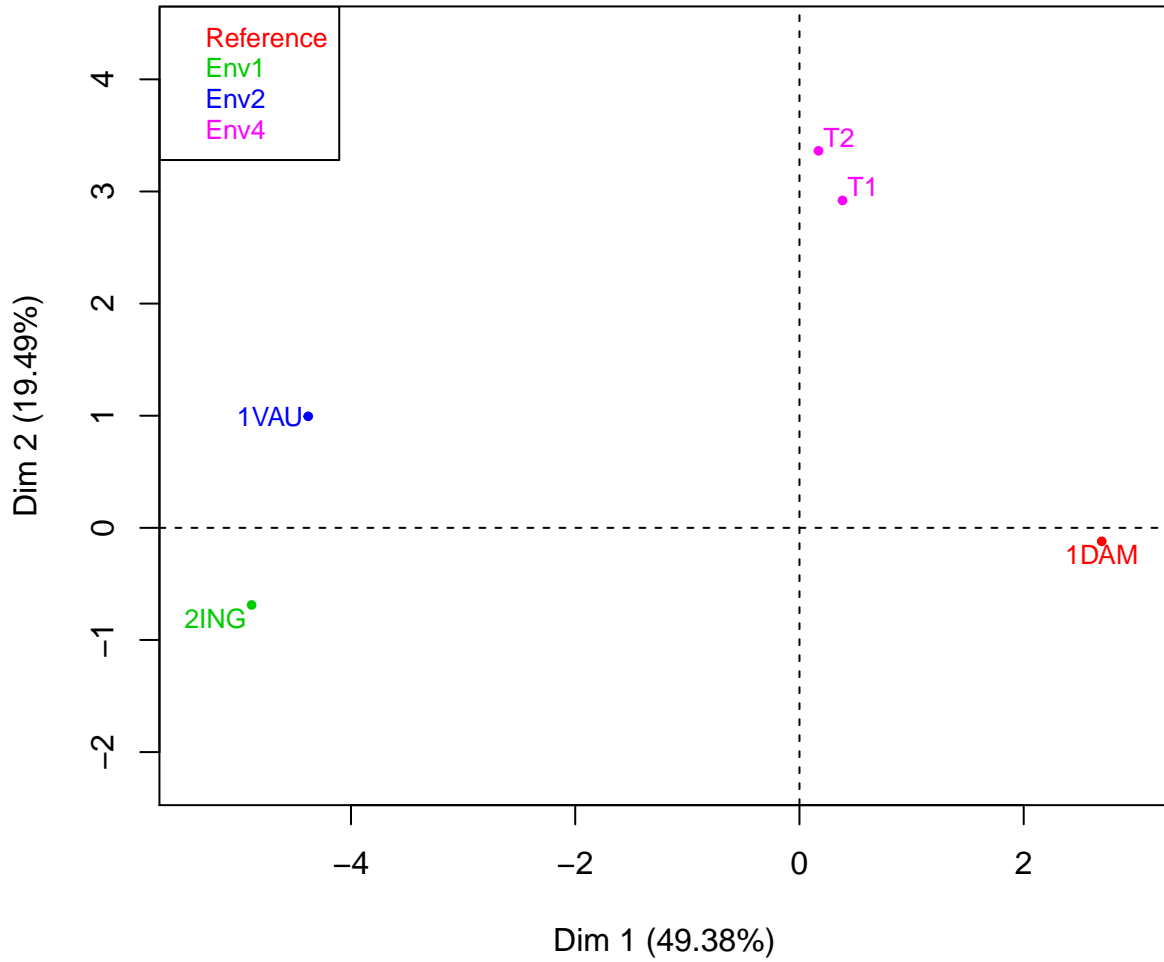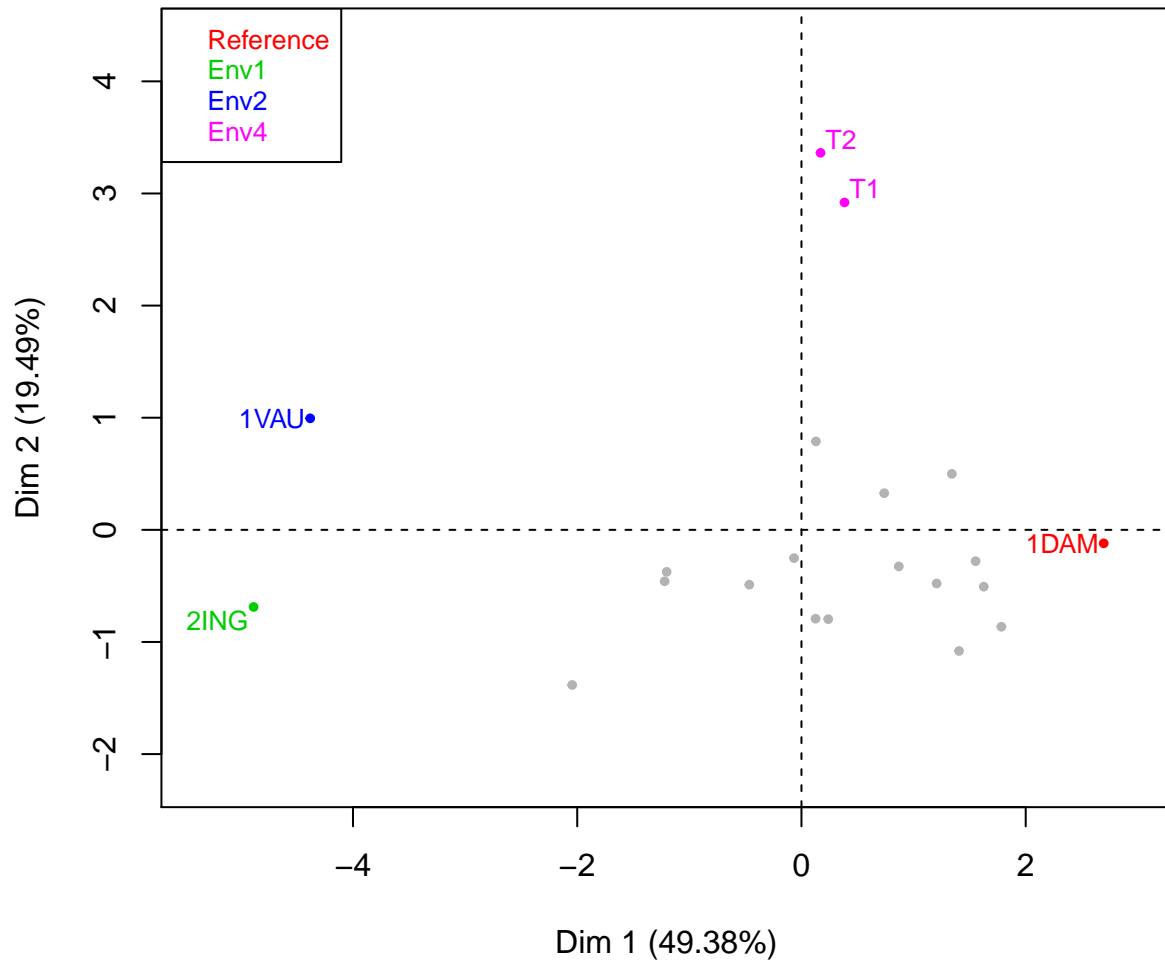
Individual factor map


```
plot(res, invisible="quali", habillage="Soil", cex=0.8, select="cos2 0.4")
```

Individual factor map
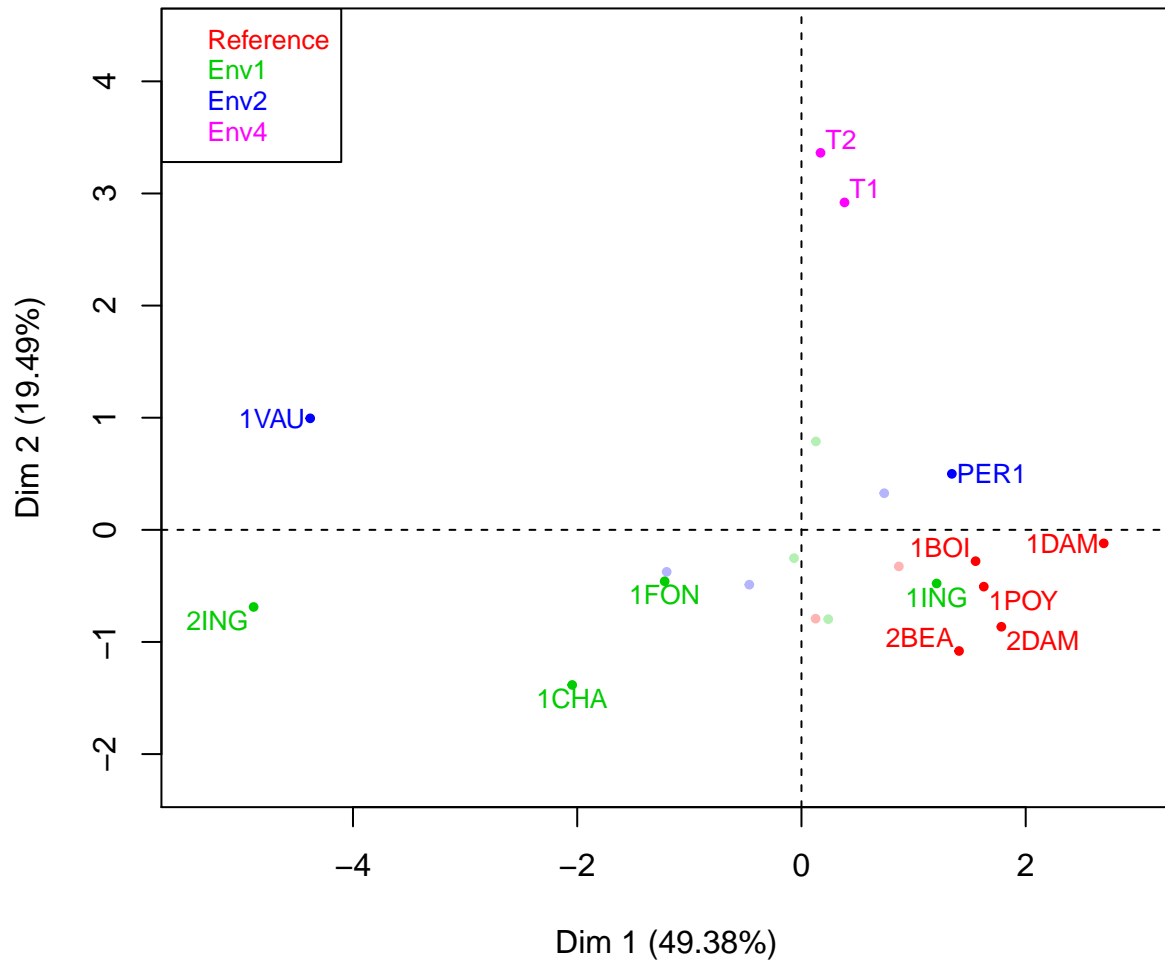

```
plot(res, invisible="quali", habillage="Soil", cex=0.8, select="contrib 5")
```

Individual factor map
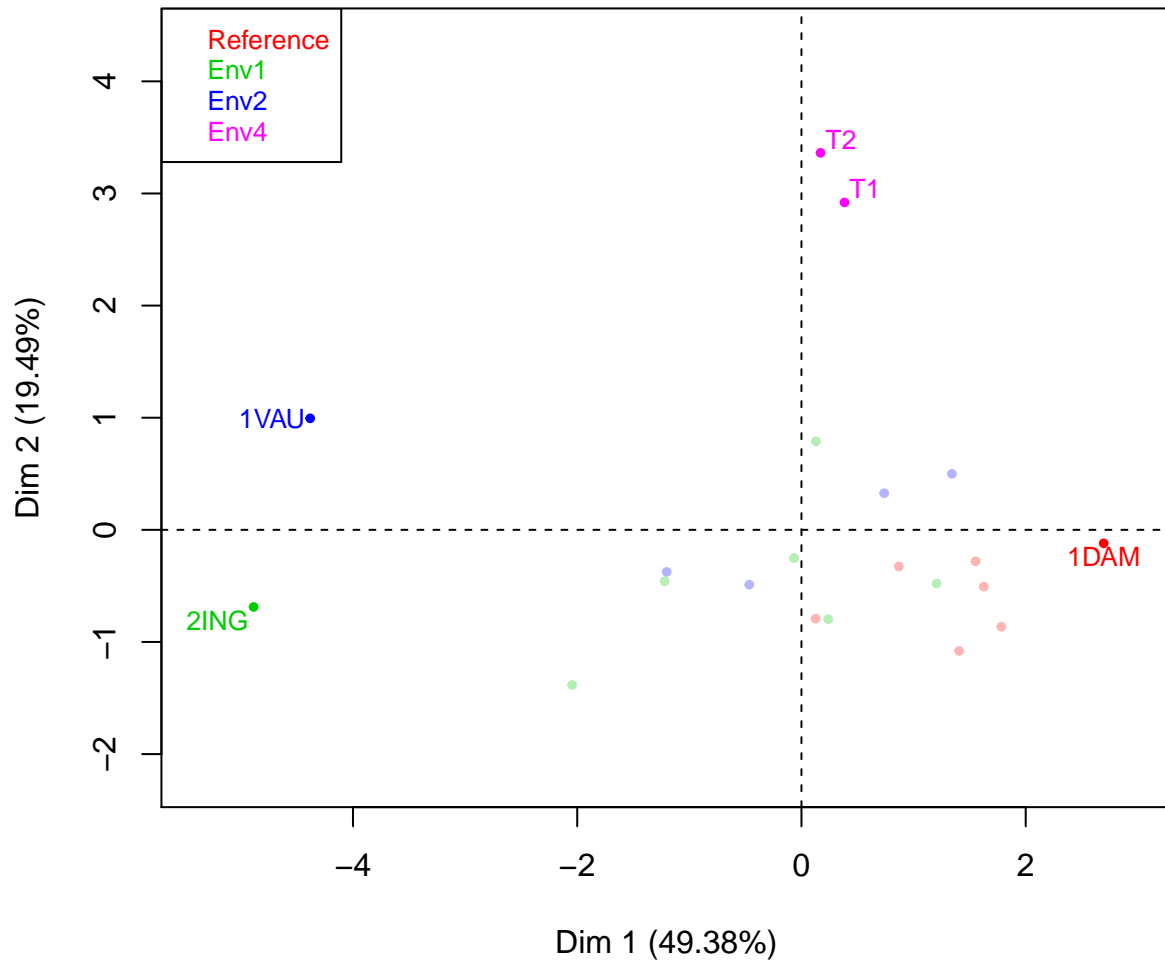

```
plot(res, invisible="quali", habillage="Soil", cex=0.8, select="contrib 5", unselect=0)
```
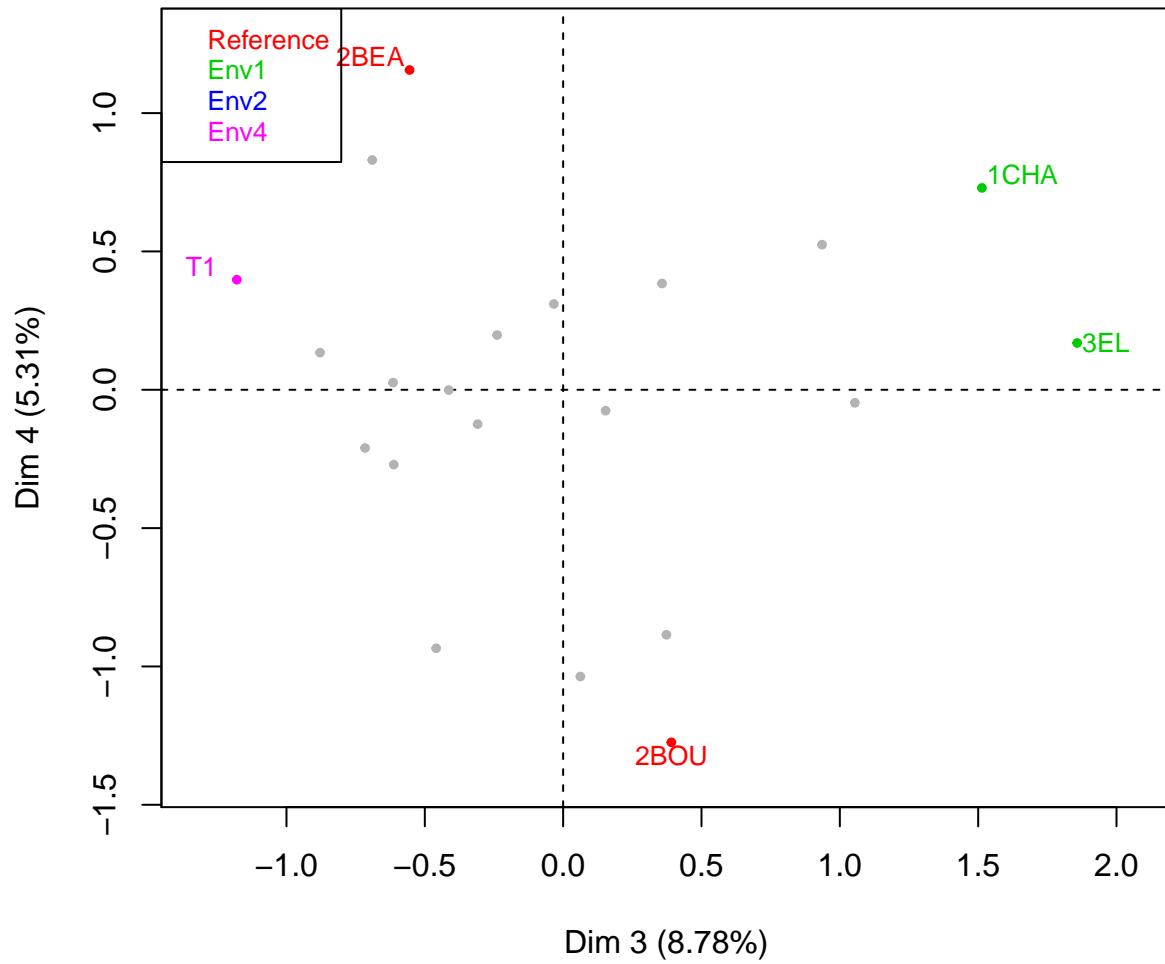
Individual factor map
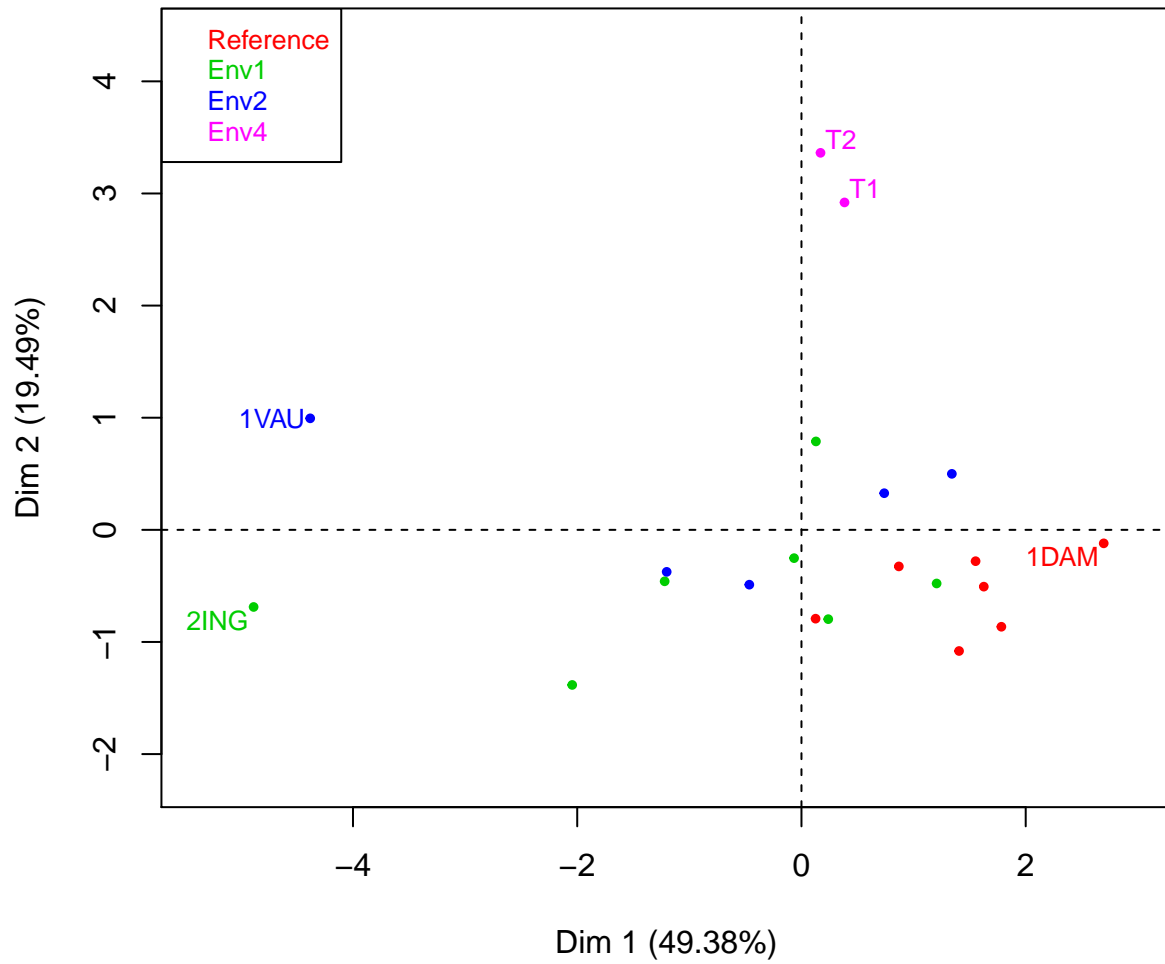

```
plot(res, invisible="quali", habillage="Soil", cex=0.8, select="contrib 5", unselect=1)
```

Individual factor map


```
plot(res, invisible="quali", habillage="Soil", cex=0.8, select="contrib 5", unselect="grey70")
```

Individual factor map


```
plot(res, invisible="quali", habillage="Soil", cex=0.8, select="contrib 5",
     unselect="grey70", axes=3:4)
```

Individual factor map


```
plot(res, invisible="quali", habillage="Soil", cex=0.8, select=c("1VAU","PER1"),
     unselect="grey70", axes=3:4)
```
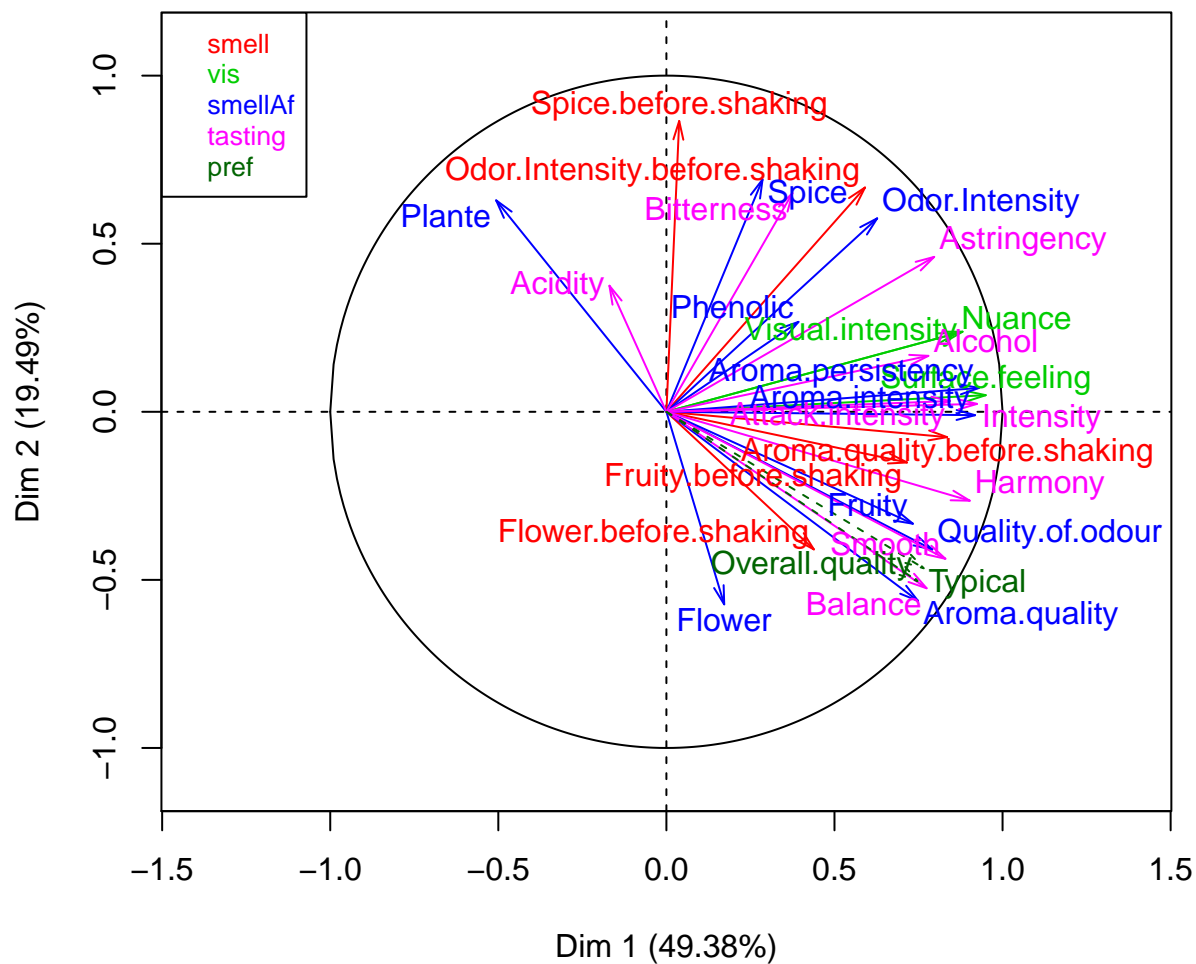
Individual factor map
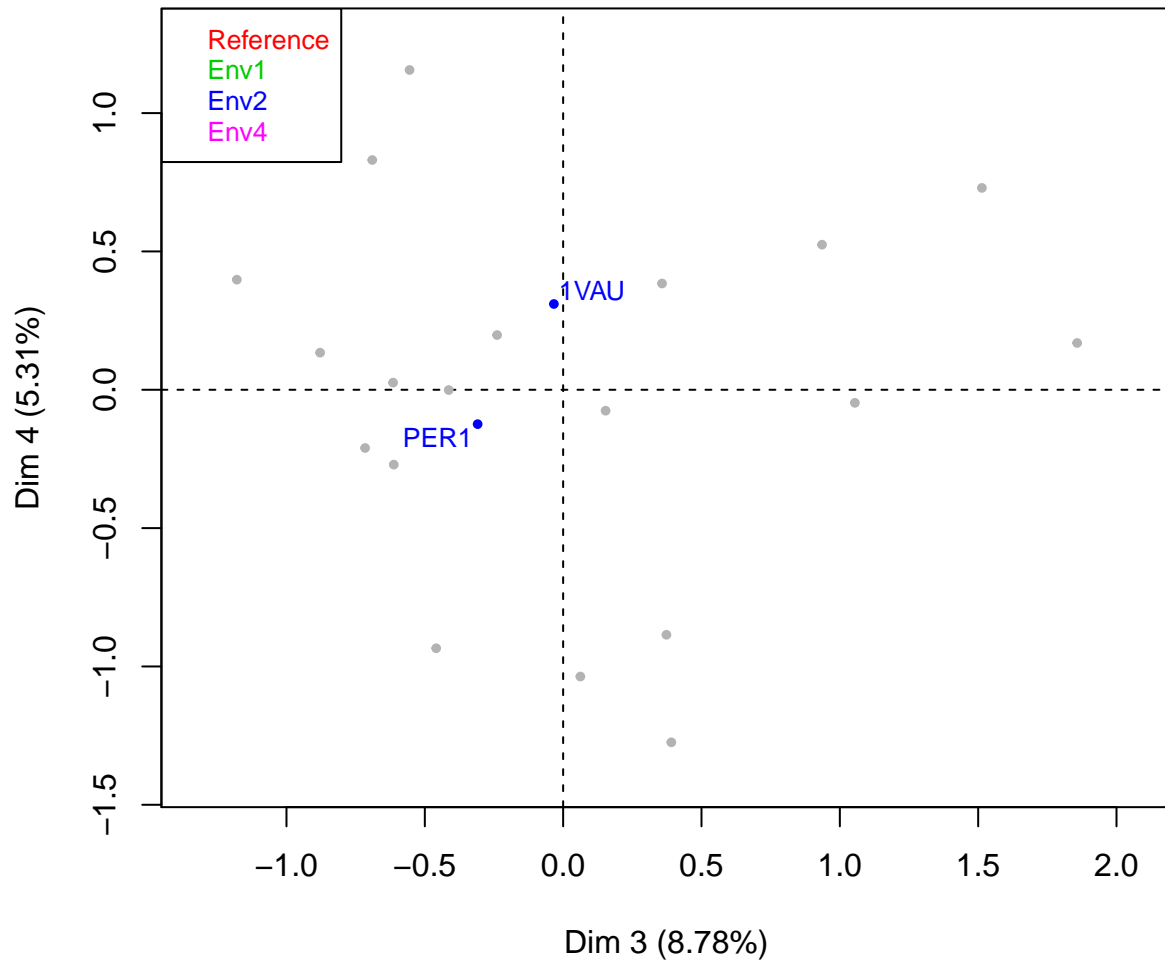
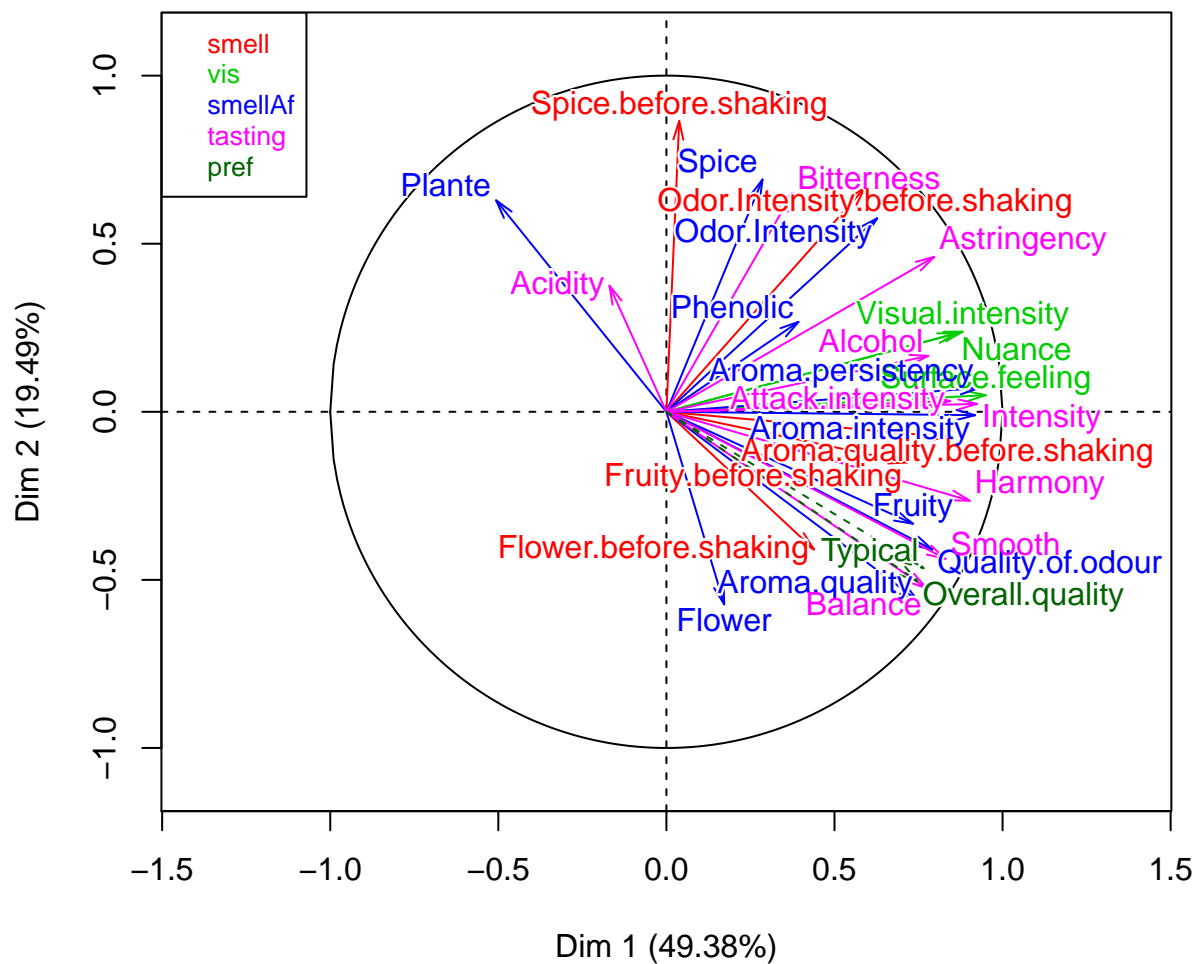

Graph of the variables

```
plot(res, choix="var")
```

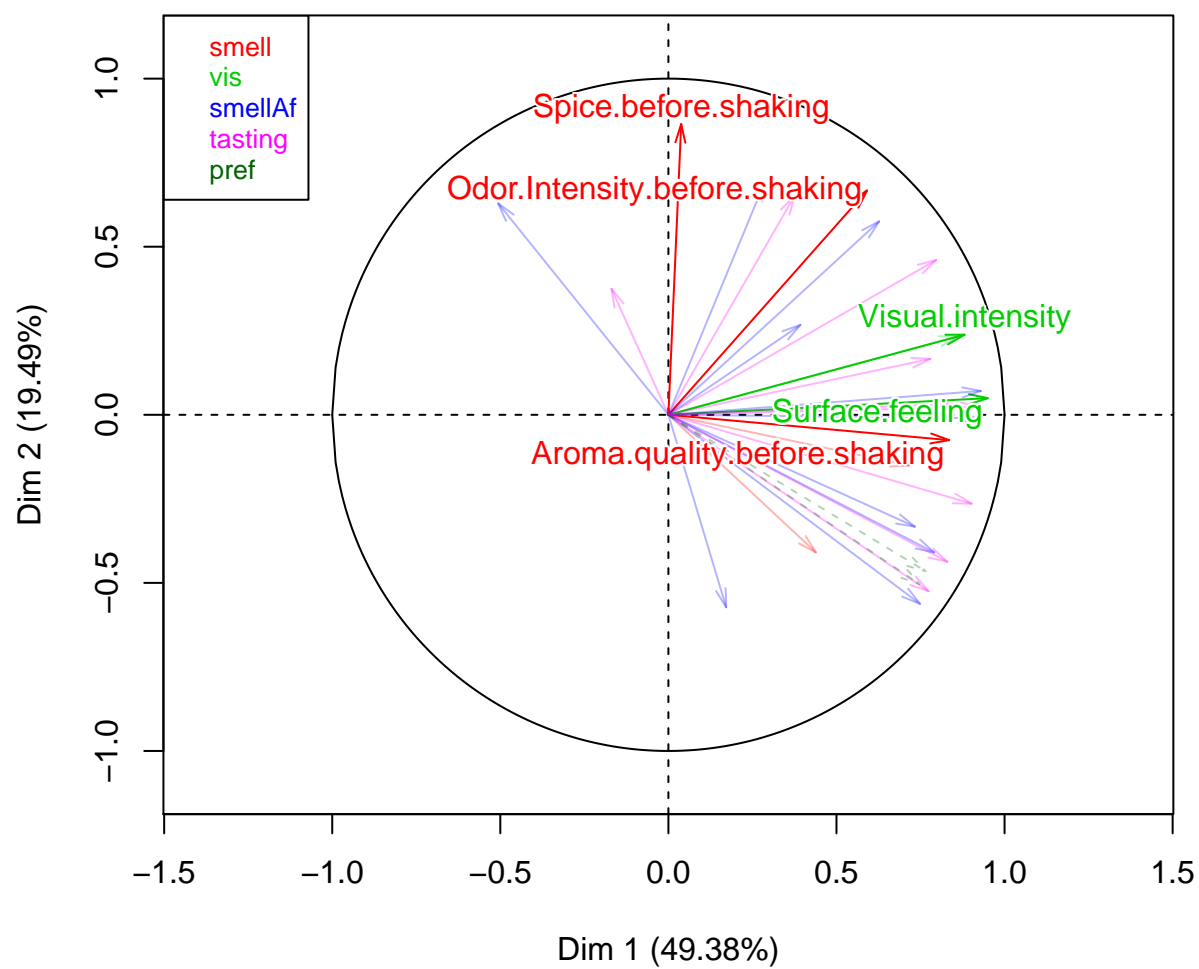# Correlation circle


```
plot(res, choix="var", shadow=TRUE)
```
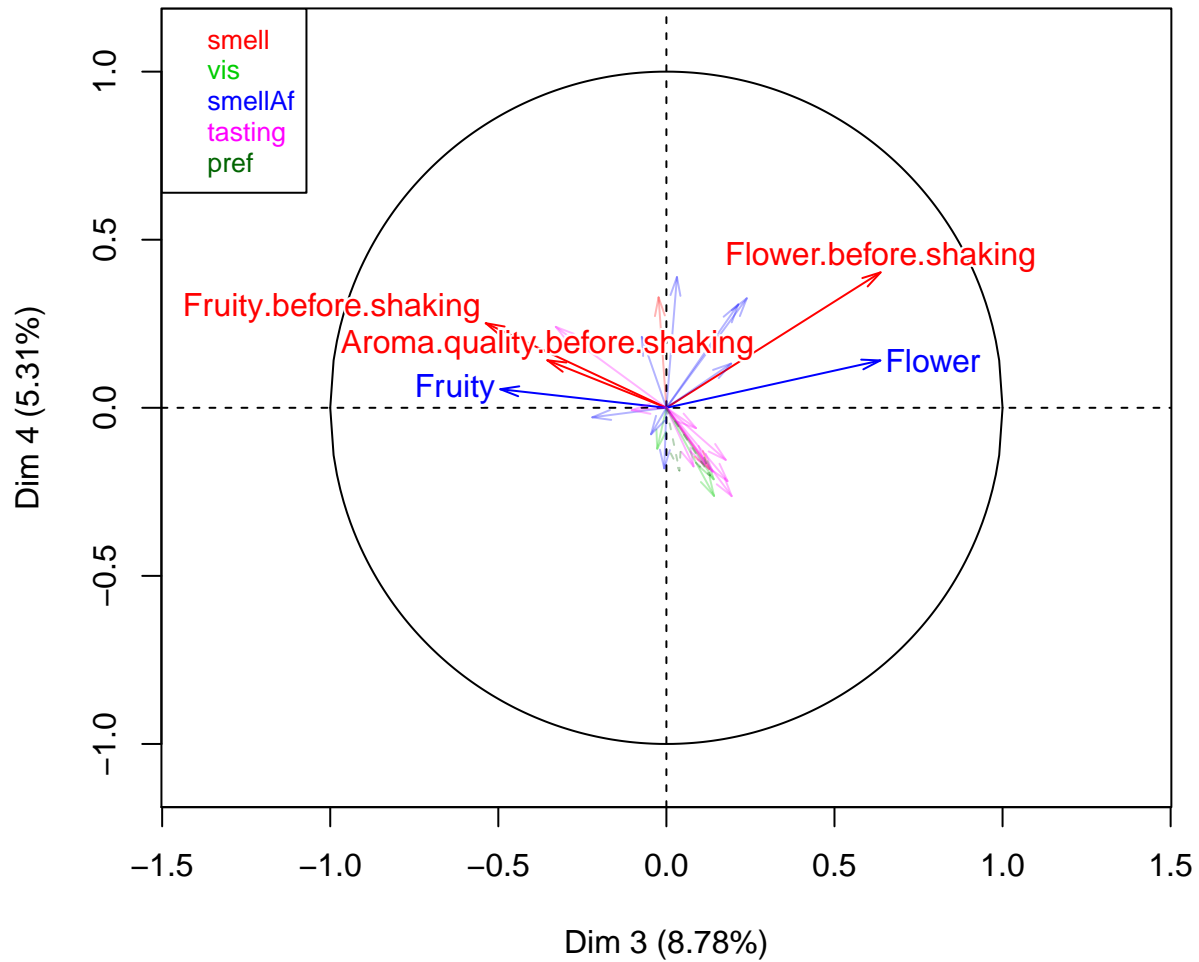
Correlation circle


```r
plot(res, choix="var", shadow=TRUE, select="contrib 5")
```

Correlation circle


```
plot(res, choix="var", shadow=TRUE, select="contrib 5", axes=3:4)
```
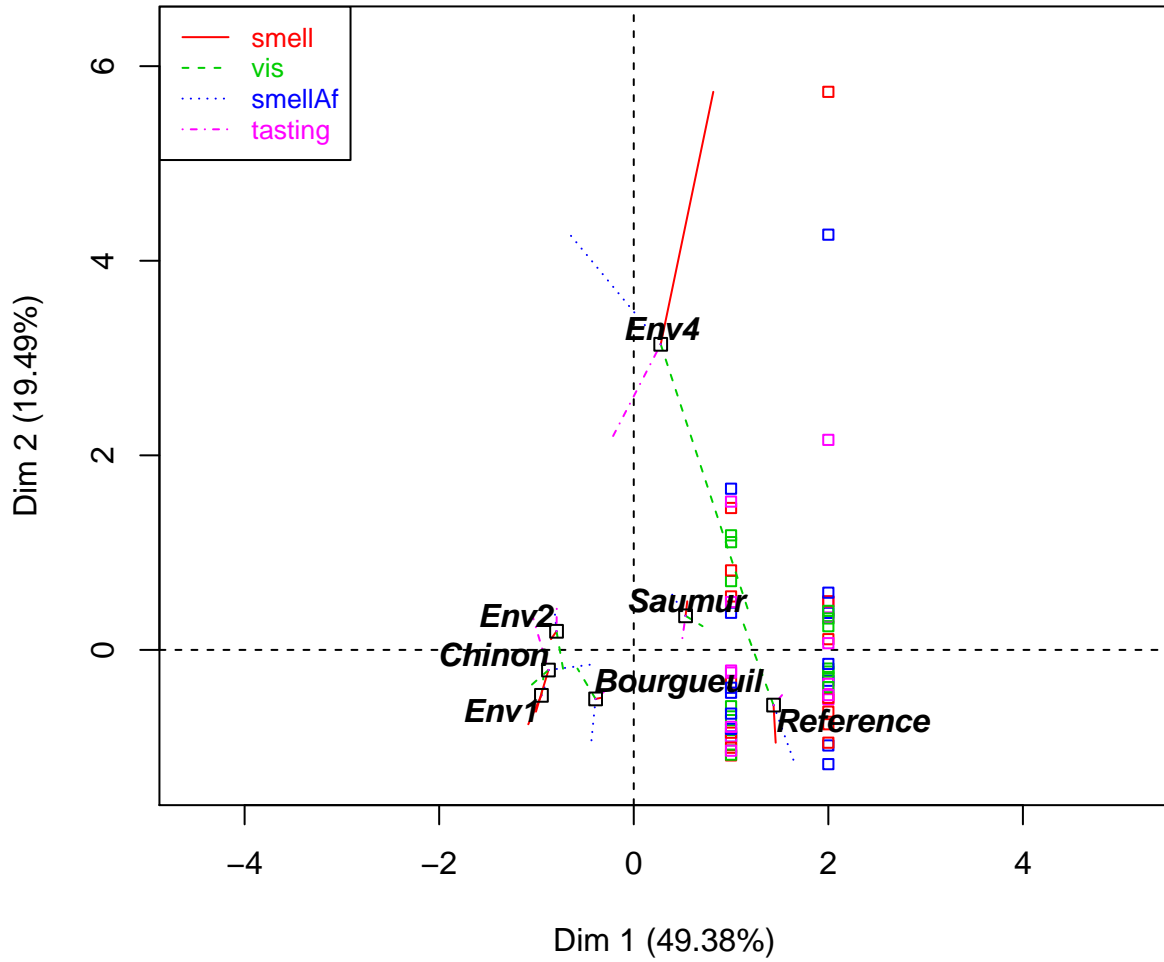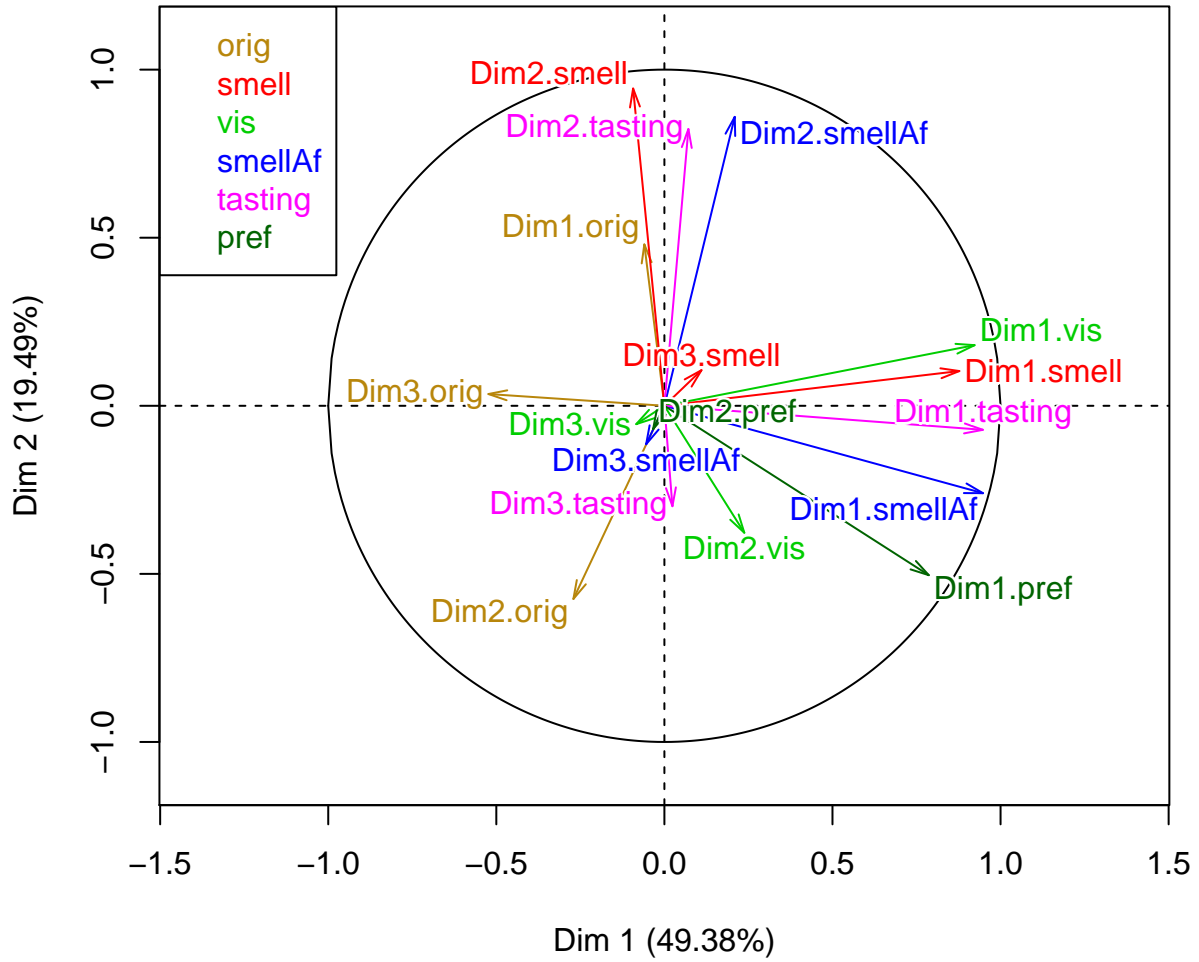
Correlation circle

Graph of the partial axes

```
res <- MFA(wine, group=c(2,5,3,10,9,2), type=c("n",rep("s",5)),
    ncp=3, name.group=c("orig","smell","vis","smellAf","tasting","pref"),
    num.group.sup=c(1,6))
```
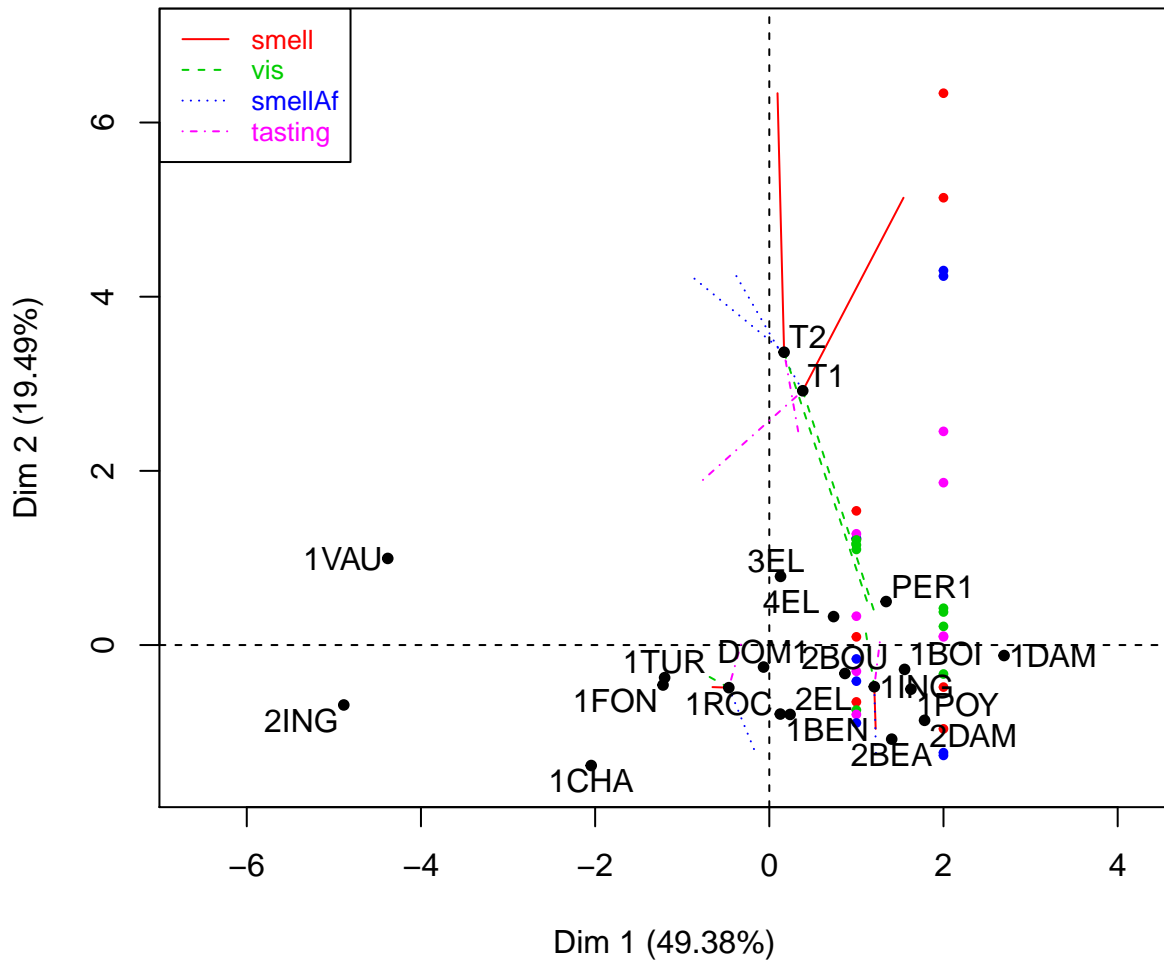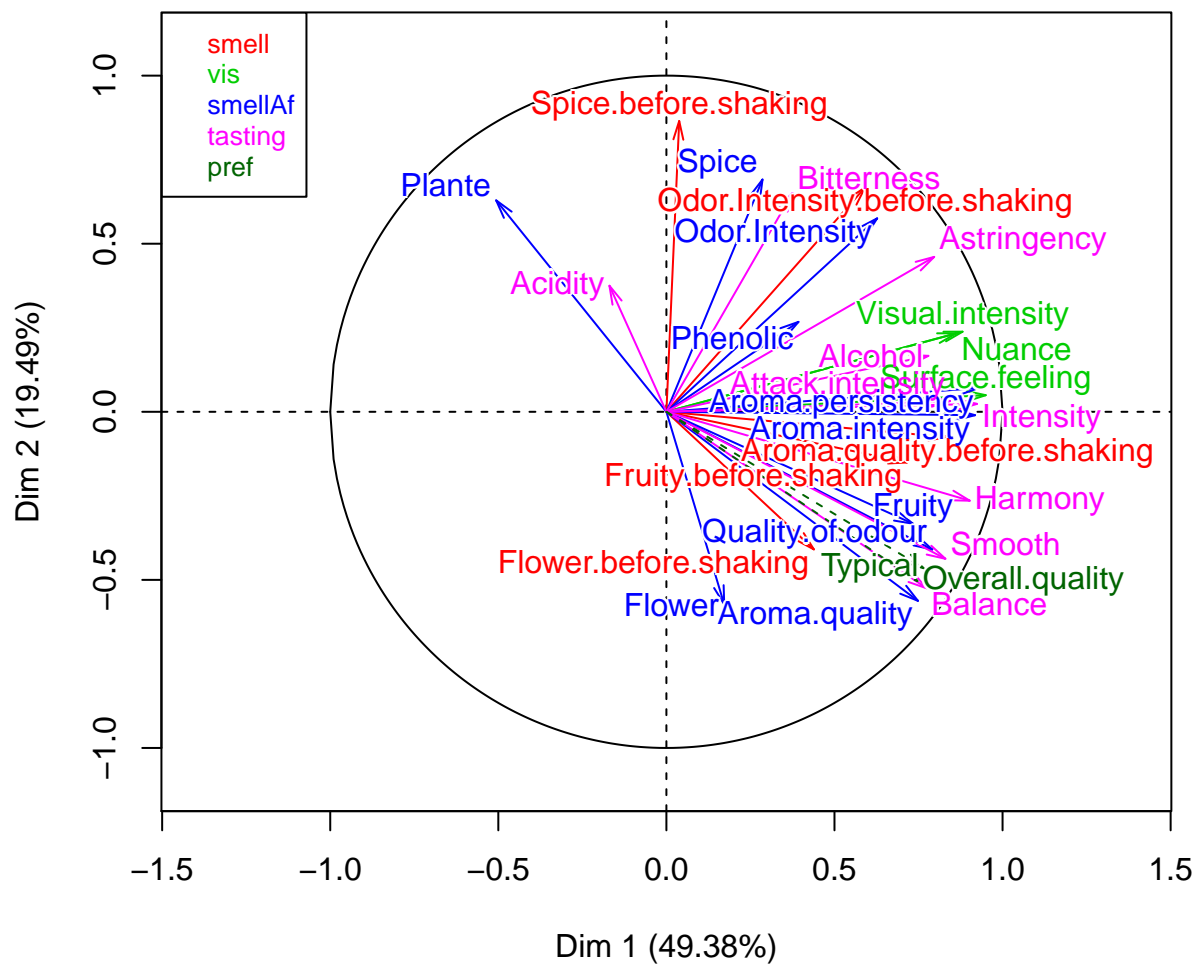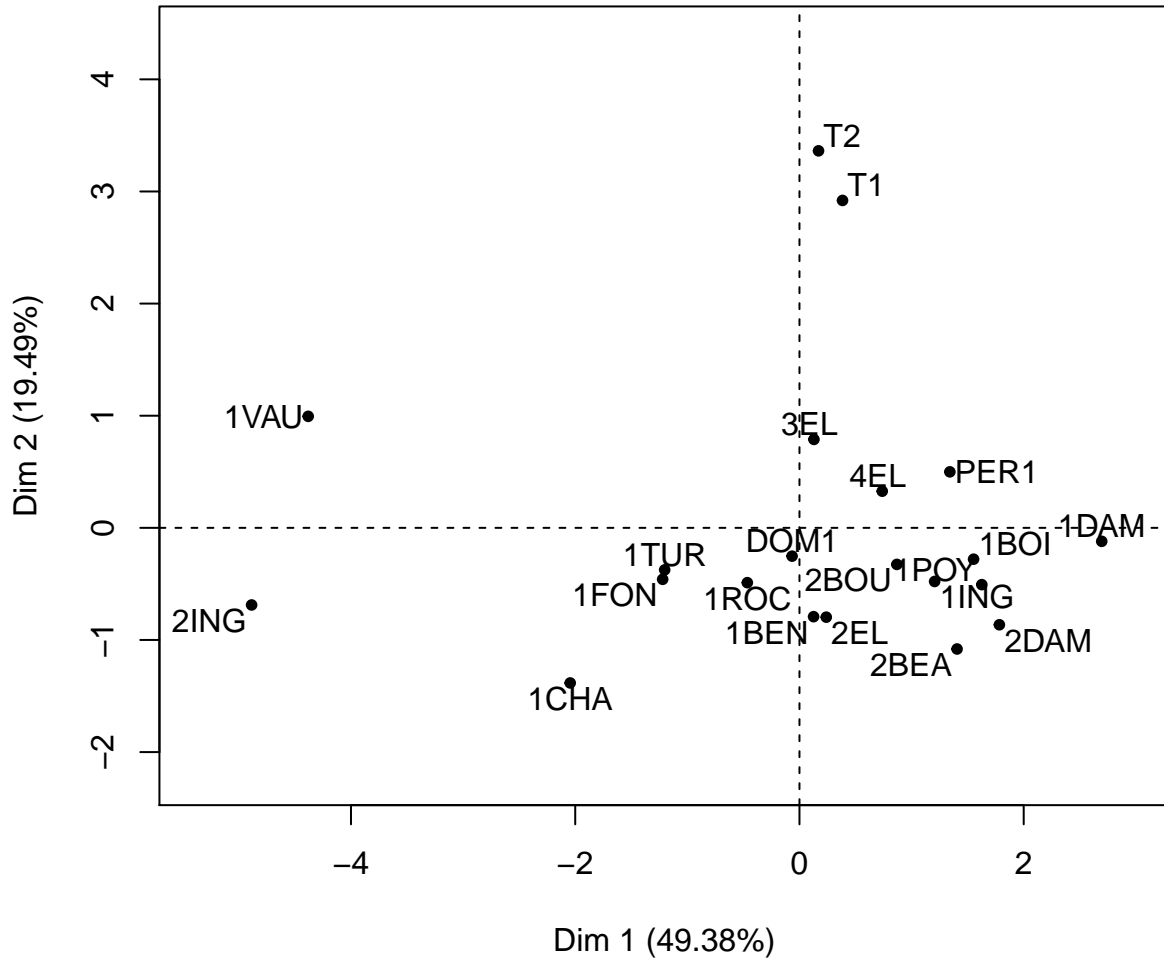
Individual factor map

Partial axes
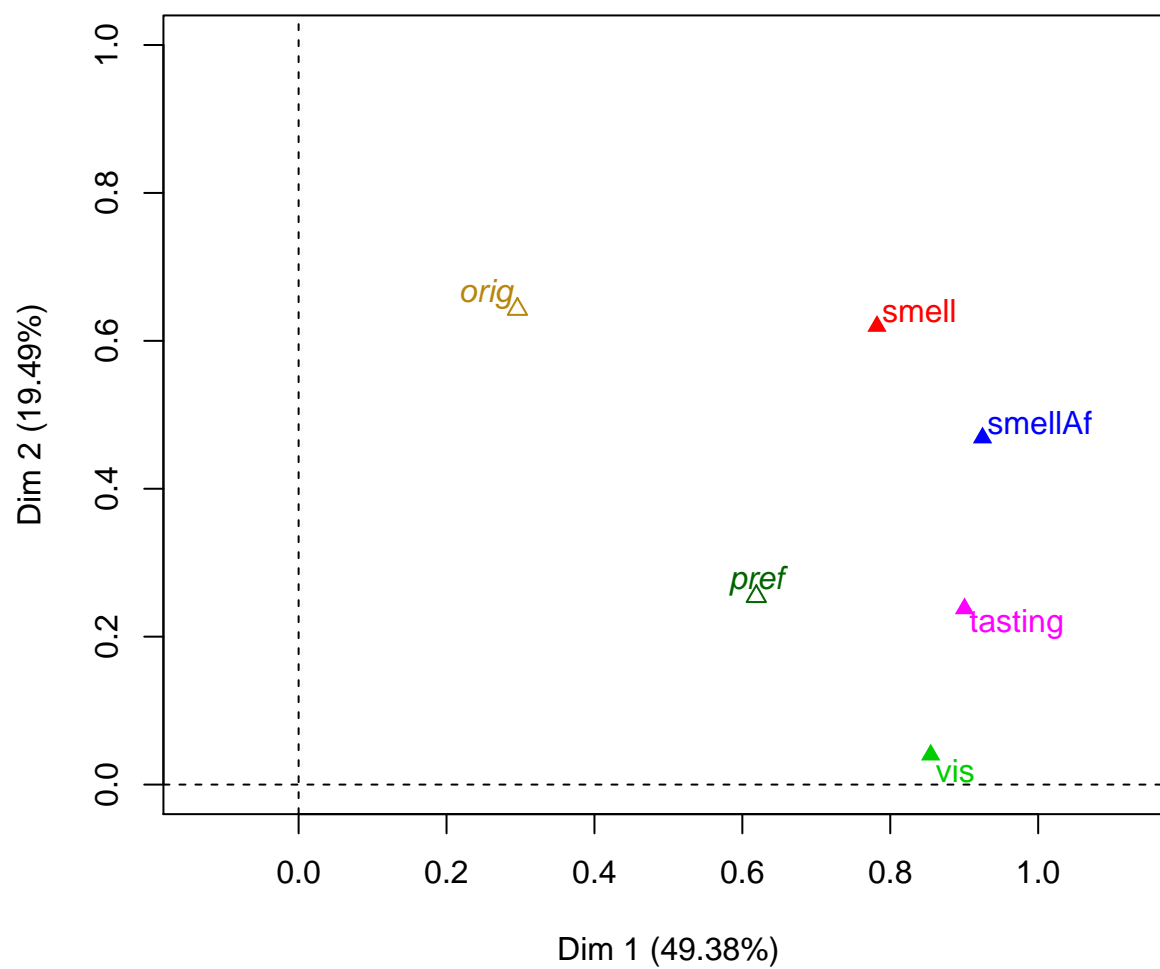
Individual factor map

Correlation circle

Individual factor map

Groups representation


```
plot(res, choix="axes")
```

Partial axes
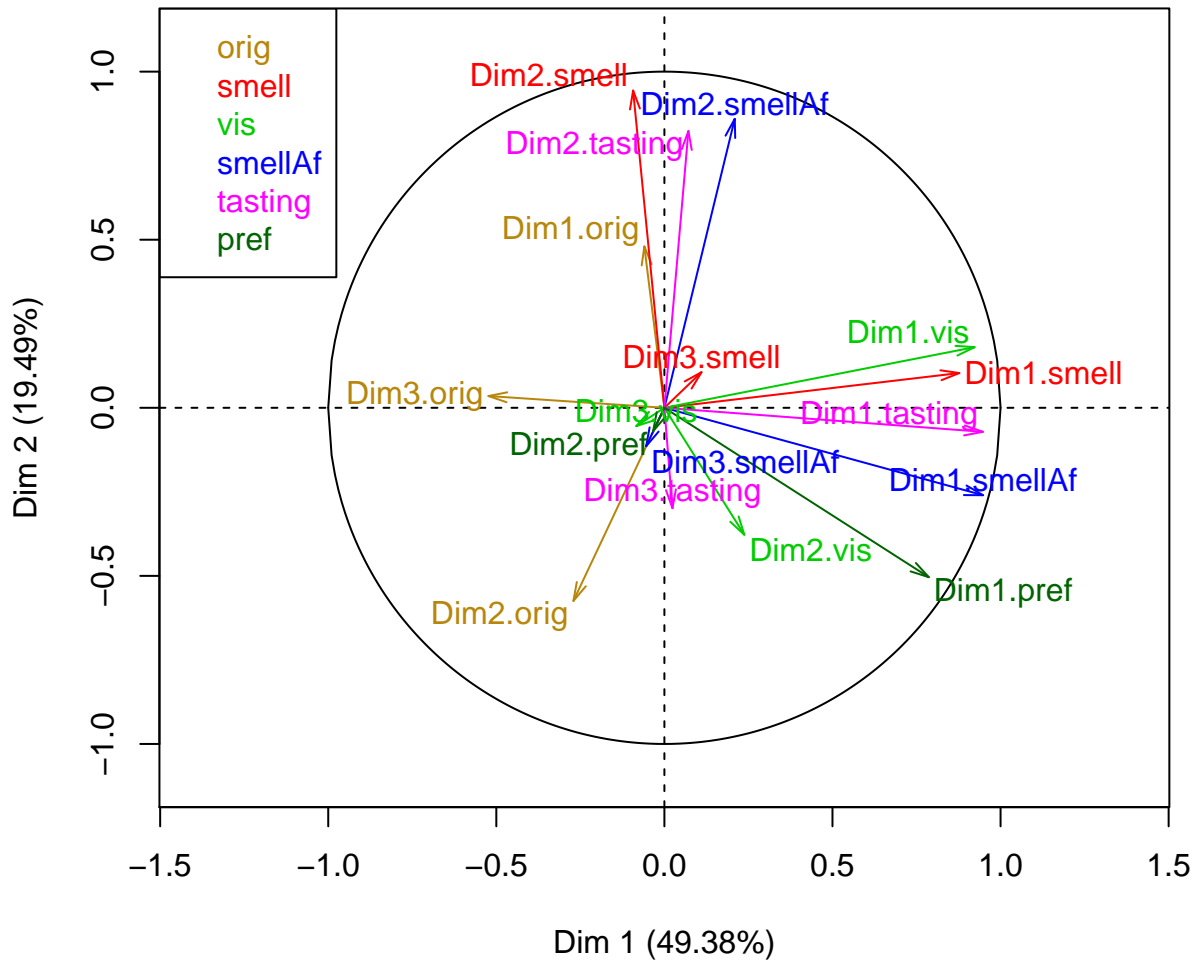
Description of dimensions

```
dimdesc(res)
```

```
## $Dim.1
## $Dim.1$quanti
##                      correlation      p.value
## Surface.feeling        0.9501131 4.605897e-11
## Aroma.persistency      0.9298582 1.082737e-09
## Intensity              0.9241930 2.214222e-09
## Aroma.intensity        0.9183490 4.380472e-09
## Harmony                0.9024824 2.221510e-08
## Visual.intensity       0.8811873 1.331392e-07
## Nuance                 0.8623373 4.995733e-07
## Attack.intensity       0.8439524 1.524322e-06
```

```
## Aroma.quality.before.shaking      0.8352510 2.462507e-06
## Smooth                            0.8299677 3.251800e-06
## Astringency                       0.7966486 1.549124e-05
## Quality.of.odour                  0.7909364 1.967655e-05
## Alcohol                           0.7792689 3.137694e-05
## Balance                           0.7740492 3.832036e-05
## Typical                           0.7656957 5.221396e-05
## Aroma.quality                     0.7484543 9.521647e-05
## Overall.quality                   0.7472814 9.901881e-05
## Fruity                            0.7333860 1.550774e-04
## Fruity.before.shaking             0.7160259 2.618708e-04
## Odor.Intensity                    0.6270975 2.345881e-03
## Odor.Intensity.before.shaking     0.5908036 4.800834e-03
## Flower.before.shaking             0.4387181 4.664182e-02
## Plante                           -0.5064137 1.915100e-02
##
## $Dim.1$category
##             Estimate    p.value
## Reference 1.444131 0.01043873
##
##
## $Dim.2
## $Dim.2$quanti
##                              correlation      p.value
## Spice.before.shaking          0.8650199 4.189450e-07
## Spice                         0.6910122 5.233277e-04
## Odor.Intensity.before.shaking 0.6672378 9.524504e-04
## Bitterness                    0.6506434 1.404051e-03
## Plante                        0.6290859 2.249914e-03
## Odor.Intensity                0.5755174 6.336628e-03
## Astringency                   0.4608480 3.550587e-02
## Smooth                       -0.4372509 4.746573e-02
## Typical                      -0.4655898 3.341665e-02
## Overall.quality              -0.5036281 1.993378e-02
## Balance                      -0.5249698 1.454356e-02
## Aroma.quality                -0.5624494 7.951915e-03
## Flower                       -0.5727974 6.648318e-03
##
## $Dim.2$quali
##             R2        p.value
## Soil 0.8255815 1.127917e-06
##
## $Dim.2$category
##      Estimate       p.value
## Env4 2.566606 2.650535e-07
##
##
## $Dim.3
## $Dim.3$quanti
##                         correlation      p.value
## Flower.before.shaking    0.6373128 0.001887133
## Flower                   0.6364710 0.001921831
## Fruity                  -0.4941180 0.022801235
## Fruity.before.shaking   -0.5374876 0.011976303
```