



SAM ASAP Sensory and Marketing  
Germany

## **Analysis of sensory data and how to present them**

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ESN Conference, Porto, May 2007

# Outline

- I Introduction
- II Univariate analysis of descriptive coffee data
- III Multivariate analysis of descriptive wine data
- IV Analysis of consumer coffee data

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I	Introduction
II	Univariate analysis of descriptive coffee data
III	Multivariate analysis of descriptive wine data
IV	Analysis of consumer coffee data

## Introduction

The aim of this presentation is to show

- applied statistical methods,
- charts that can be used for reports and presentations,
- possible ways of interpretation.
  
- The methods shown in this presentation are used by SAM ASAP and cover nearly 80% of all projects.
  
- The main focus will be on the practical use of the methods and on the interpretation of the output and graphics of the statistical analyses.

## Overview: Statistical Methods

- Summary statistics
- Analysis of variance
- Multiple comparison tests
- Principal component analysis
- Penalty analysis

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## Background – Study and Data

### Coffee study

- Panel: Descriptive coffee panel in Munich, 10 panelists
- Products: 6 soluble coffees
- Training: 12 sessions, including pilot test
- Measurement: all products 3 times by every panelist
- Attribute: 48 attributes for aroma, flavour, mouthfeel, aftertaste



## Raw data

Assessor	Product	Repet.	strong	freshly ground	malty	mouldy	watery	flowery	artificial	rotten	sour
6157	Coffee F	1	69	25	32	19	76	16	14	23	8
6157	Coffee F	2	81	18	26	11	79	14	10	7	8
6157	Coffee F	3	71	19	7	7	75	53	71	7	8
6157	Coffee A	1	41	32	37	6	75	18	8	23	11
6157	Coffee A	2	24	28	9	19	34	68	13	6	7
6157	Coffee A	3	32	12	25	17	61	10	11	5	9
6157	Coffee B	1	61	17	11	21	55	10	10	5	9
6157	Coffee B	2	83	17	25	9	78	8	16	7	6
6157	Coffee B	3	63	26	17	11	61	19	57	7	5
6157	Coffee C	1	72	28	20	61	77	31	21	13	14
6157	Coffee C	2	70	11	9	10	81	54	28	8	11
6157	Coffee C	3	58	18	25	14	54	12	83	8	10
6157	Coffee D	1	64	8	21	35	67	17	14	10	13
6157	Coffee D	2	36	9	15	18	57	12	10	26	9
6157	Coffee D	3	34	13	15	29	41	16	25	11	7
6157	Coffee E	1	80	18	9	5	70	49	17	8	9
6157	Coffee E	2	69	13	18	9	50	13	8	8	11
6157	Coffee E	3	73	17	25	8	73	21	5	7	5

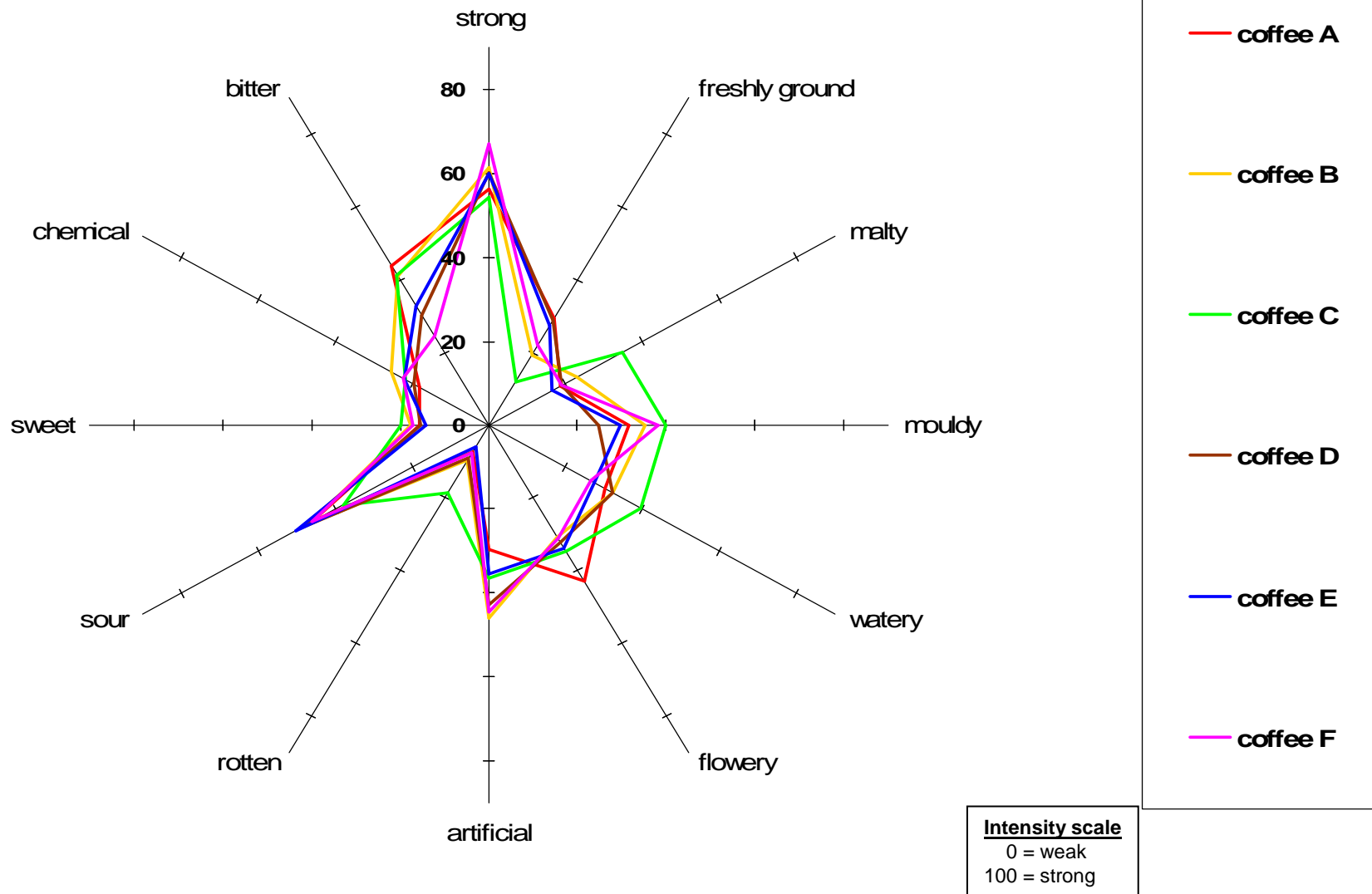
## Summary table – means flavour attributes

attribute	coffee A	coffee B	coffee C	coffee D	coffee E	coffee F
strong	56,2	61,5	54,4	60,1	60,0	66,9
freshly ground	29,3	19,3	12,1	28,9	27,3	21,9
malty	18,5	23,1	34,7	18,8	16,3	18,8
mouldy	31,5	35,3	39,9	24,6	29,5	38,1
watery	30,3	32,3	39,7	32,4	27,5	26,5
flowery	43,0	30,9	34,7	32,4	33,8	31,0
artificial	29,7	46,1	36,4	42,9	35,5	44,6
rotten	7,4	9,5	18,5	9,0	5,9	7,5
sour	46,0	46,7	38,0	49,0	50,5	45,9
sweet	15,6	17,5	19,7	15,3	14,3	17,2
chemical	18,0	25,4	21,8	19,6	22,1	22,3
bitter	43,89	40,74	41,26	30,37	32,74	24,44

## Summary table – standard deviation flavour attributes

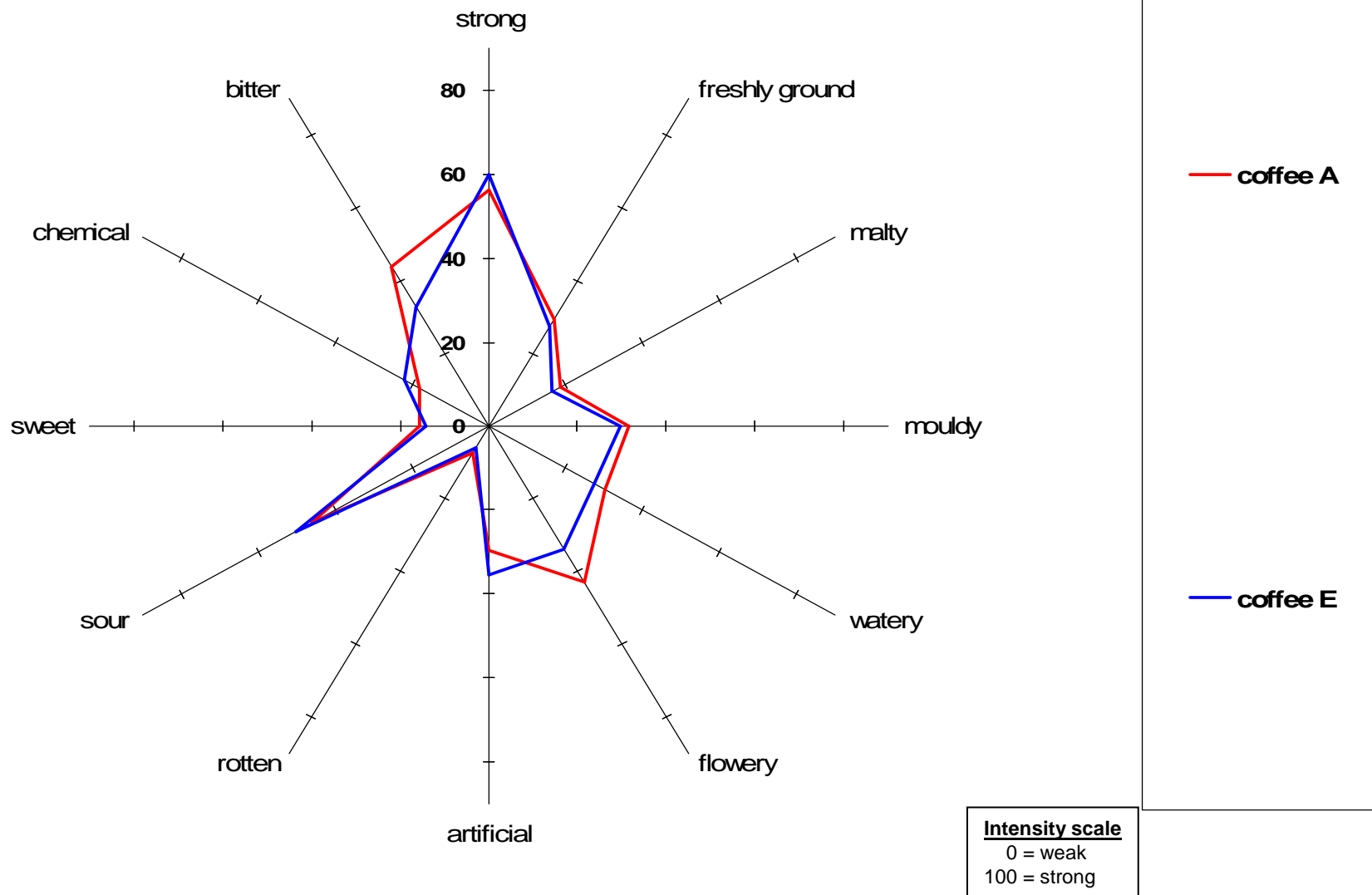
attribute	coffee A	coffee B	coffee C	coffee D	coffee E	coffee F
strong	30,5	25,9	26,6	21,1	26,3	25,2
freshly ground	23,9	24,1	22,8	29,9	23,3	20,0
malty	22,3	18,8	22,7	22,9	20,2	22,4
mouldy	13,2	12,6	15,2	25,5	12,5	15,6
watery	19,7	15,4	17,3	19,8	17,8	16,2
flowery	19,6	21,2	14,3	26,3	23,7	24,2
artificial	17,0	16,3	17,7	25,4	20,6	17,4
rotten	7,0	8,6	6,3	11,5	6,9	4,5
sour	23,4	26,0	26,7	21,1	24,3	24,9
sweet	15,0	11,2	12,0	15,2	11,6	16,6
chemical	17,9	20,6	22,6	22,9	20,1	22,9
bitter	12,5	11,4	3,7	12,4	17,4	7,0

# Coffee Panel – flavour attributes Spider web chart



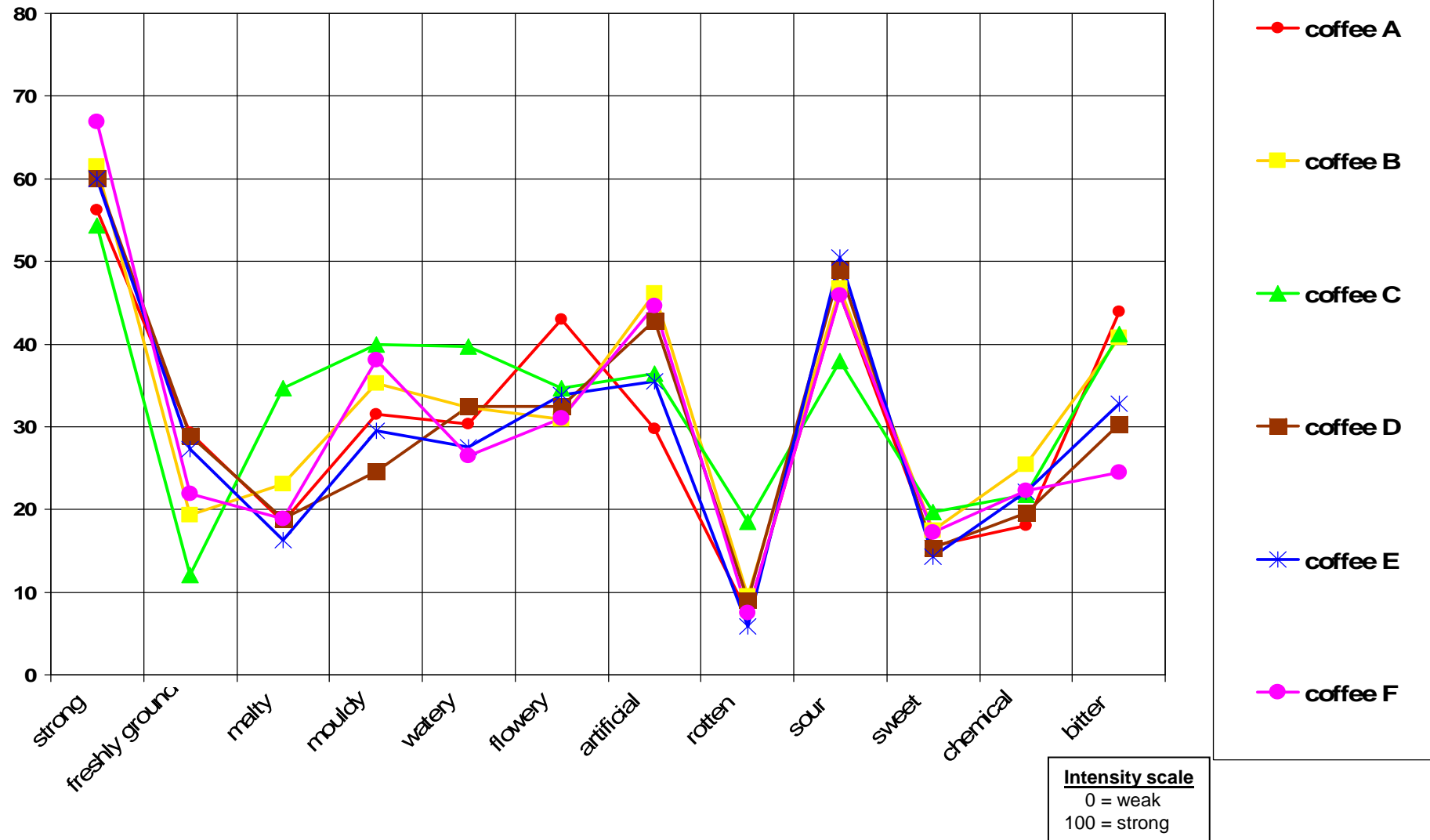
# Coffee Panel – flavour attributes

## Spider web chart



# Coffee Panel – flavour attributes

## Line chart



## Statistical Analysis

- Question:  
Do exist real / significant differences between products?
- To answer this question a hierarchical 2-step procedure is being conducted to check the following two questions:
  - 1) Do exist product differences? If the answer is yes
  - 2) Which of the products are significantly different?

## Statistical Analysis

- Step 1: Univariate analysis of variance (ANOVA) with factors
  - product
  - assessor (block effect to account for different scale use)
- Step 2: Multiple test
  - Duncan
  - Least significant difference
  - ...

## Statistical Analysis

For hypothesis testing with ANOVA we need some assumptions:

- The samples (products) represent independent samples drawn from specific populations with unknown means  
=> random order or random balanced order
- Each of the populations (products) is normally distributed.  
=> check for normality
- Each of the 5 populations has the same variance.  
=> check variance for each product

## Output table – Univariate ANOVA

### Tests of Between-Subjects Effects

Dependent Variable: bitter

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	43291,981(a)	13	3330,152	12,659	,000
Intercept	205013,389	1	205013,389	779,326	,000
assessor	35539,556	9	4442,444	16,887	,000
product	7752,426	5	1550,485	5,894	,000
Error	38933,630	148	263,065		
Total	287239,000	162			
Corrected Total	82225,611	161			

a R Squared = ,527 (Adjusted R Squared = ,485)

Statistic program: SPSS 13.0

## Output table – Duncan test

bitter

Duncan

product	N	Subset		
		1	2	3
coffee F	27	24,4444		
coffee D	27	30,3704		
coffee E	27	32,7407	32,7407	
coffee B	27		40,7407	40,7407
coffee C	27		41,2593	41,2593
coffee A	27			43,8889
Sig.		,077	,069	,506

Means for groups in homogeneous subsets are displayed.

Based on Type III Sum of Squares

The error term is Mean Square(Error) = 263,065.

a Uses Harmonic Mean Sample Size = 27,000.

b Alpha = ,05.

Statistic program: SPSS 13.0

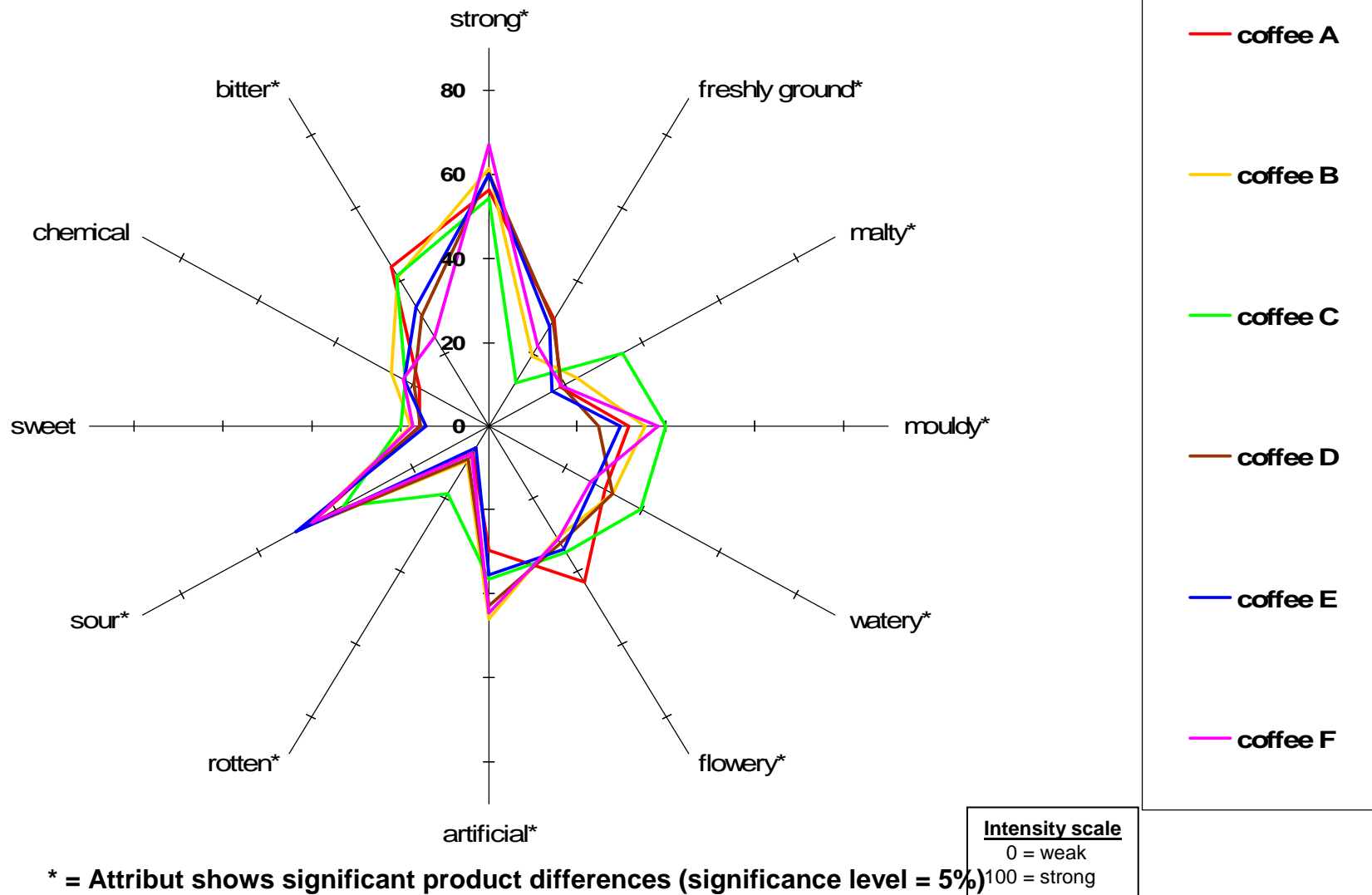
## Output table – Duncan test

	PRODUCT	Mean	1	2
4	4	43,181818	****	
5	5	57,424242		****
2	2	59,363636		****
1	1	62,424242		****
3	3	62,515152		****

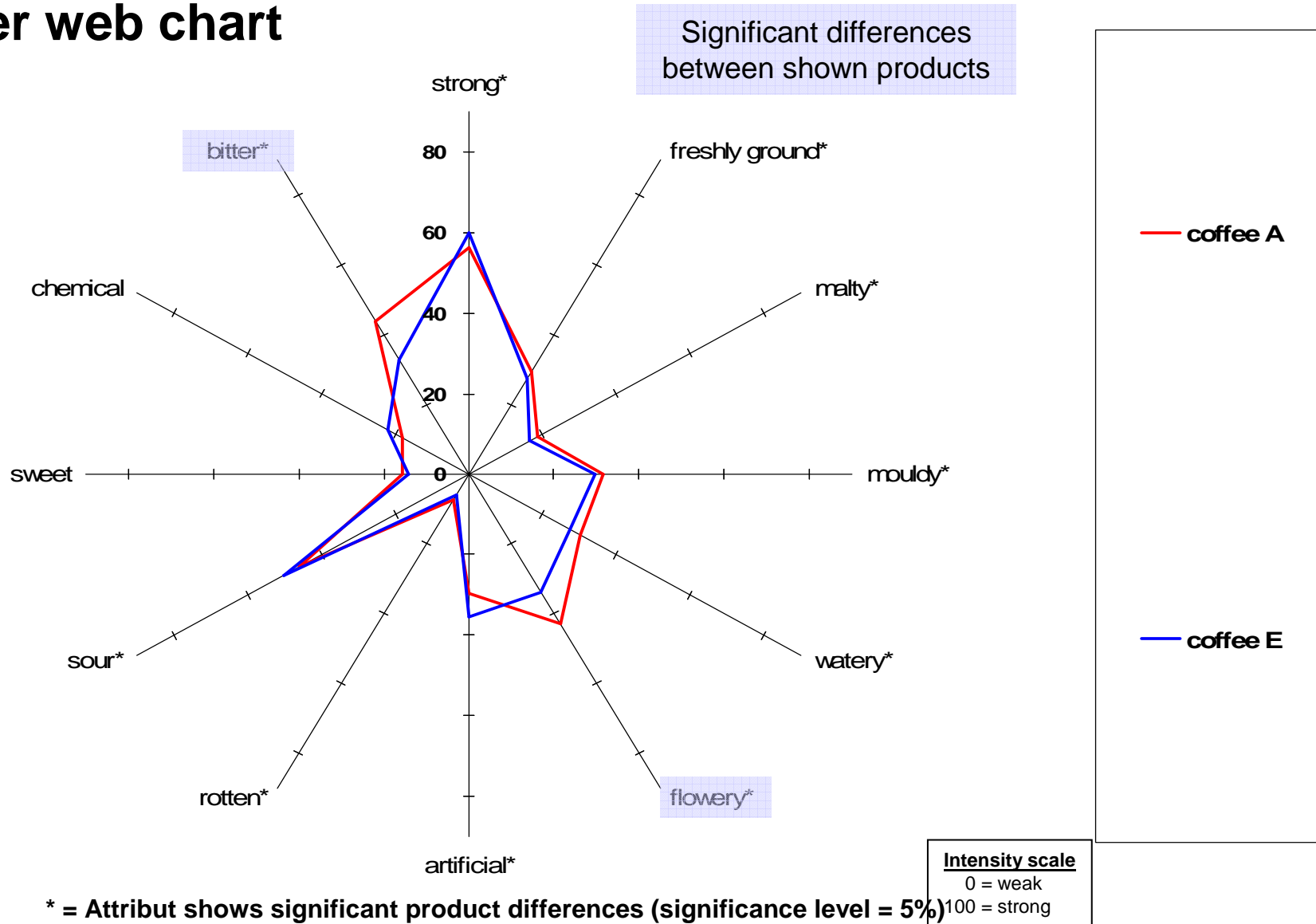
## Output table – Duncan test

	<b>PRODUCT</b>	<b>Mean</b>	<b>1</b>	<b>2</b>
<b>1</b>	<b>1</b>	<b>62,424242</b>		<b>B</b>
<b>2</b>	<b>2</b>	<b>59,363636</b>		<b>B</b>
<b>3</b>	<b>3</b>	<b>62,515152</b>		<b>B</b>
<b>4</b>	<b>4</b>	<b>43,181818</b>	<b>A</b>	
<b>5</b>	<b>5</b>	<b>57,424242</b>		<b>B</b>

# Coffee Panel – flavour attributes Spider web chart



# Coffee Panel – flavour attributes Spider web chart



## Results

- For a better overview, the coffee products are displayed with their characteristic attributes and intensities.
- The attributes are indicated with + or -:
  - ++** indicates the strongest intensity compared to all other products
  - +** indicates a stronger intensity compared to most of the other products
  - indicates a weaker intensity compared to most of the other products
  - indicates the weakest intensity compared to all other products

## Results coffee panel / Flavour

<b><u>Coffee A</u></b>	
++ freshly ground; ++ flowery; ++ bitter	-- artificial

<b><u>Coffee B</u></b>	
+ strong; + mouldy; ++ artificial; + bitter	- flowery

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## Background – Study and Data

### EPP Red wine 2005 study

- Europe's 60 most prominent red wines,
- covering European main markets including France, Germany, Italy, Spain, Switzerland
- From 12 supplier countries (Argentina, Australia, Chile, France, Germany, Hungary, Italy, Kosovo, South Africa, Spain, Switzerland, USA)
- Different varieties and blends (merlot, cabernet sauvignon, shiraz, ...)
- Different market positions (vins de pays, AOC, ...)



## Background – Study and Data EPP Red wine 2005 study

- Panel: Descriptive wine panel in Paris, 12 panelists
- Training: 10 sessions
- Measurement: all products twice by every panelist
- Attributes: 61 attributes for appearance, aroma, mouthfeel, flavour, aftertaste



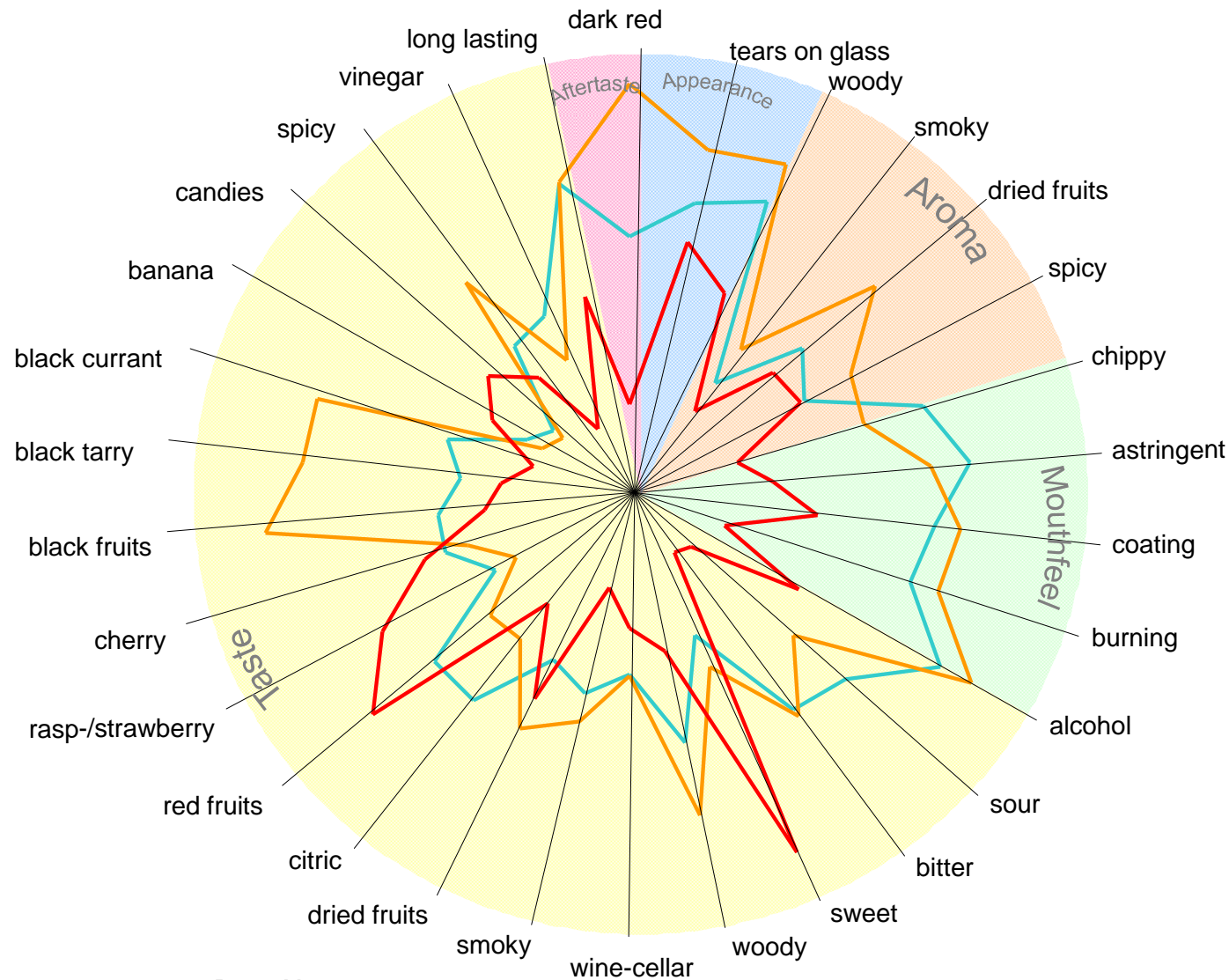
# Summary table - means



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Produktname	AS_Rot	AS_AnhaftenGlass	AS_SchlierenGlas	GR_Intensität	GR_Alkohol	GR_Stechend	GR_Holzlig	GR_Keller	GR_Blumig	GR_Heu	GR_Rauchig	GR_Fehigeruch	GR_Fruchtig	GR_Trockenobst	GR_Zitrus	GR_RotFrüchte	GR_Himbeere	GR_Kirsche	GR_Erdbeere	GR_RotJonannisb
Albali tp	39.3	40.6	40.8	42.1	35.2	21.4	41.8	27.3	23.7	23.6	21.8	13.7	33.3	28.9	16.3	23.7	17.4	18.6	16.0	20.6
Amselfelder	24.2	36.9	32.6	38.7	36.1	24.9	34.7	31.4	24.3	27.3	17.6	20.3	34.5	20.3	22.7	31.7	21.8	20.5	18.4	23.6
Balaton H&S	36.9	39.0	36.5	41.9	38.3	25.5	37.4	31.3	26.7	27.6	18.5	17.1	37.7	24.9	22.5	27.2	19.2	21.6	14.9	21.2
Blestac Bdx	46.2	41.9	42.0	42.2	35.0	19.9	38.1	28.5	22.3	19.0	16.3	10.5	35.9	32.9	18.0	22.3	17.6	16.7	14.4	14.8
BlossomH	41.5	37.4	35.3	41.2	39.4	23.2	35.0	27.6	26.9	24.1	16.4	14.7	38.9	29.8	15.0	28.6	21.6	20.2	19.6	18.8
Bouchard Bgne	20.8	34.5	36.4	40.6	35.0	22.8	36.5	27.4	25.8	22.1	17.3	9.9	35.4	25.4	23.0	33.5	19.2	22.4	20.0	24.9
Caceres rio	40.5	38.1	37.2	43.1	36.8	20.8	38.8	33.3	23.9	31.5	22.3	17.2	33.4	27.8	16.4	26.2	18.2	18.5	14.0	19.4
Campo ma	44.0	39.8	39.8	38.9	36.0	19.9	41.0	27.5	20.0	21.1	20.7	15.6	33.6	35.2	14.9	23.9	20.3	16.9	13.3	17.7
Cam po Viejo	42.5	41.6	37.3	43.1	32.8	16.1	38.0	33.9	26.7	30.0	20.8	17.1	40.4	34.2	15.0	24.4	20.9	19.8	18.0	15.3
Castel cs	41.3	41.3	38.4	41.1	38.6	28.1	40.1	34.2	24.1	25.9	21.6	16.4	35.0	28.6	15.7	23.2	19.9	16.3	18.8	17.3
Castellino	35.3	37.1	34.8	42.9	33.9	20.9	38.3	35.5	29.4	32.0	18.8	21.9	39.5	31.2	17.7	32.7	25.0	26.0	21.6	23.9
Cecchi chianti	40.1	36.9	40.4	43.0	36.2	24.2	39.9	29.4	23.8	28.5	18.9	16.6	38.4	25.7	15.5	28.1	19.3	18.9	16.9	19.3
Chantre Bdx	41.7	37.8	40.3	42.3	37.2	25.9	37.9	33.1	24.1	25.3	14.7	12.5	40.6	35.1	16.3	29.5	22.7	25.9	17.1	23.3
Chenet c/sh	40.1	39.0	34.3	41.2	38.4	23.6	38.0	28.2	26.6	24.0	16.7	12.0	36.3	32.0	18.2	23.4	17.0	17.3	14.0	19.5
Chenet m	41.6	40.1	36.0	41.3	36.0	20.9	39.5	28.1	24.6	27.0	18.5	12.3	33.8	25.1	22.0	27.4	16.7	19.7	15.3	20.0
Cordier Bdx	40.0	36.4	37.8	41.7	37.0	22.3	37.7	30.7	21.7	28.1	16.7	18.6	34.7	27.1	17.8	29.0	20.3	20.2	19.0	21.3
CoulSud m	43.4	39.1	39.1	42.7	37.6	25.1	37.8	24.0	24.2	17.6	16.5	10.2	40.2	29.6	18.2	27.2	21.3	20.6	18.8	22.7
Cramoisay	29.9	37.5	40.7	42.8	36.2	24.6	34.5	26.8	29.6	23.1	16.0	15.0	37.6	26.3	19.1	32.7	24.0	19.2	15.9	26.1
Dauphins CdR	27.7	39.6	37.3	40.7	34.0	24.3	35.9	32.4	23.6	30.6	18.8	20.1	33.1	27.4	20.9	30.8	17.9	19.2	14.7	24.8
Domkeller	10.4	32.6	29.3	36.3	30.2	18.4	24.9	23.6	27.0	20.8	11.6	15.2	30.3	20.6	16.7	33.1	24.2	21.2	22.7	23.0
DonMendo	34.0	35.9	33.4	41.0	33.8	16.0	38.5	30.2	21.6	23.4	16.7	16.0	34.4	26.2	16.0	29.3	17.6	19.9	14.6	21.6
Duboeuf Bj	26.8	31.7	28.2	39.3	32.6	25.7	31.2	20.6	30.4	26.8	14.8	16.8	41.6	29.3	20.6	33.5	33.2	25.1	23.4	29.5
DWeintor dn	39.9	37.1	37.0	42.9	34.1	17.9	33.7	27.5	28.6	21.8	20.2	11.1	37.8	29.7	17.7	32.1	22.2	21.4	17.1	24.6
ElCoto	38.6	39.7	38.6	43.6	36.7	21.5	39.7	33.7	23.0	27.3	20.6	18.1	35.3	30.6	16.9	25.2	20.4	18.3	15.7	20.5
Emperador c/cam	48.3	42.2	38.6	45.3	35.0	18.9	38.8	32.1	23.3	33.7	15.3	17.3	35.4	33.4	13.9	22.4	16.5	16.7	13.7	17.4
Faustino V	46.0	40.0	39.4	43.8	37.1	20.7	43.3	28.4	26.0	30.1	21.8	17.6	37.2	33.4	15.7	21.1	15.6	17.1	13.4	18.3
Filou	26.9	30.4	30.5	39.8	36.3	21.5	33.8	29.5	28.3	25.6	18.2	15.6	39.3	28.0	22.6	33.6	22.0	24.7	23.4	23.1
Fuerto tp	42.6	39.5	34.4	41.9	36.4	17.6	35.9	30.8	24.8	22.8	17.4	13.5	41.9	29.8	17.3	26.4	22.6	20.3	17.1	19.4
Gallo cs	48.1	40.3	39.2	46.6	37.7	19.6	37.9	33.1	23.9	31.5	19.5	14.7	41.7	32.6	15.8	22.5	17.9	16.0	15.5	17.0
Gallo zi	48.9	41.2	42.2	45.9	38.4	21.7	41.1	32.1	25.9	23.0	20.1	10.4	41.8	33.8	15.5	23.2	16.3	16.8	13.4	17.0

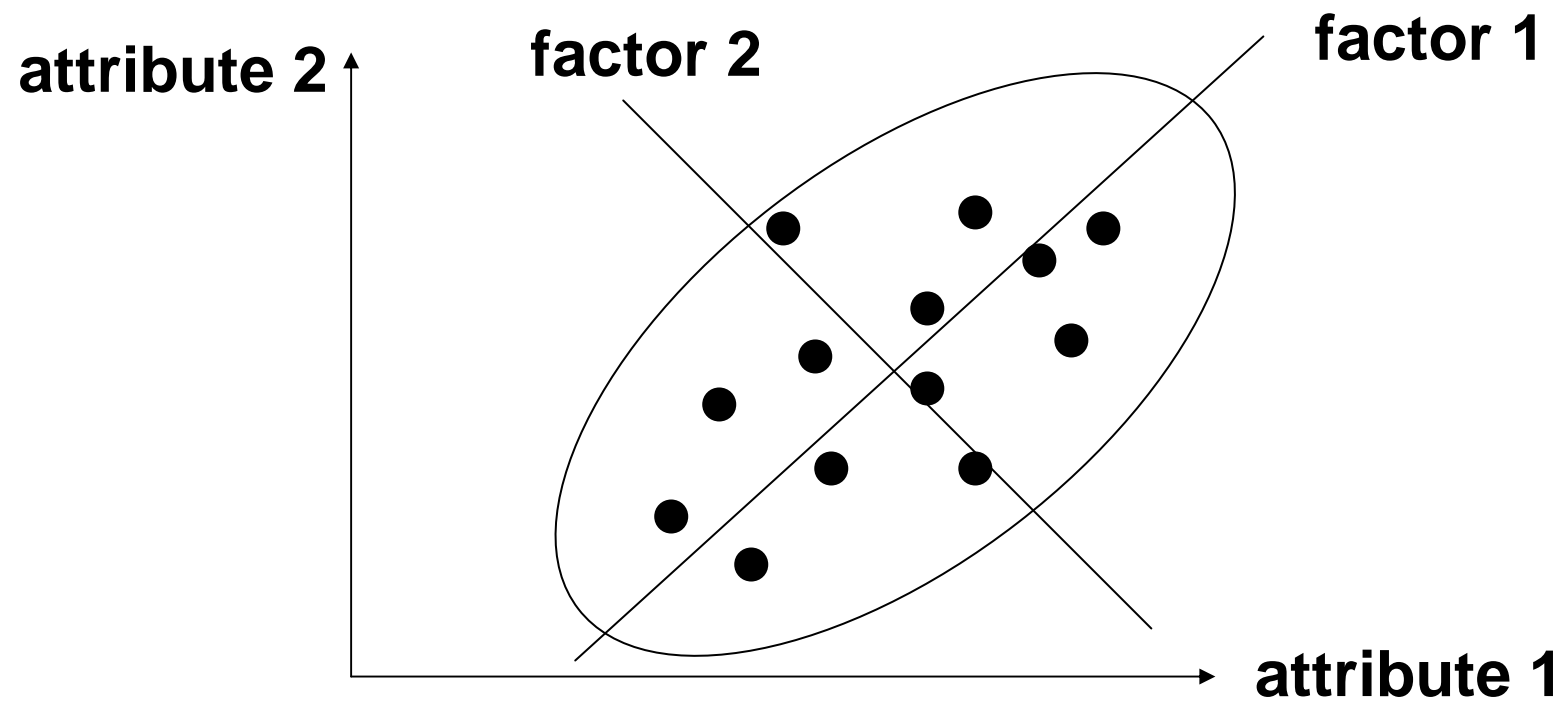
# Wine Panel – Spider web chart



## Principal Component Analysis (PCA)

- PCA is a multivariate statistical method.
- Given many attributes from a descriptive panel, some will be correlated. The PCA finds these patterns of correlation and substitutes a new variable, called a factor, for the group of original attributes that were correlated. The analysis then seeks a second and third group and derives a factor for each, based on the variance left over at each step once the variance now accounted for by the previous factor is removed.

# Principal Component Analysis (PCA)



# Principal Component Analysis (PCA)

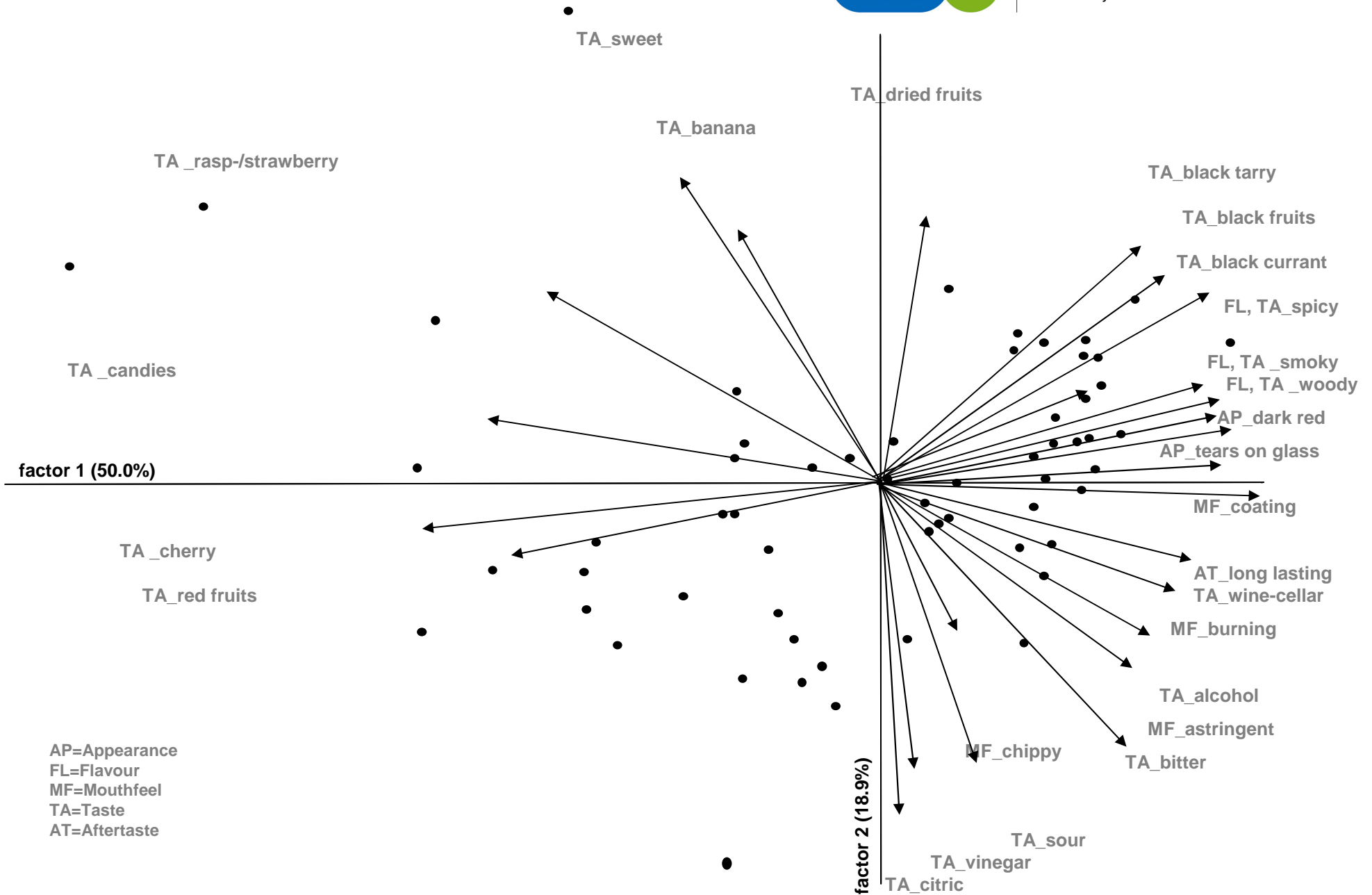
## Data considerations and calculation

- Take mean values for all products and interesting attributes
- Attributes:
  - Take all attributes
  - Consider only significant attributes
  - Consider a subset of attributes like all taste attributes
- Calculate the principal component analysis
- From the output/results take the 'loadings' for the attributes and the 'scores' for the products.
- Consider the first 2 PCAs first and draw a scatter plot.
- If following PCAs show a relatively big amount of variability, consider them in following charts.

# Biplot EPP Red



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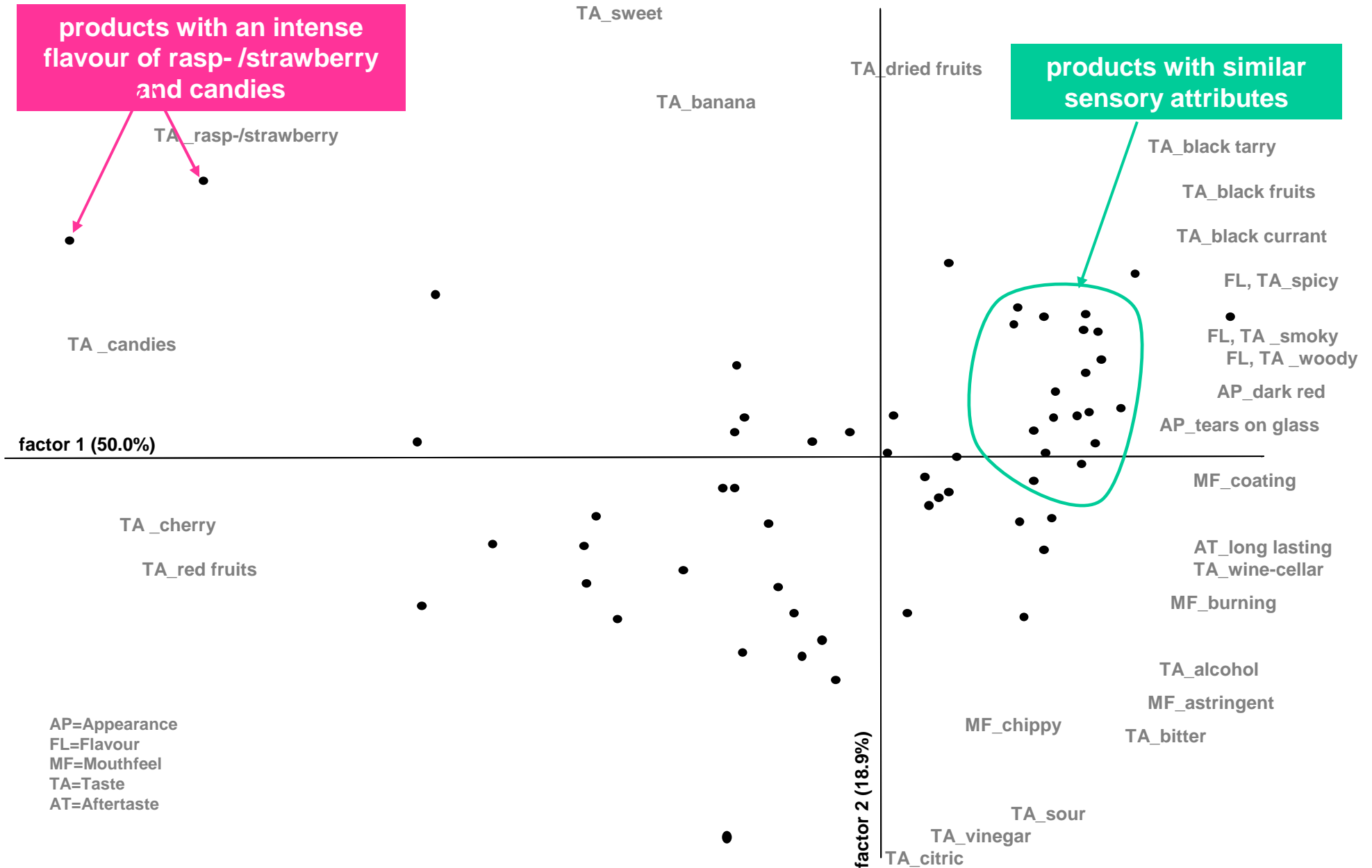


AP=Appearance  
FL=Flavour  
MF=Mouthfeel  
TA=Taste  
AT=Aftertaste

# Biplot EPP Red



SAM ASAP Sensory and Marketing  
Germany



AP=Appearance  
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MF=Mouthfeel  
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AT=Aftertaste

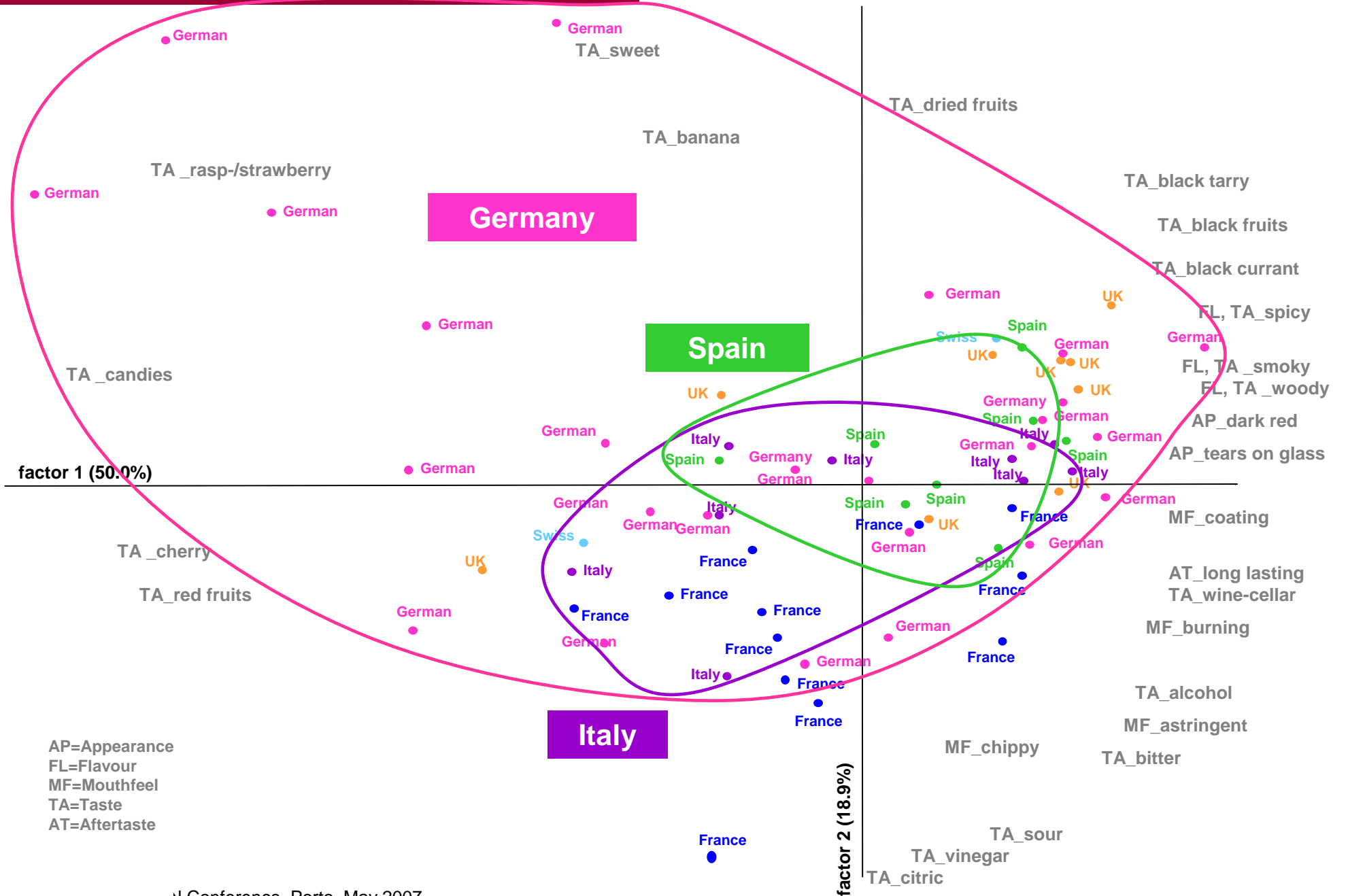
## Principal Component Analysis (PCA) - Interpretation

- ‘% of total variance’ for each PC shows the importance of each PC.
- Arrows with a small angle between them indicate high correlation between the corresponding attributes.
- The longer the arrow, the better the explanation of the respective attribute in the shown dimensions.
- Products that lie close together are judged similar for the attributes.
- Arrows of attributes describe the area in the plot concerning the products.

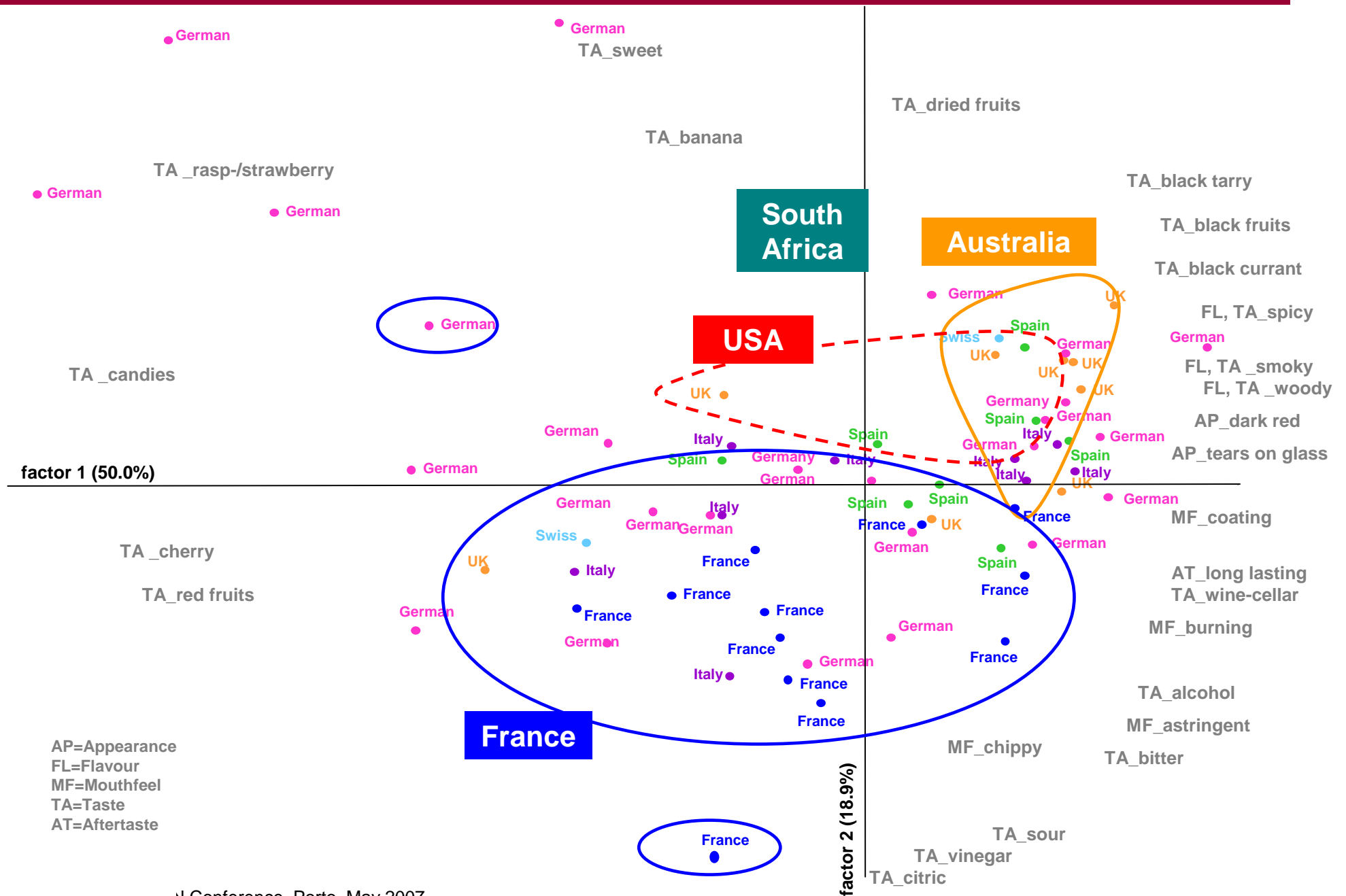
# Biplot EPP Red Wine -



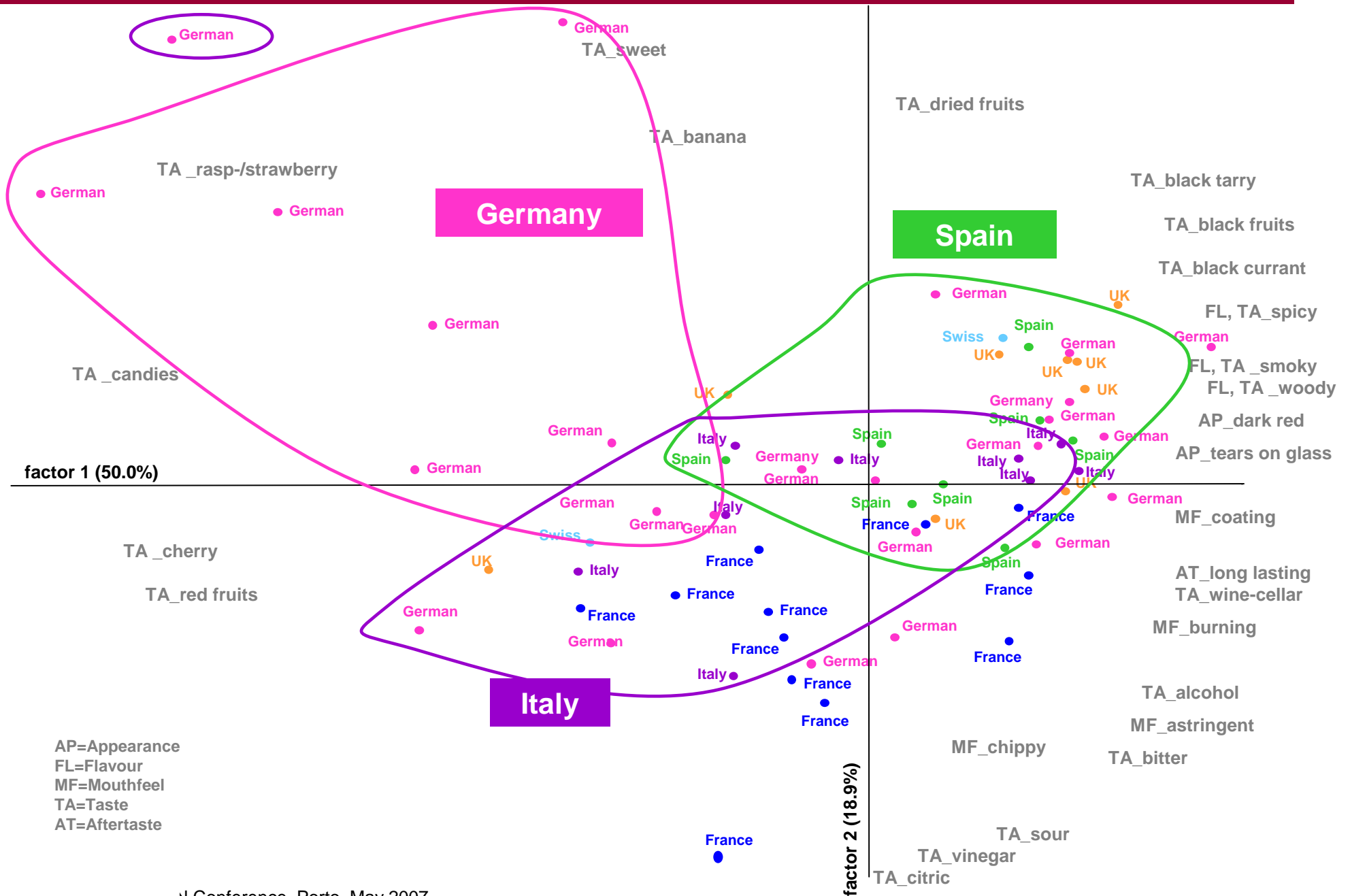
# Markets: Germany, Italy,



# COUNTRY OF ORIGIN: FRANCE/AUSTRALIA/USA/SOUTH AFRICA



# COUNTRY OF ORIGIN: GERMANY/ITALY/SPAIN



AP=Appearance  
 FL=Flavour  
 MF=Mouthfeel  
 TA=Taste  
 AT=Aftertaste

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## Background – Study and Data

### Coffee consumer study

- Consumers: 144 consumers
- Phone based screening from the SAM ASAP- consumer database after the following criteria:
- Location: Central location test Munich, Germany
- Gender: 60% male (N=88) / 40% female (N=56)
- Age: 18-29 years (N=73) / 30-49 years (N=71)
- 100% affinity to soluble coffees
  
- Products: 6 soluble coffees
- Questionnaire:



## Testing Procedure – Questionnaire - Scales

- Two kinds of scales were used to evaluate the products. A nine point category scale with two anchor points was used for the hedonic questions, a five point category scale was used for the just about right questions.

How do you like the mouthfeel of the product?

dislike          like

1 9

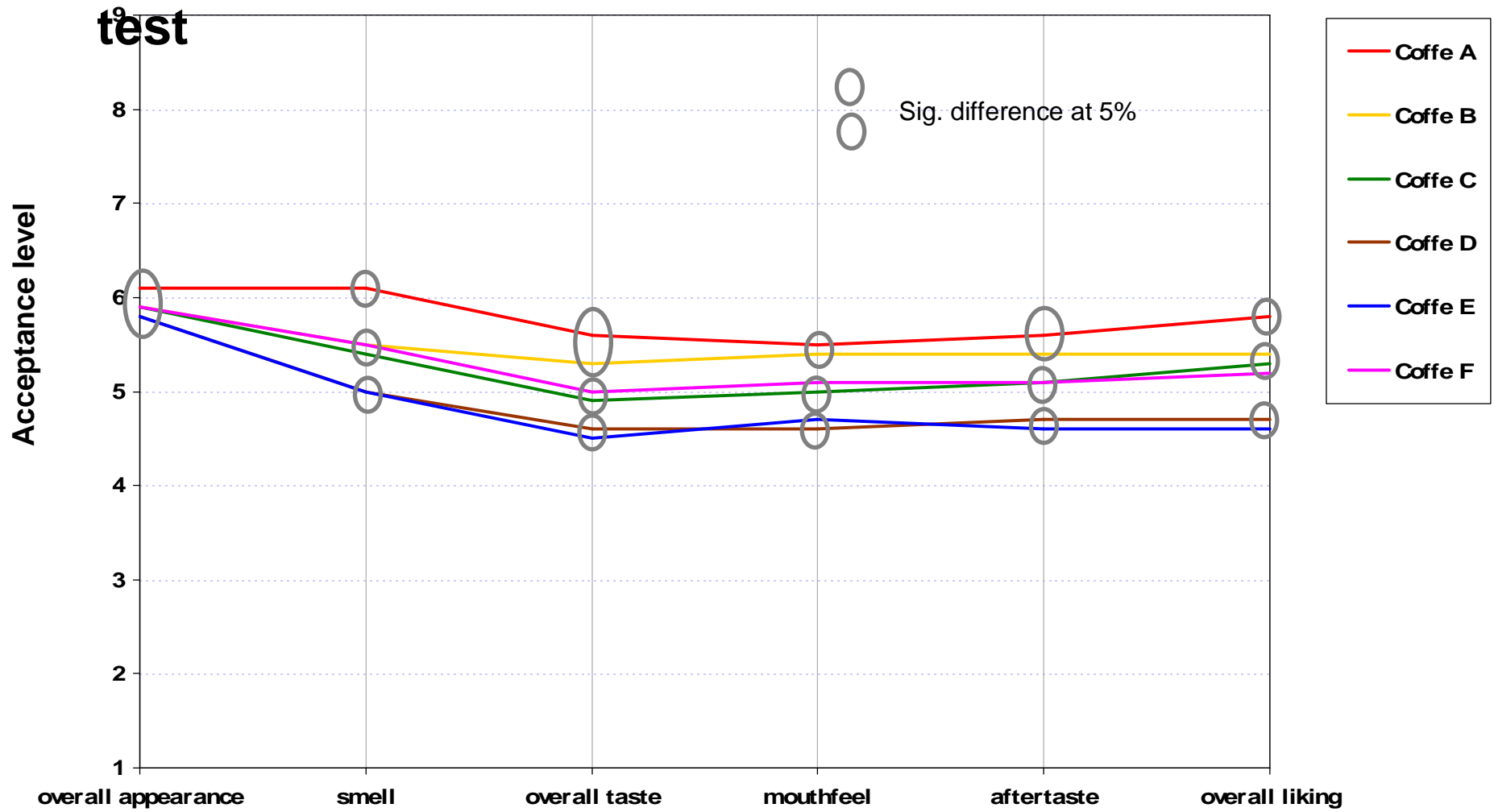
How do you judge the mouthfeel?

Mouthfeel

much too thin	too thin	just about right	too thick	much too thick
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
-2		0		+2

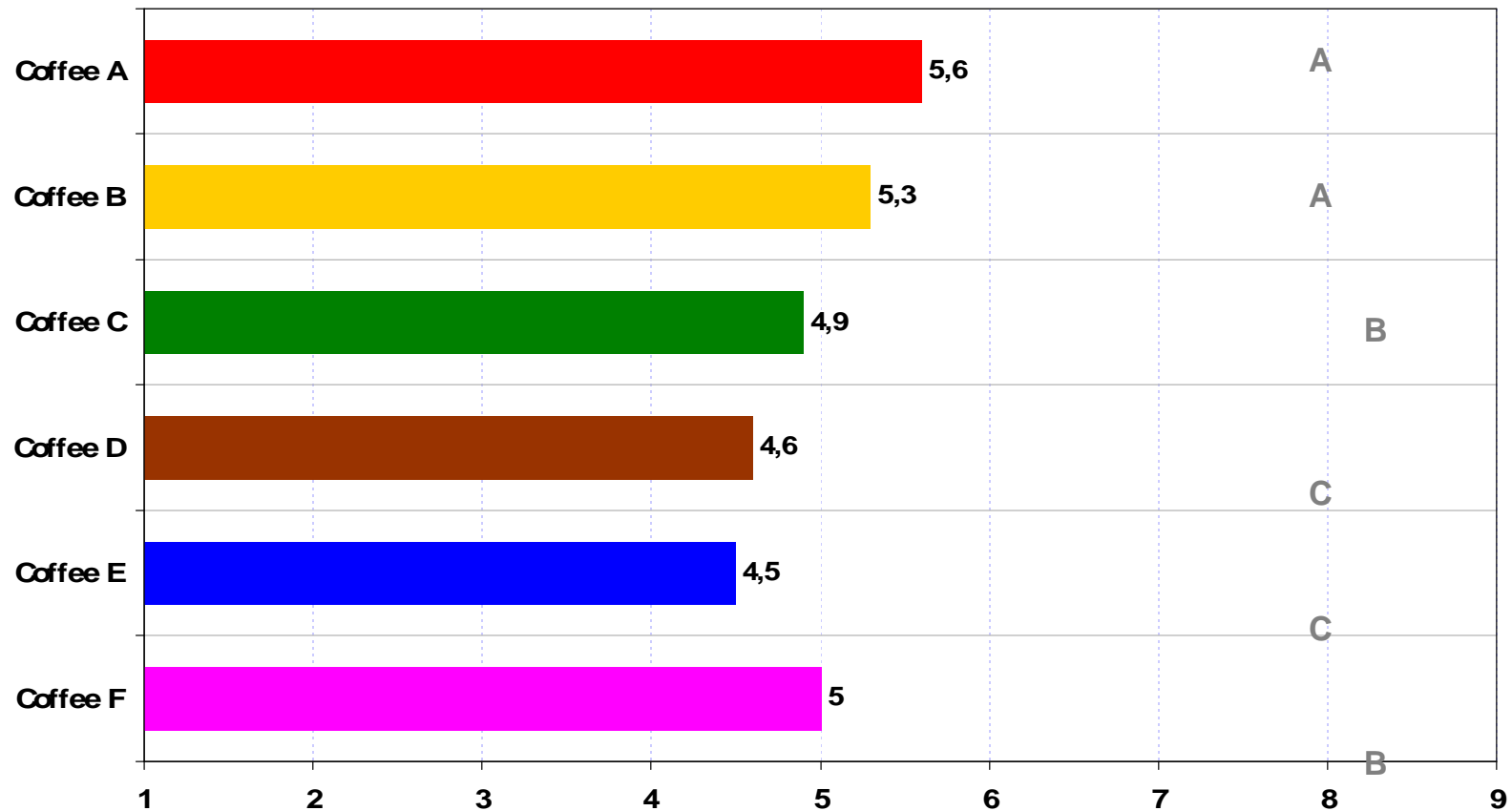
# Results – coffee (N=144)

## Hedonic questions – Means and ANOVA with Duncan



Acceptance scale:  
1 = worst judgment  
9 = best judgment

## Results – coffee (N=144) Overall taste



Significant differences are described by different letters  
(level of significance = 5% ).

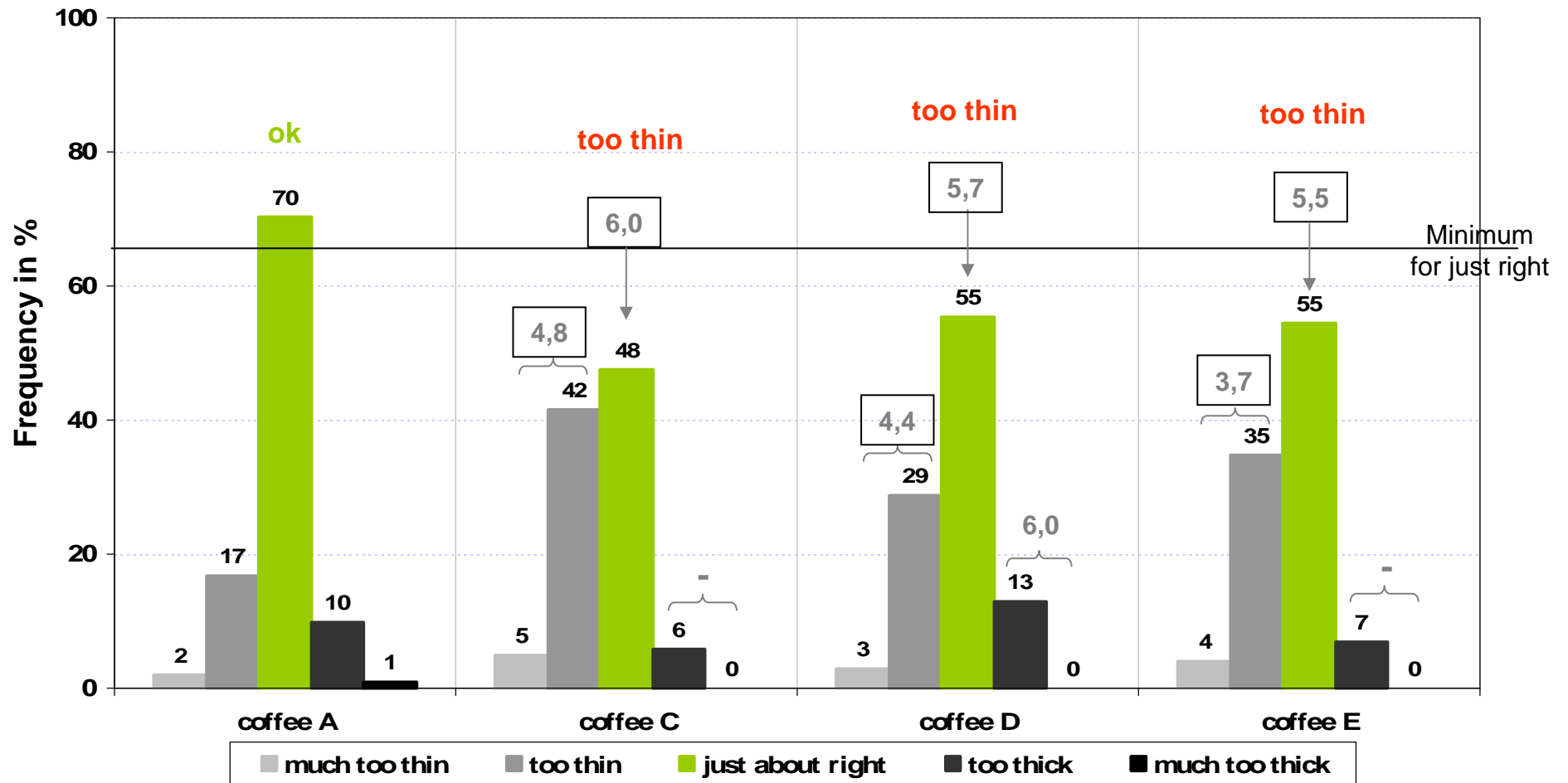
Acceptance scale:  
1 = worst judgment  
9 = best judgment

## Results „just about right“ questions Penalty Analysis

- „ok“ indicates that the product is perceived as just right by at least 65% of the consumers for that specific dimension.
- A sensory dimension is „not relevant“ if the means of the answers that differ from just right have no significant influence on the overall liking of the product.
- A sensory dimension has an „optimization potential“ if the means of the answers that differ from just right have a significant influence on the overall liking in both directions.
- Indications for improvement are described - for example - as „too thin“ (numbers in brackets display the percentage of consumers having this perception). In this case it could be proved that the answers that differ from just right have a significant influence on the overall liking of the product. Consumers who judged the product not just right in the specific category considered the product in overall liking significantly worse than the consumers who said the product is just right.

# Penalty Analysis – coffee (N=144)

## Mouthfeel



Numbers in grey display the mean of overall liking for this group and product.



**Thank you for your attention!**

## **Contact**

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