



## ✨ Sensometric tutorial 4

# Analysing L-shape data in sensory and consumer sciences

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# Content

1. BACKGROUND

2. ANALYSIS OF L-SHAPE DATA

3. CASE STUDY - YOGHURT DATA

# BACKGROUND

# Sensory and Consumer information

- **Common approach to integrate sensory and consumer information**
  - Characterise the sensory properties of the new food products using trained assessors
  - Ask consumers their degree of liking for these new food products
  - Preference Mapping techniques are used to identify the most liked sensory properties

# Sensory and Consumer information

- **Key questions**

- Could we get more consumer information for improving sensory properties, marketing strategies, etc. of the new food products?
- Which consumer attributes (e.g. demographics, attitudes, habits, etc.) drive liking differences beyond varying preferences for the sensory properties?

# Sensory and Consumer information

## **Sensory and consumer information**

- sensory properties - **X** data (description: static, temporal)
- consumer perception - **Y** data (likings, choices,...)
- consumer attributes - **Z** data (demographics, habits, attitudes,...)

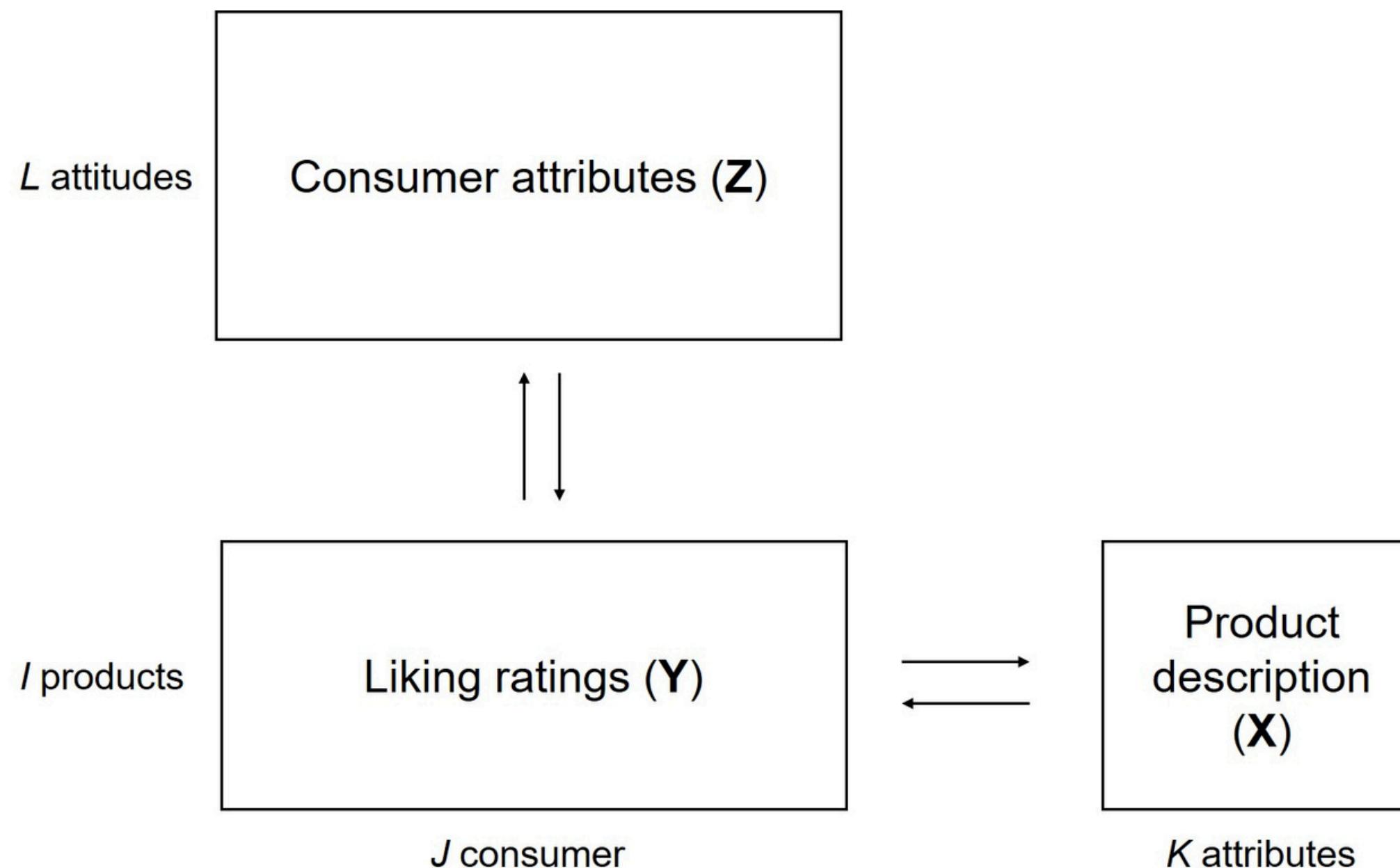
# Sensory and Consumer information

## Sensory and consumer information

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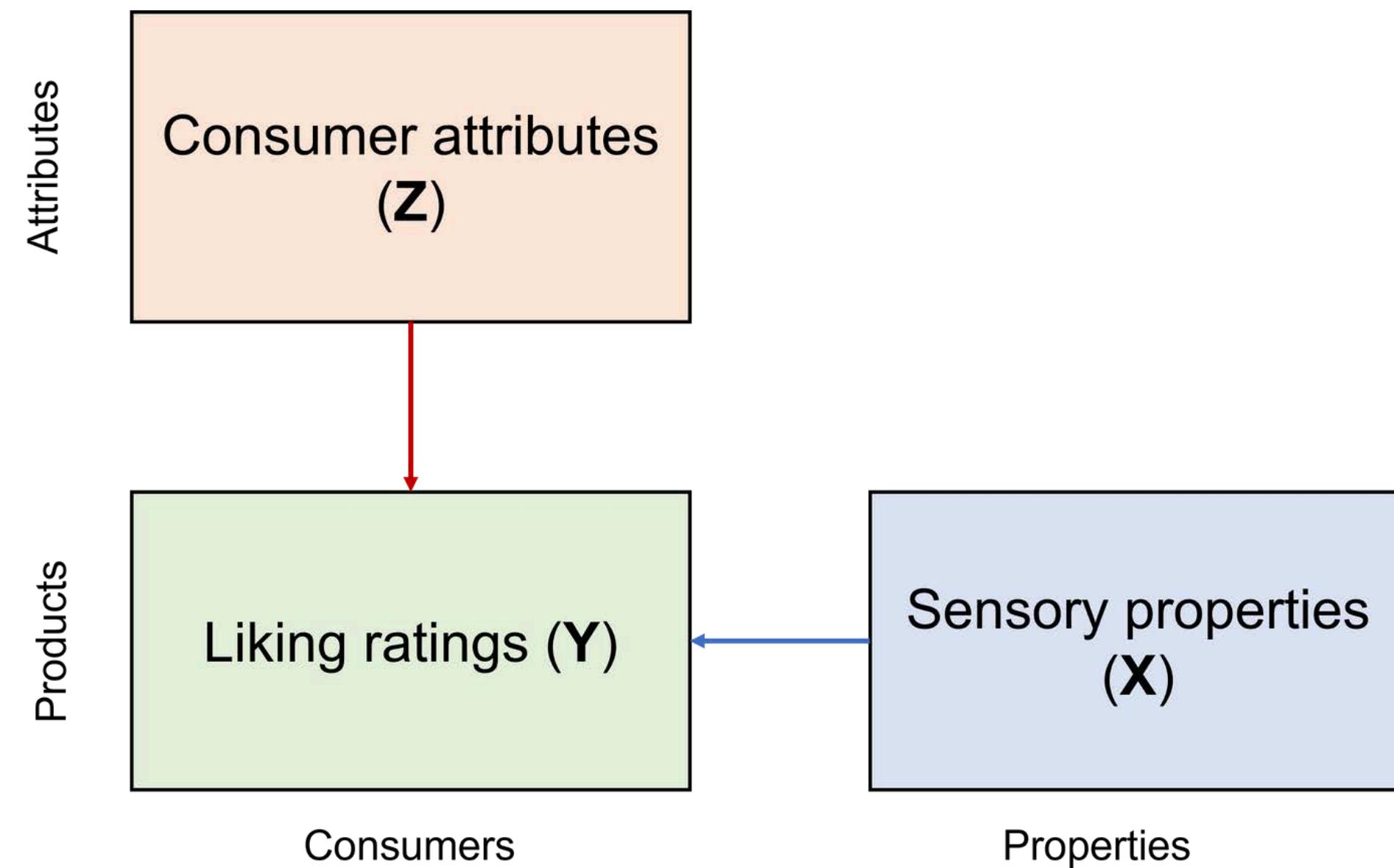
? **How to integrate these blocks (X,Y,Z) of data?**

# L-shape data



*Endo- regression*  
*Exo- regression*

# L-shape data



*Endo- regression*

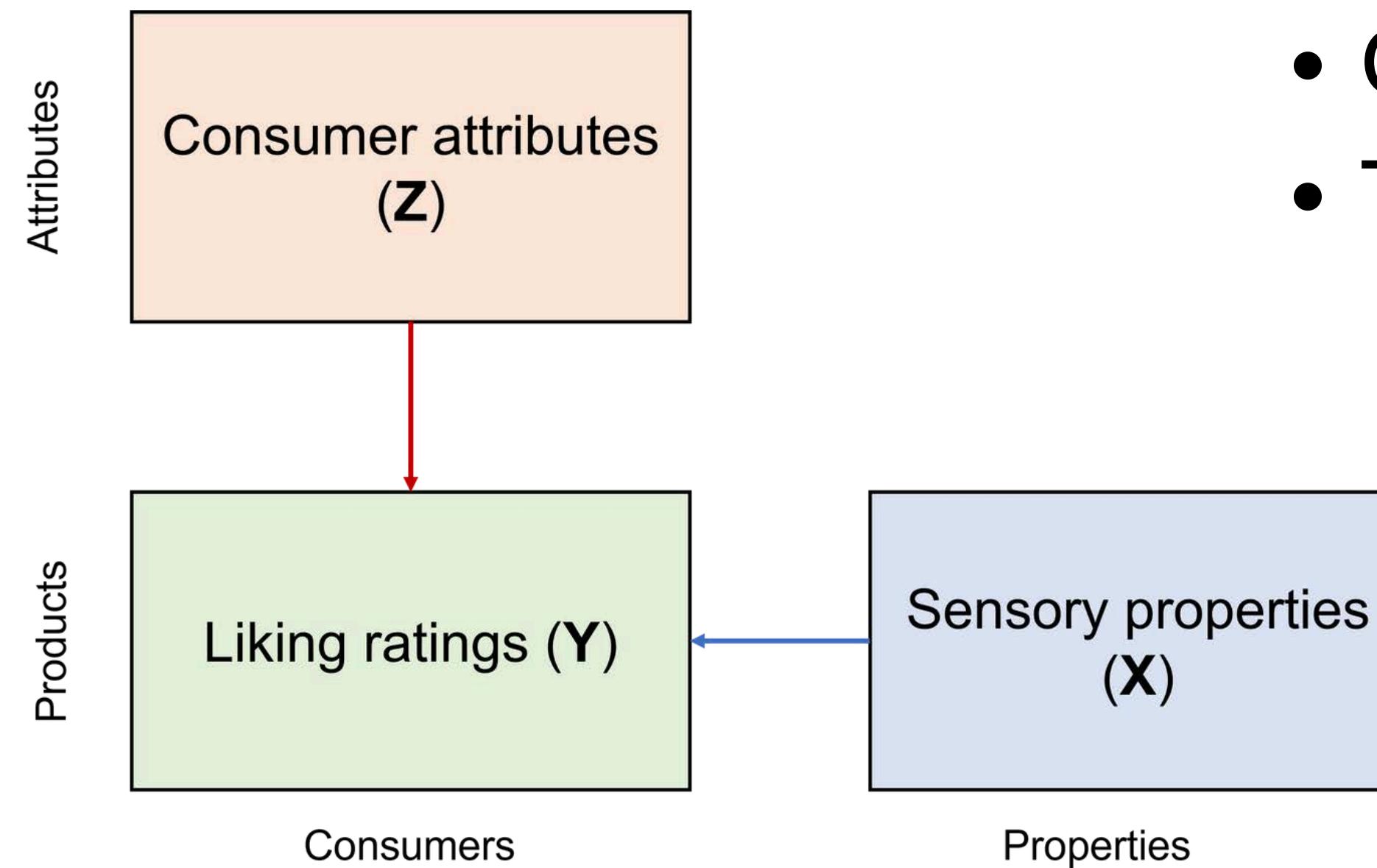
# ANALYSIS OF L-SHAPE DATA

I. L-shape data: one-step vs two-step procedure

II. Consumer segmentation

III. Multiblock in L-shape data

# L-shape data



- One-step L-PLS
- Two-step procedure (TSP)

# One-step vs Two-step

- One-step approach (*i.e. L-PLS*)
  - Consumer degree of liking ratings are approximated by a sum of ‘interactions’ between linear combinations of sensory properties, and consumer attributes
  - The L-PLS regression method used here is based on a **Singular Value Decomposition (SVD)** of  $\mathbf{X}'\mathbf{Y}\mathbf{Z}'$  with deflation between each component

# One-step vs Two-step

- One-step approach (*i.e. L-PLS*)
  - Consumer degree of liking ratings are approximated by a sum of ‘interactions’ between linear combinations of sensory properties, and consumer attributes
  - The L-PLS regression method used here is based on a **Singular Value Decomposition (SVD)** of  $\mathbf{X}'\mathbf{Y}\mathbf{Z}'$  with deflation between each component
  - Simple approach based on only one-step, but properties are not well understood

Attributes

Consumer attributes  
( $Z$ )

Products

Liking ratings ( $Y$ )

Sensory properties  
( $X$ )

Consumers

Properties

- One-step procedure (L-PLS)
  - SVD of  $X'YZ'$

# One-step vs Two-step

- **Two-step approach (*i.e. TSP*)**
  - **Step 1 (*horizontal direction*):** Analyse the relation between sensory properties and consumer degree of liking ratings using PLS regression
  - **Step 2 (*vertical direction*):** Consumer loadings are related to consumer attributes using PLS regression

# One-step vs Two-step

- **Two-step approach (*i.e. TSP*)**
  - **Step 1 (*horizontal direction*):** Analyse the relation between sensory properties and consumer degree of liking ratings using PLS regression
  - **Step 2 (*vertical direction*):** Consumer loadings are related to consumer attributes using PLS regression
  - Based on sequential use of well established methods, but the properties of the approach have not been investigated yet

Attributes

Consumer attributes  
( $Z$ )

Products

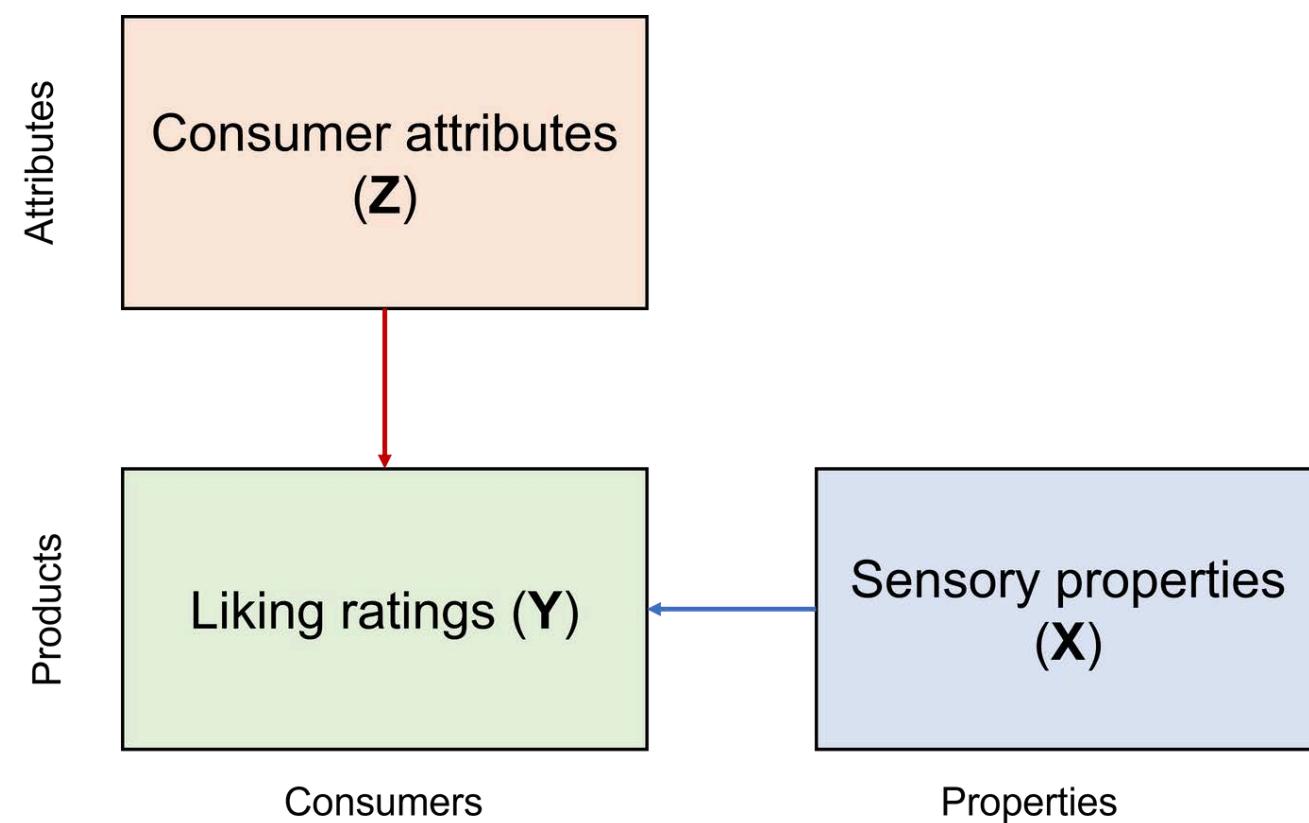
Liking ratings ( $Y$ )

Sensory properties  
( $X$ )

Consumers

Properties

- Two-step procedure (TSP)
  - Horiz. PLS:  $Y \sim X$
  - Verti. PLS:  $Y_{\text{loadings}} \sim Z$



- One-step procedure (L-PLS)

- SVD of  $X'YZ'$

- Two-step procedure (TSP)

- Horiz. PLS:  $Y \sim X$
- Verti. PLS:  $Y_{\text{loadings}} \sim Z$

I. L-shape data: one-step vs two-step procedure

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# Segmentation

Attitudes

Consumer attributes  
( $Z'$ )

Products

Liking ratings ( $Y$ )

Consumers

- **Prior segmentation**  
Social demography: age, gender, income
- **Posterior segmentation**  
Consumer likings, choices  
Consumer attitudes

# Segmentation

Attitudes

Consumer attributes  
( $Z'$ )

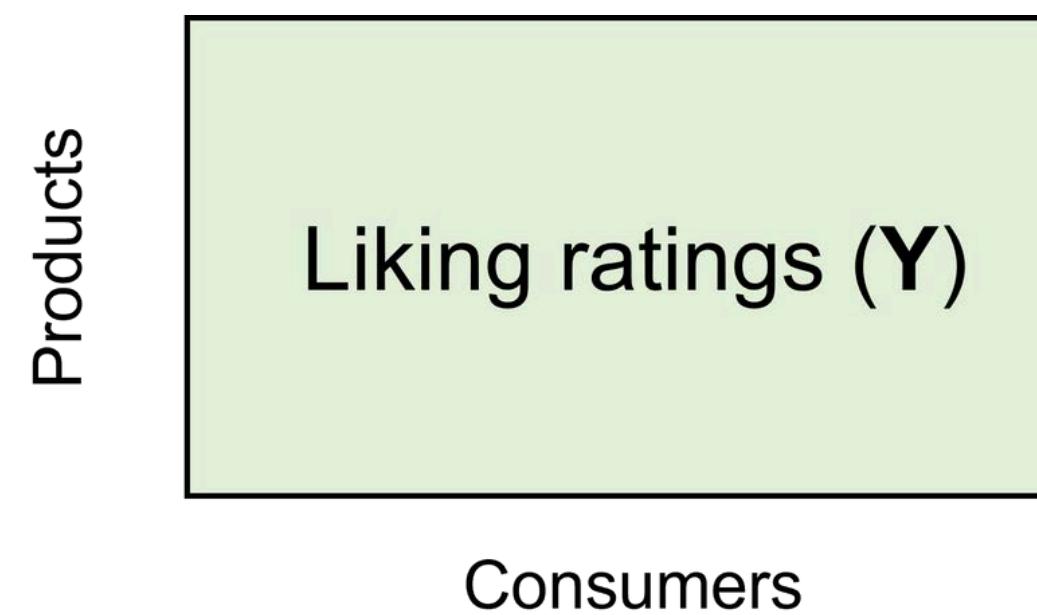
Products

Liking ratings ( $Y$ )

Consumers

- **Prior segmentation**  
Social demography: age, gender, income
- **Posterior segmentation**  
Consumer likings, choices  
Consumer attitudes

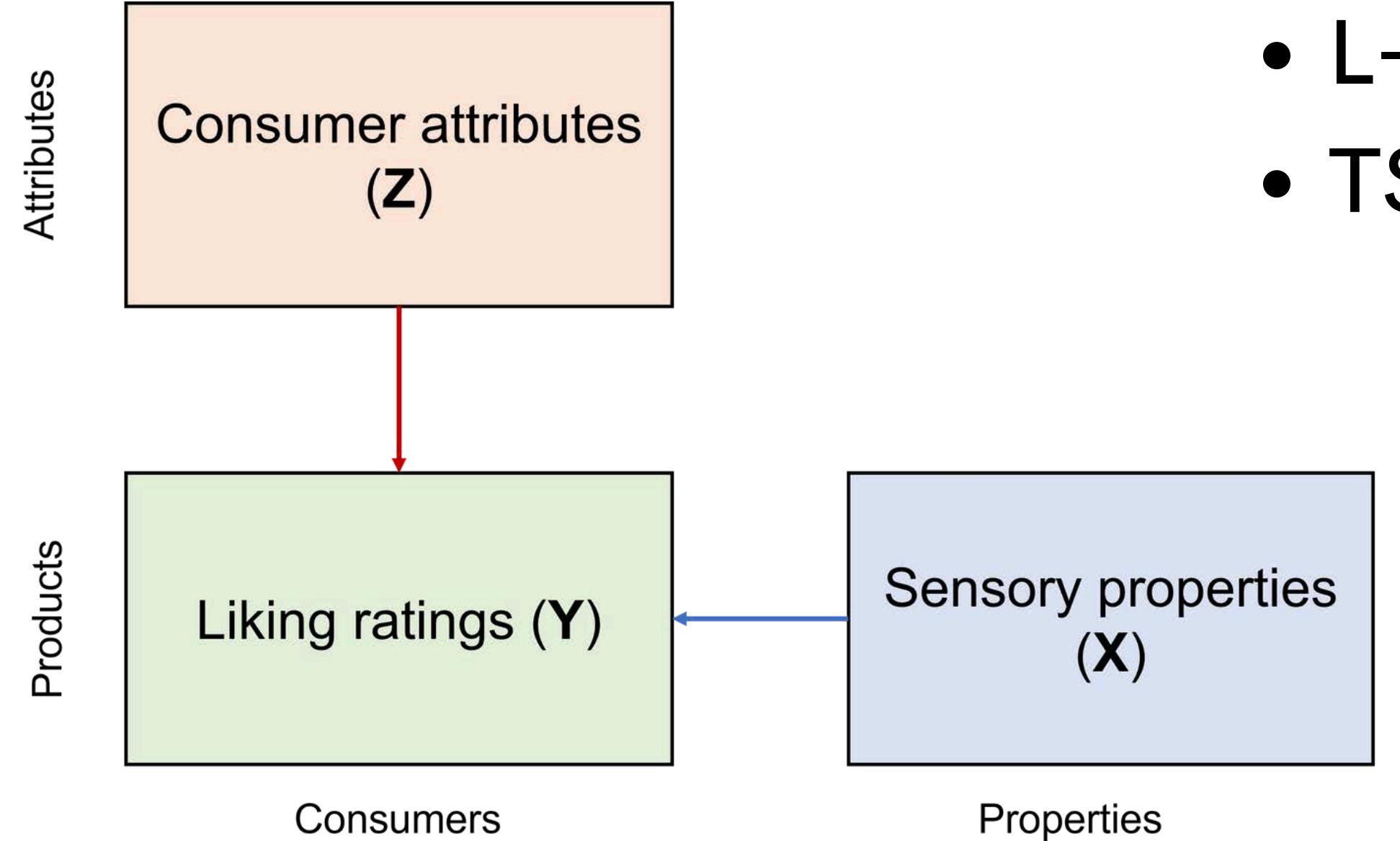
# Segmentation



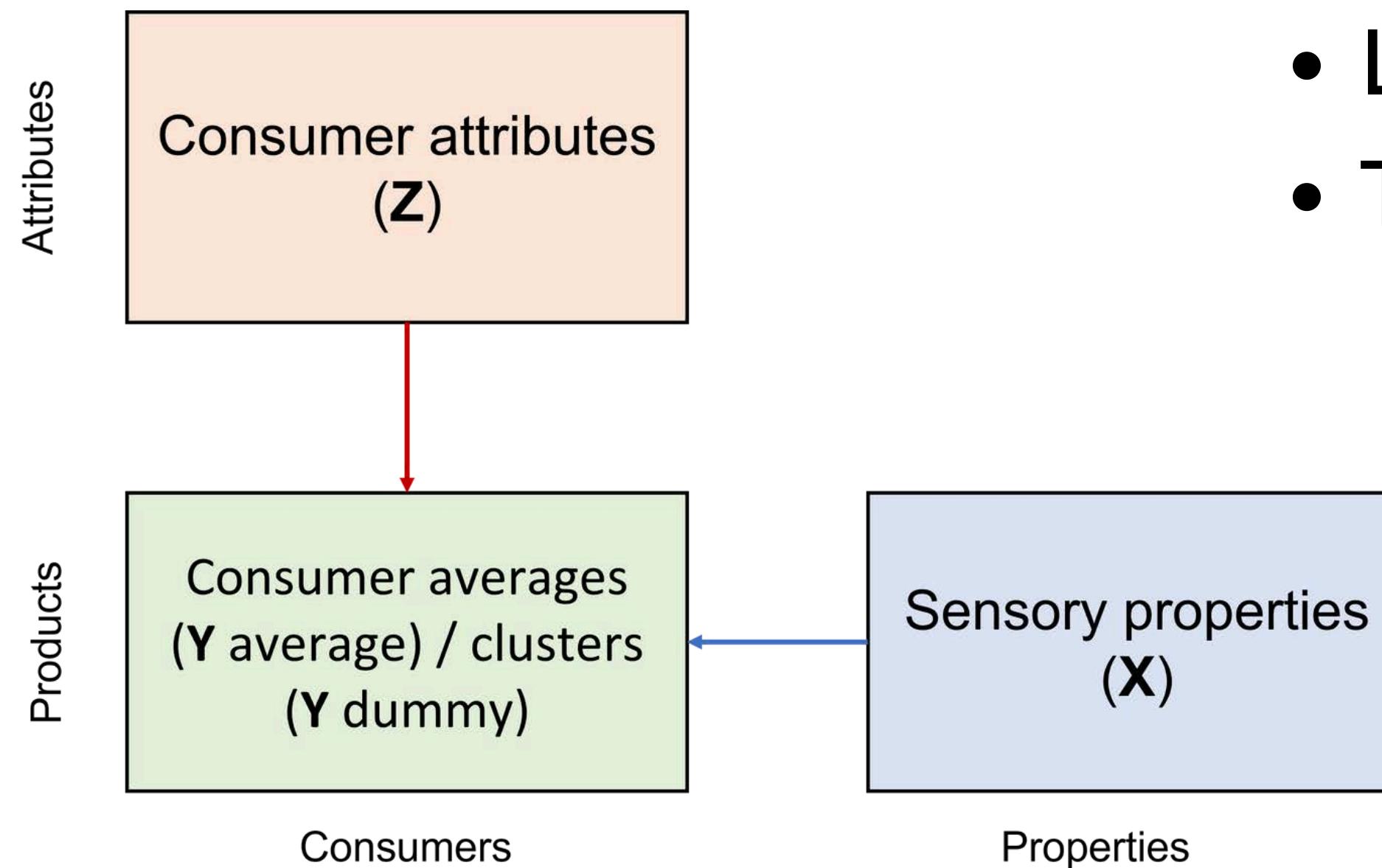
## Posterior segmentation

1. Mixed ANOVA Model: *liking ~ product + consumer*  
then, select **residuals**
2. Posteriori segmentation
  - Apply PCA on residuals
  - Determine segments based on PCA score (product) and loading (consumer) plots

# L-shape



# L-shape and Segmentation



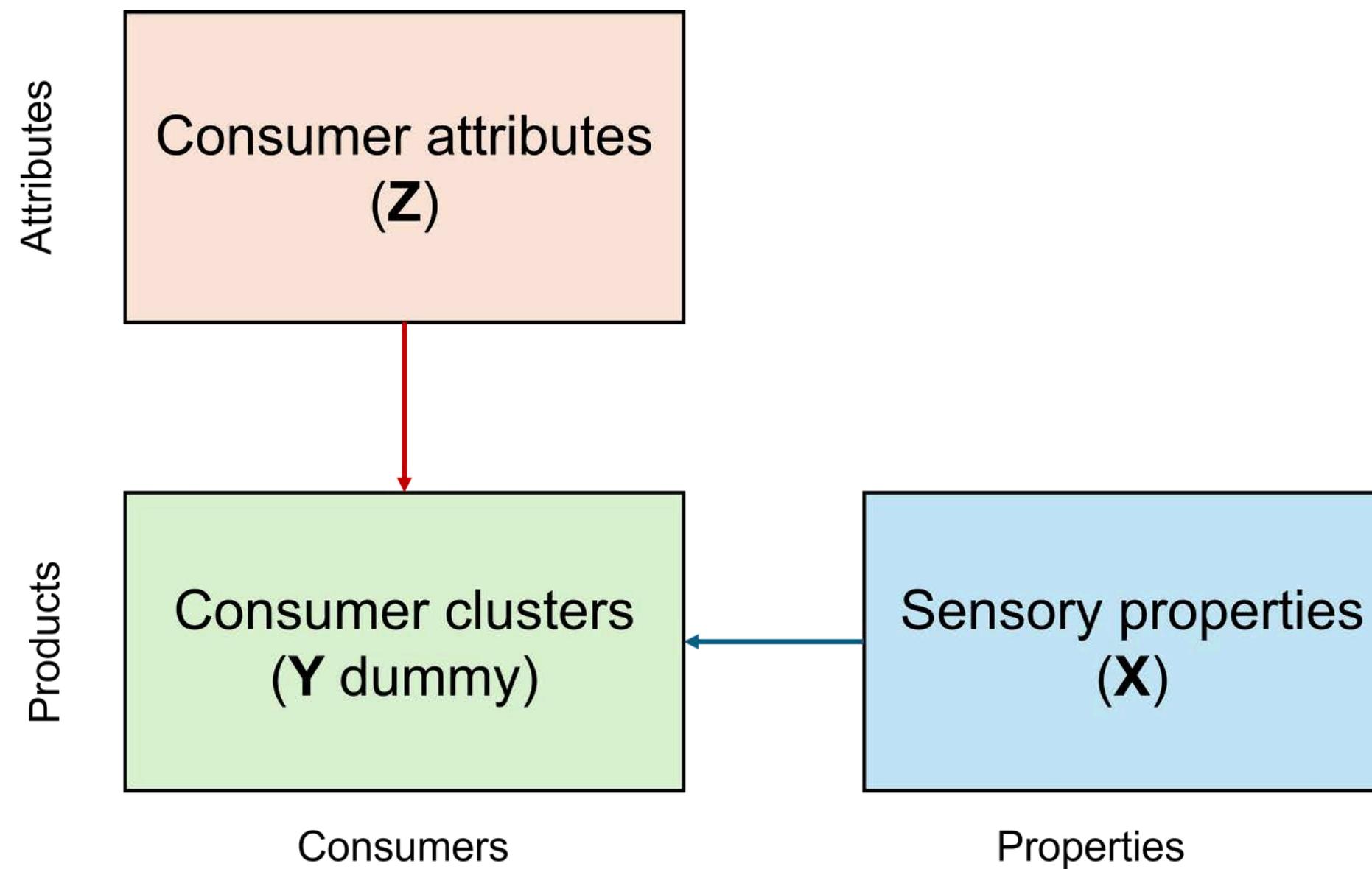
- L-PLS: averages ( $Y$ -average)
- TSP: clusters ( $Y$ -dummy)

# Y-average

Product	C1001	C1002	C1003	C1004	C1006	C1007	C1008	C1009
thin_fla_low	-4.53	-18.16	-18.16	-4.53	-4.53	-18.16	-21.51	-21.51
thick_fla_low	0.42	3.17	3.17	0.42	0.42	3.17	15.58	15.58
thin_flo_low	-11.13	-1.21	-1.21	-11.13	-11.13	-1.21	-16.47	-16.47
thick_flo_low	-2.05	9.18	9.18	-2.05	-2.05	9.18	8.07	8.07
thin_fla_opt	7.15	-15.95	-15.95	7.15	7.15	-15.95	-1.29	-1.29
thick_fla_opt	4.65	10.02	10.02	4.65	4.65	10.02	19.54	19.54
thin_flo_opt	1.09	-2.63	-2.63	1.09	1.09	-2.63	-13.57	-13.57
thick_flo_opt	4.40	15.58	15.58	4.40	4.40	15.58	9.65	9.65

- *Y-average is the matrix with products in rows, and consumers in columns*
- *Consumers belonging to the same segment have the same liking values*

## Y-average



L-PLS + segmentation

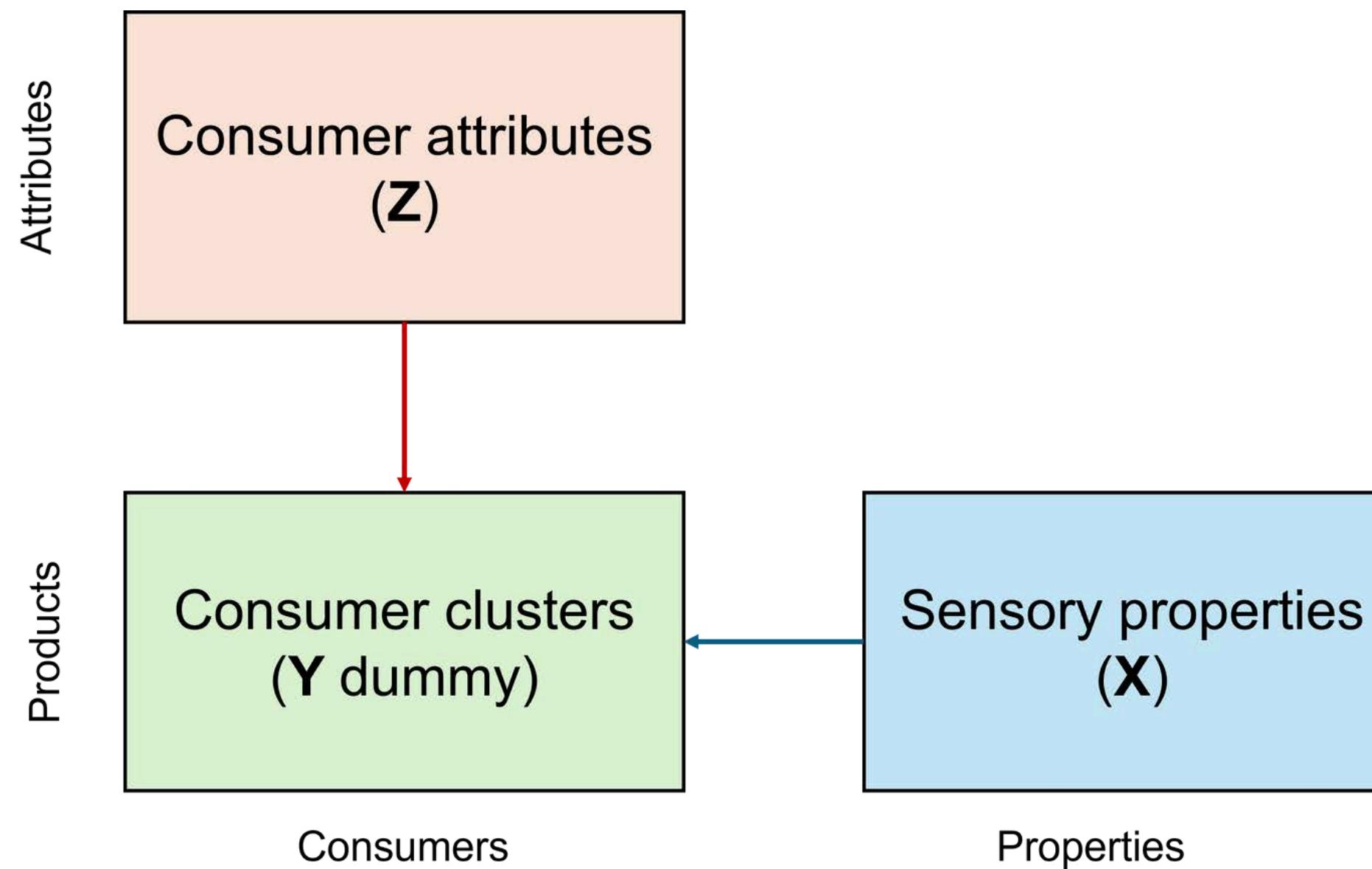
- SVD of  $\mathbf{X}'\mathbf{Y}_{\text{average}}\mathbf{Z}'$

# Y-dummy

Consumer	Cluster 1	Cluster 2	Cluster 3
C1001	1	0	0
C1002	0	1	0
C1003	0	1	0
C1004	1	0	0
C1006	1	0	0
C1007	0	1	0
C1008	0	0	1
C1009	0	0	1

- *Y-dummy is the matrix with consumers in rows, and segments in columns*
- *Consumers belonging to a cluster have the 1's, otherwise 0's*

## Y-dummy



### TSP + segmentation

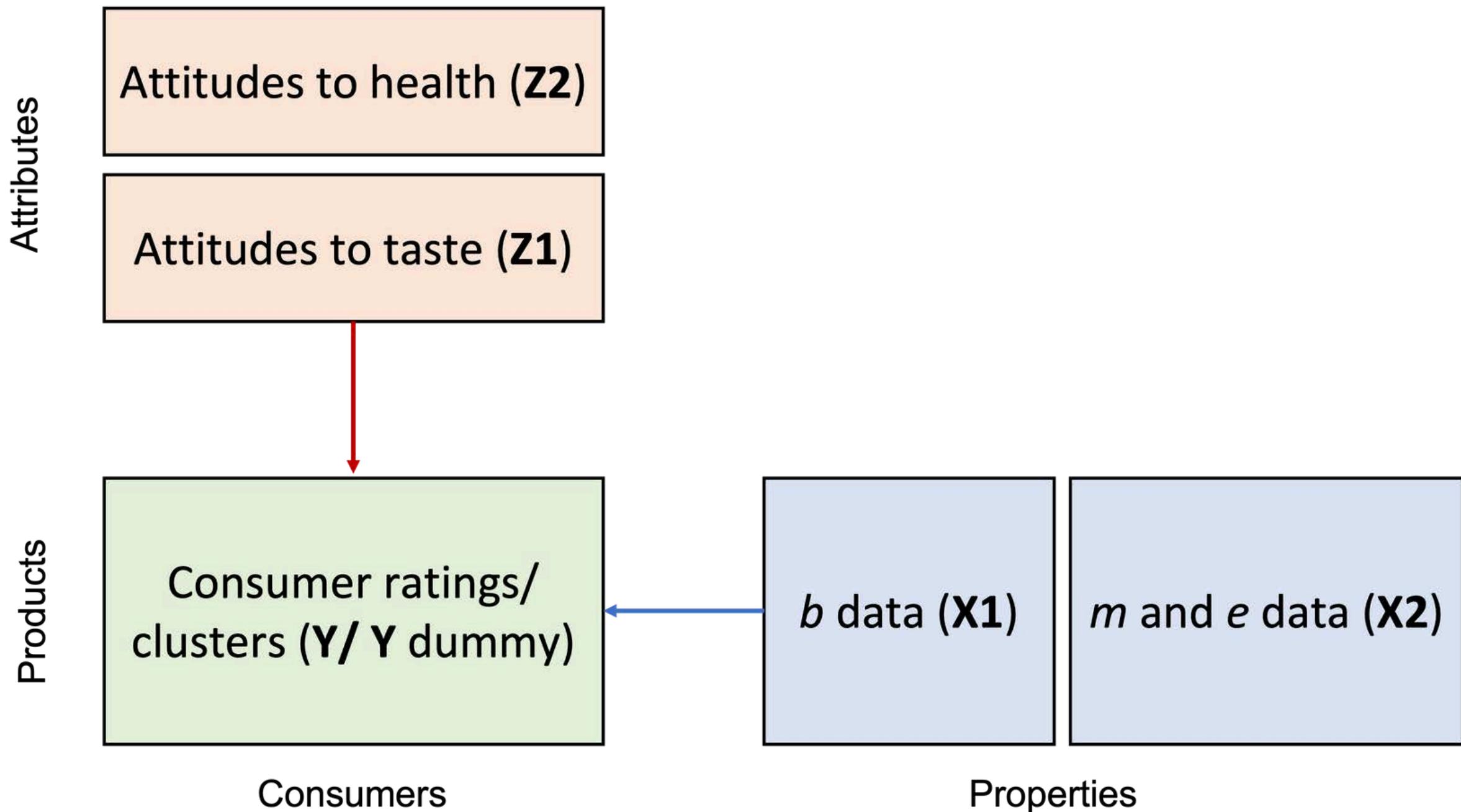
- Horiz. PLS:  $Y \sim X$
- Verti. PLS:  $Y_{\text{dummy}} \sim Z$

I. L-shape data: one-step vs two-step procedure

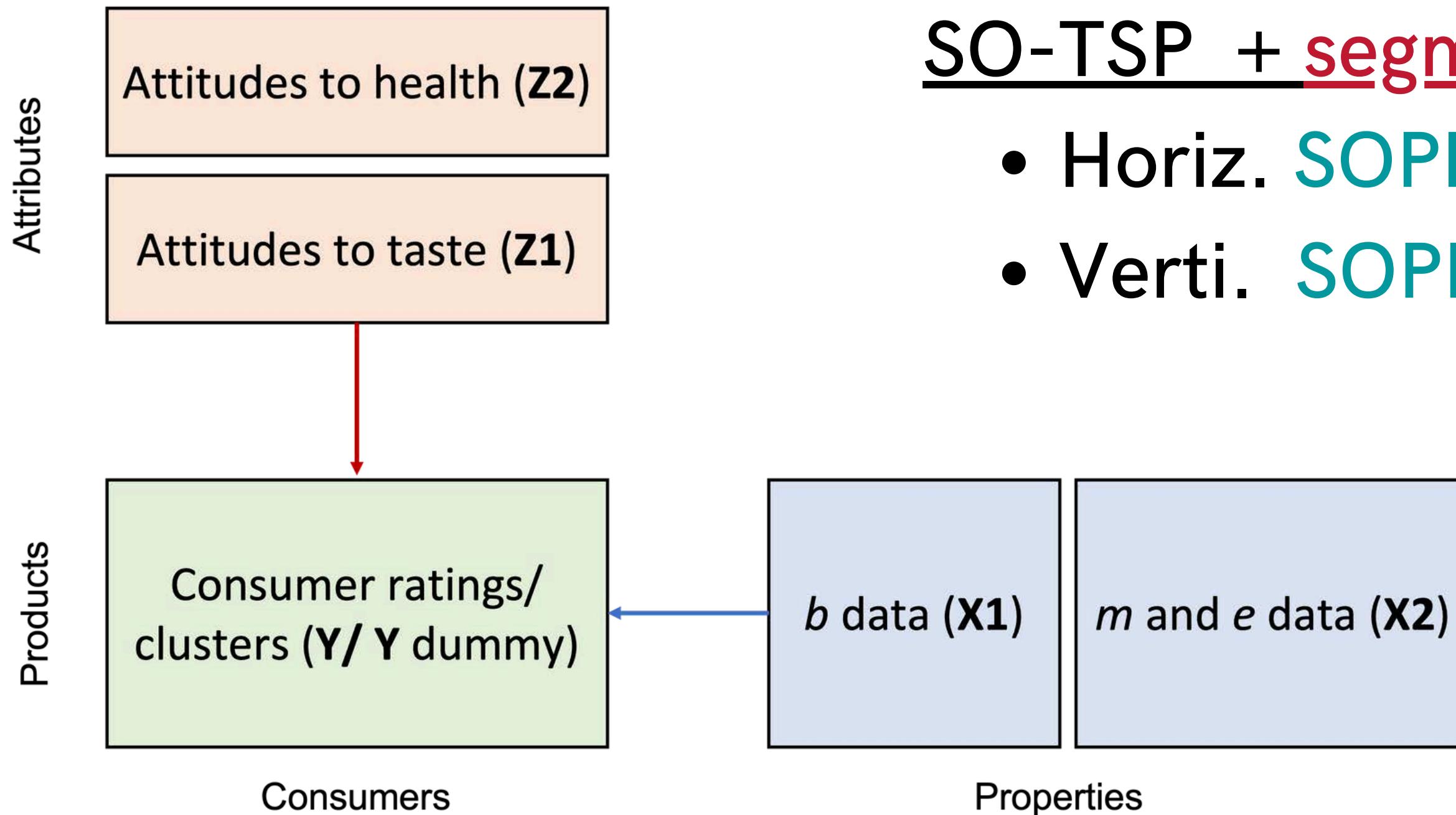
II. Consumer segmentation

III. Multiblock in L-shape data

# Multiblock L-shape data



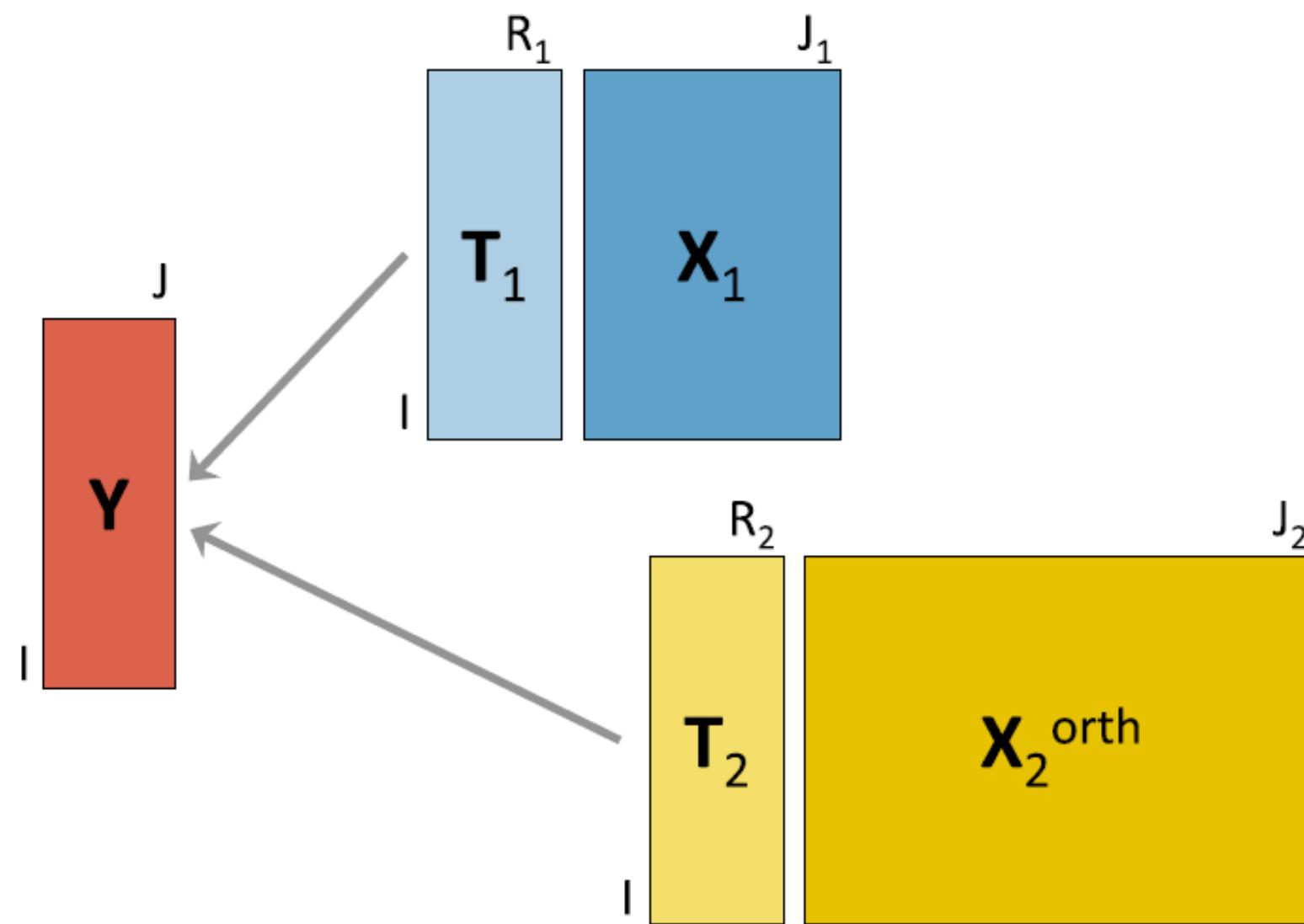
# Multiblock L-shape data



SO-TSP + segmentation

- Horiz. SOPLS:  $Y \sim X_1 + X_2$
- Verti. SOPLS:  $Y_{\text{dummy}} \sim Z_1 + Z_2$

# SOPLS regression



## First block

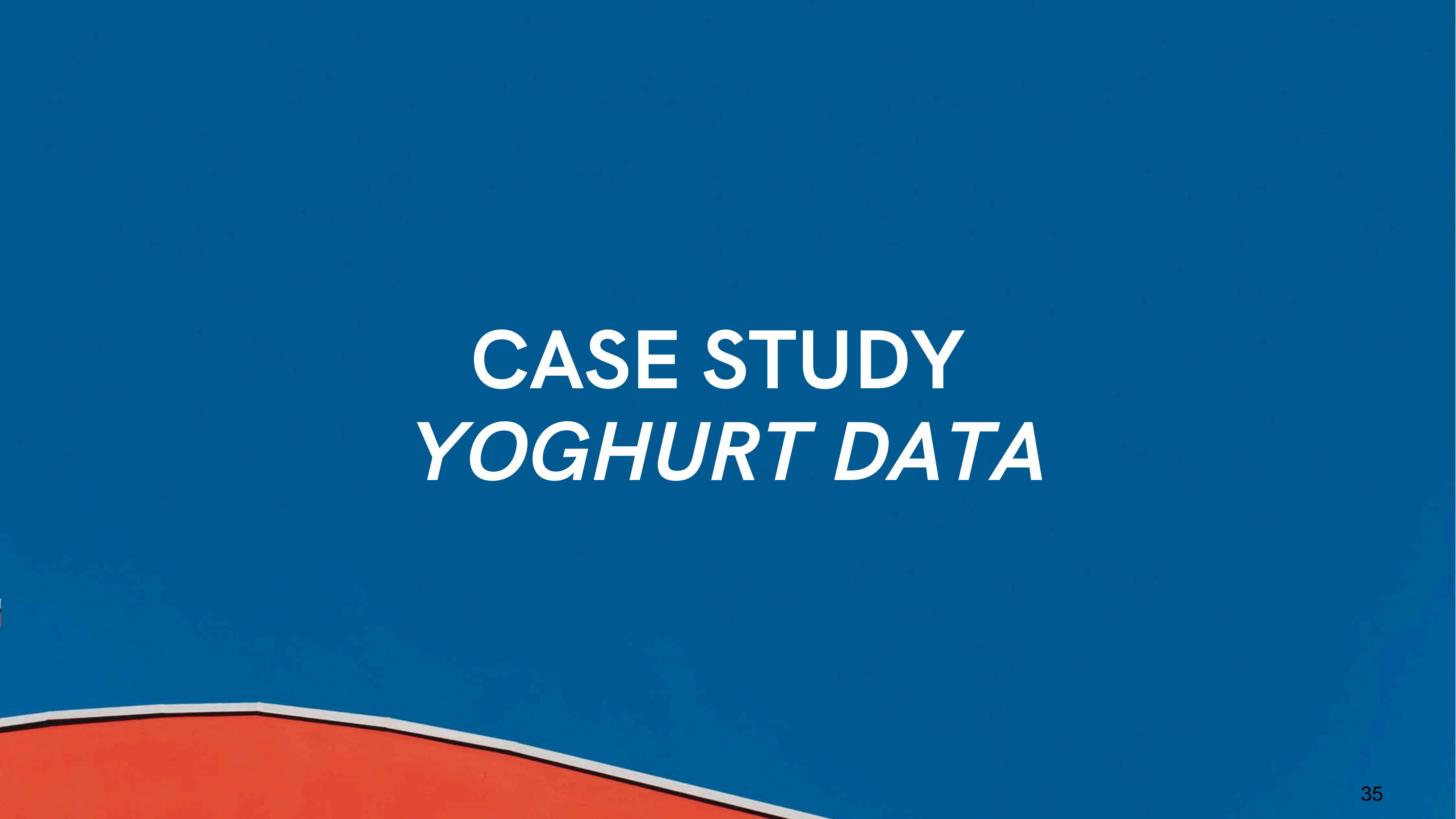
- 1 :  $PLS(\mathbf{X}_1, \mathbf{Y}) \Rightarrow \mathbf{T}_1, \mathbf{P}_1$  – PLS regression for  $\mathbf{X}_1$  and  $\mathbf{Y}$
- 2 :  $\mathbf{X}_2^{\text{orth}} = (\mathbf{I} - \mathbf{T}_1(\mathbf{T}_1^t \mathbf{T}_1)^{-1} \mathbf{T}_1^t) \mathbf{X}_2$  – orthogonalised  $\mathbf{X}_2$  wrt.  $\mathbf{T}_1$
- 3 :  $\mathbf{Y}^{\text{orth}} = (\mathbf{I} - \mathbf{T}_1(\mathbf{T}_1^t \mathbf{T}_1)^{-1} \mathbf{T}_1^t) \mathbf{Y}$  – orthogonalised  $\mathbf{Y}$  wrt.  $\mathbf{T}_1$

## Second block

- 4 :  $PLS(\mathbf{X}_2^{\text{orth}}, \mathbf{Y}^{\text{orth}}) \Rightarrow \mathbf{T}_2, \mathbf{P}_2$  – PLS regression for  $\mathbf{X}_2^{\text{orth}}$  and  $\mathbf{Y}^{\text{orth}}$
- 5 :  $\mathbf{Y} = \mathbf{T}_1 \mathbf{Q}_1 + \mathbf{T}_2 \mathbf{Q}_2 + \mathbf{F}$  – estimate prediction equation using LS



# CASE STUDY *YOGHURT DATA*



# Data collection

- 8 yoghurts following a full factorial design: *viscosity* (thin/thick), *particle size* (flake/flour), *flavour intensity* (low/optimal)
- Trained panel described **static** (QDA) and **dynamic sensory profiles** (TDS)
- 101 consumers tasted each sample and rated their **likings** on LAM scale
- Consumer attributes were collected from questionnaire of attitudes to **taste** and **healthiness** of food

# Consumer attributes

Consumer attributes and codes used in the plots.

Attribute	Definition
gen_1R	The healthiness of food has little impact on my food choices
gen_2	I am very particular about the healthiness of food I eat
gen_3R	I eat what I like and I do not worry much about the healthiness of food
gen_4	It is important for me that my diet is low in fat
gen_5	I always follow a healthy and balanced diet
gen_6	It is important for me that my daily diet contains a lot of vitamins and minerals
gen_7R	The healthiness of snacks makes no difference to me
gen_8R	I do not avoid foods, even if they may raise my cholesterol
lig_1R	I do not think that light products are healthier than conventional products
lig_2R	In my opinion, the use of light products does not improve one's health
lig_3R	In my opinion, light products don't help to drop cholesterol levels
lig_4	I believe that eating light products keep one's cholesterol level under control
lig_5	I believe that eating light products keeps one's body in good shape
lig_6	In my opinion by eating light products one can eat more without getting too many calories
nat_1	I try to eat foods that do not contain additives
nat_2R	I do not care about additives in my daily diet
nat_3	I do not eat processed foods, because I do not know what they contain
nat_4	I would like to eat only organically grown vegetables
nat_5R	In my opinion, artificially flavoured foods are not harmful for my health
nat_6R	In my opinion, organically grown foods are no better for my health than those grown conventionally

cra_1R	In my opinion it is strange that some people have cravings for chocolate
cra_2R	In my opinion it is strange that some people have cravings for sweets
cra_3R	In my opinion it is strange that some people have cravings for ice-cream
cra_4	I often have cravings for sweets
cra_5	I often have cravings for chocolate
cra_6	I often have cravings for ice-cream
rew_1	I reward myself by buying something really tasty
rew_2	I indulge myself by buying something really delicious
rew_3	When I am feeling down I want to treat myself with something really delicious
rew_4R	I avoid rewarding myself with food
rew_5R	In my opinion, comforting oneself by eating is self-deception
rew_6R	I try to avoid eating delicious food when I am feeling down
ple_1R	I do not believe that food should always be source of pleasure
ple_2R	The appearance of food makes no difference to me
ple_3	When I eat, I concentrate on enjoying the taste of food
ple_4	It is important for me to eat delicious food on weekdays as well as weekends
ple_5	An essential part of my weekend is eating delicious food
ple_6R	I finish my meal even when I do not like the taste of a food
Age	Age
Gender	Gender (1-male, 0-female)

**I. L-shape data: one-step vs two-step procedure**

**II. Consumer segmentation**

**III. Multiblock in L-shape data**

# Yoghurt samples

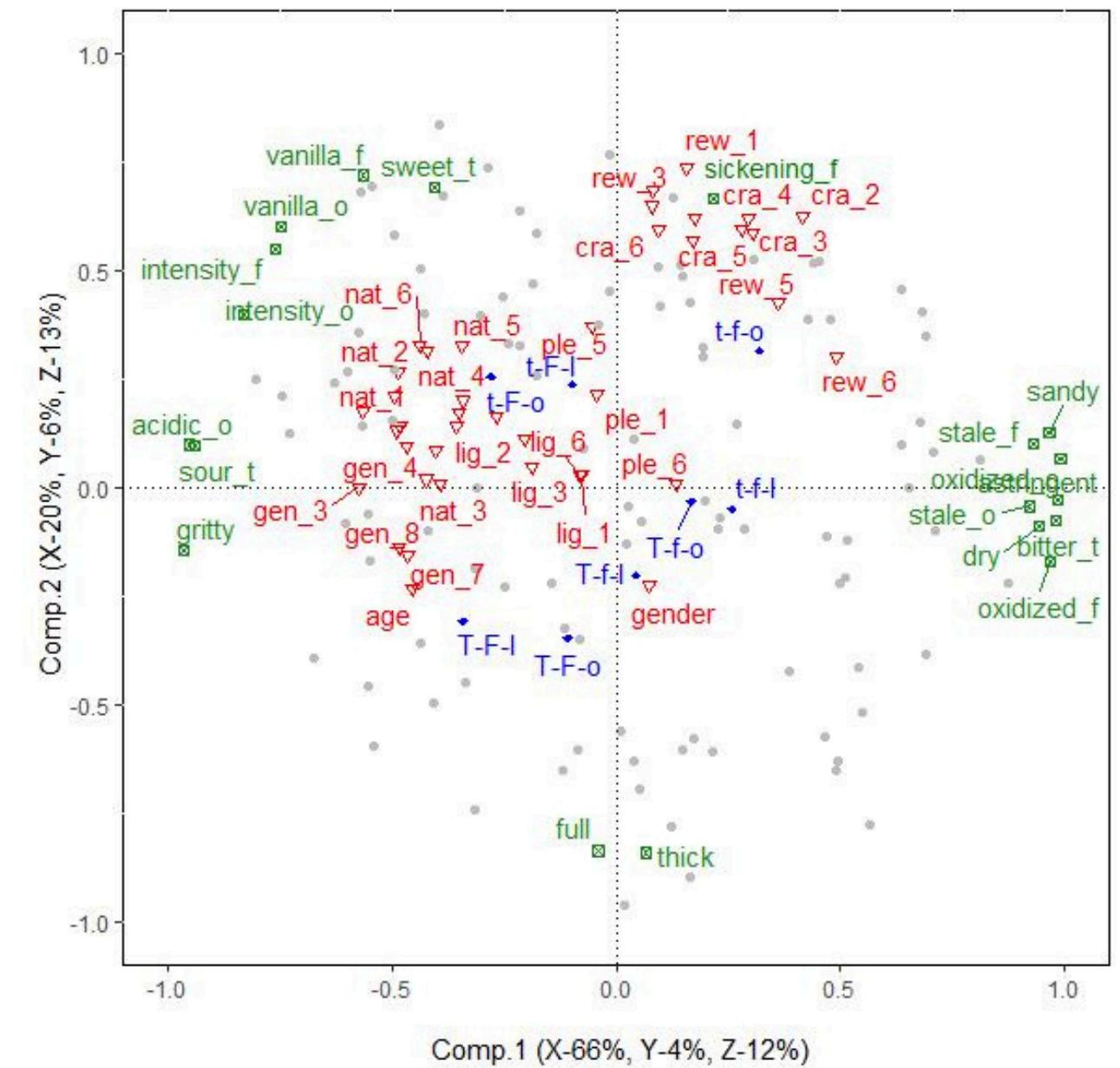
Formulation of yoghurt samples and the symbols used in plots.

Sample	Viscosity	Particle size	Flavour intensity
P1 (t-F-l)	Thin	Flakes	Low
P2 (T-F-l)	Thick	Flakes	Low
P3 (t-f-l)	Thin	Flour	Low
P4 (T-f-l)	Thick	Flour	Low
P5 (t-F-o)	Thin	Flakes	Optimal
P6 (T-F-o)	Thick	Flakes	Optimal
P7 (t-f-o)	Thin	Flour	Optimal
P8 (T-f-o)	Thick	Flour	Optimal

# 1. One-step (L-PLS)

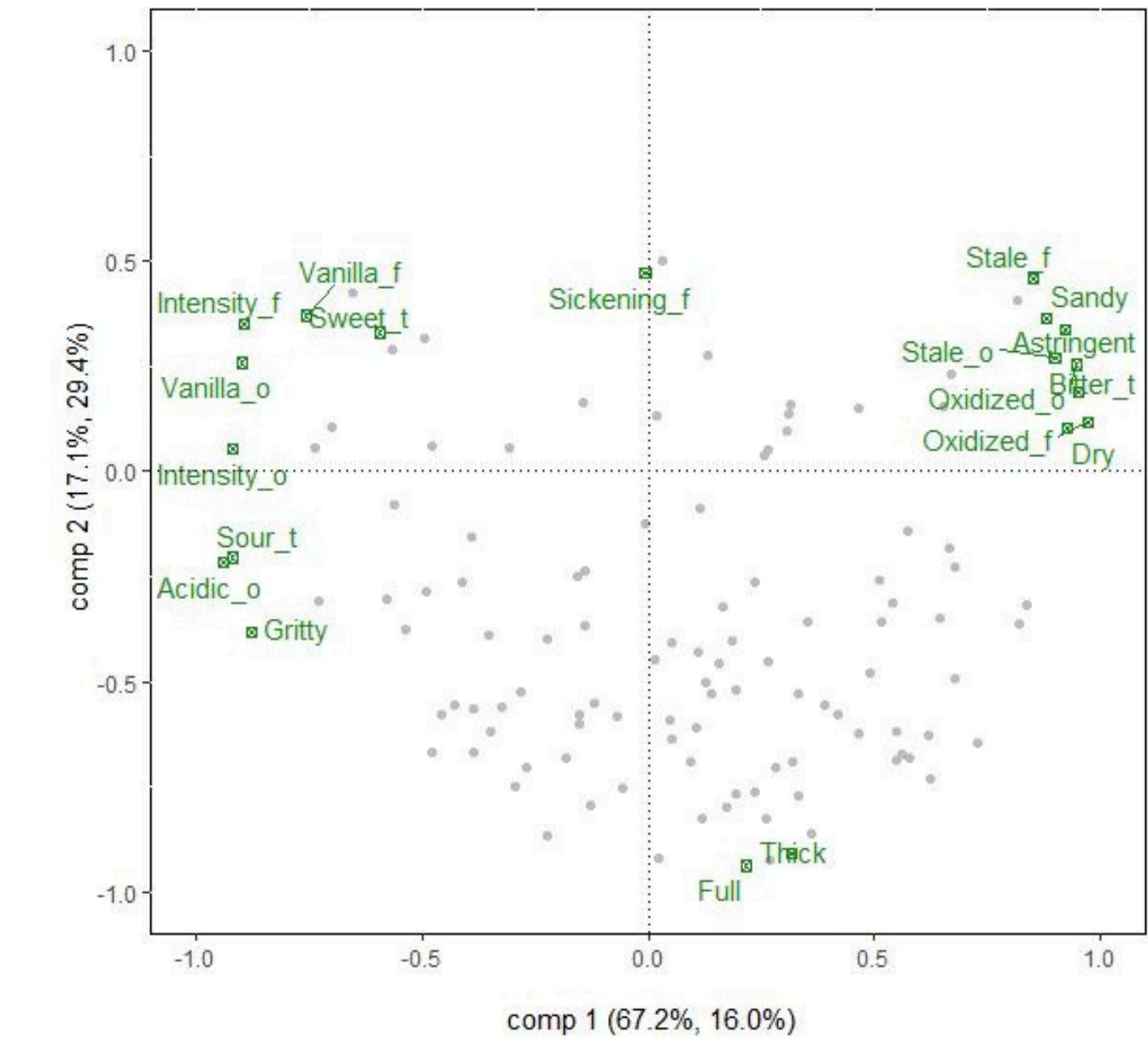
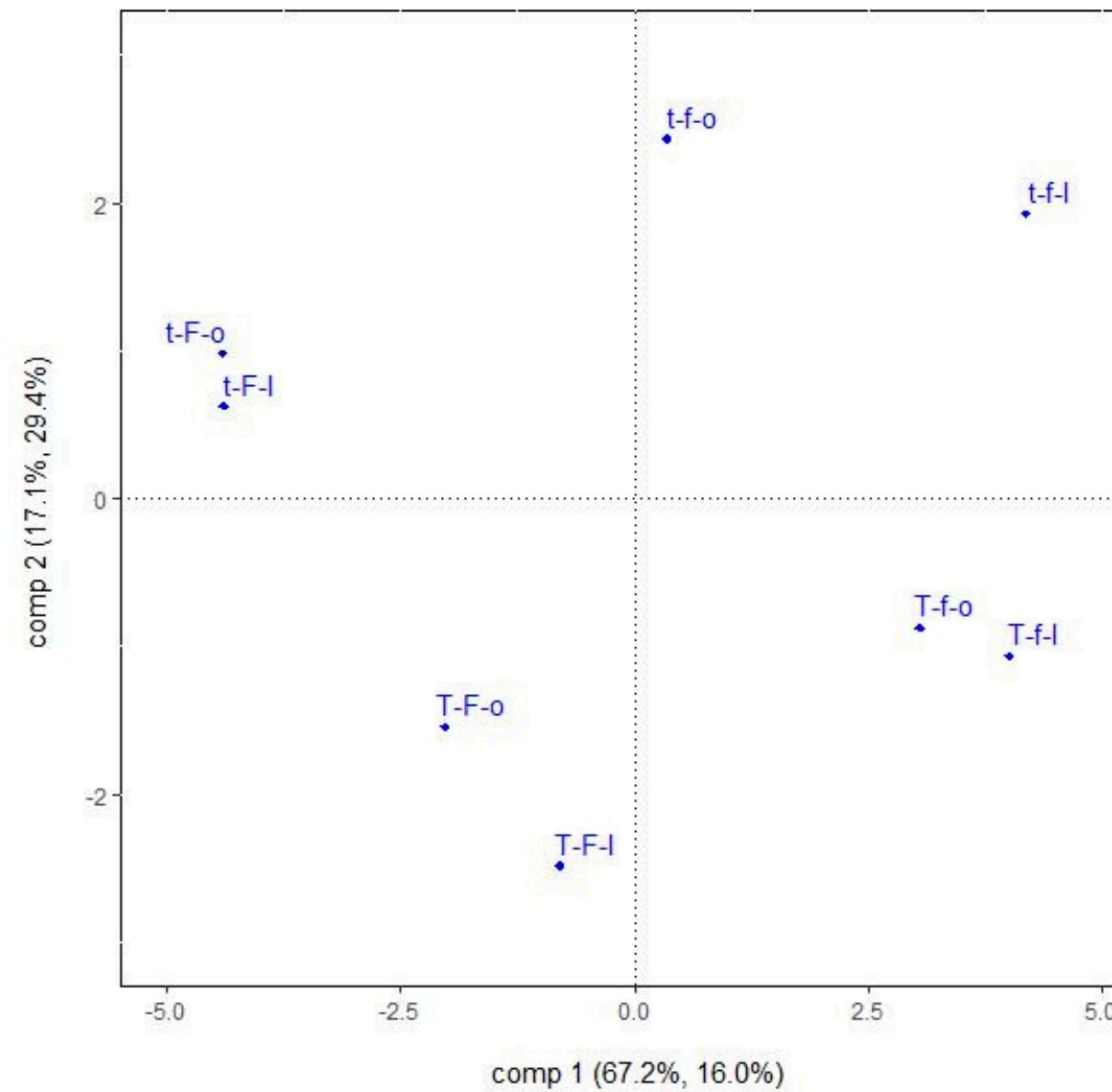
## L-PLS

- Consumers related to **reward** (rew\_1), **craving** (cra\_4) - yoghurts **less full, thick**
- Yoghurts **less full, thick**
- Consumers linked **health interest** and **pleasure** (nat\_2, lig\_1, ple\_1)
- *Flake yoghurts (t-F-I, T-F-I, t-F-o, T-F-o)*



## 2. Two-step (TSP)

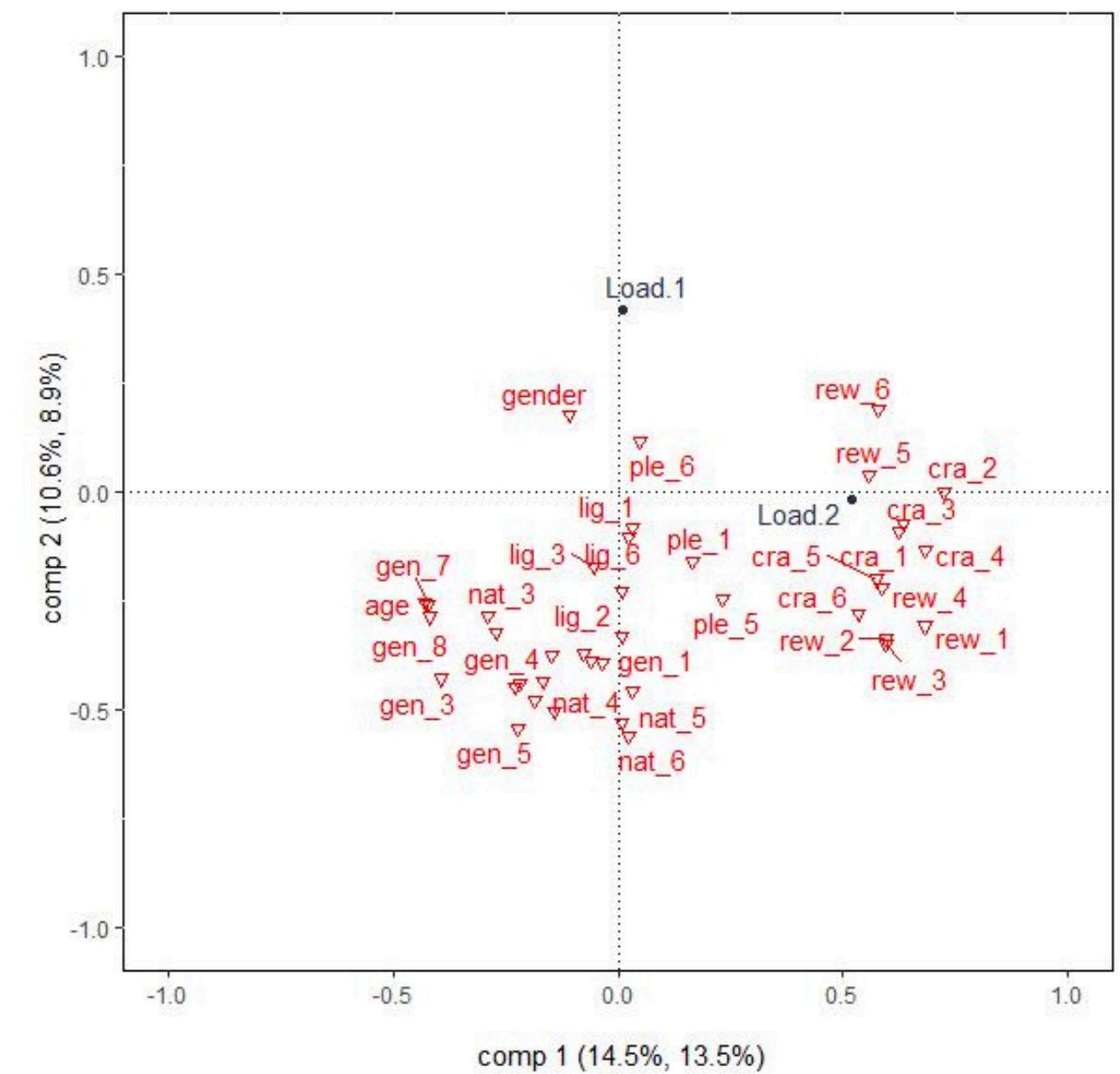
### Step 1: Y-X



## Step 2: Yloadings-Z

Consumers (*high Load.2*) related to taste

- food as reward (rew\_5, rew\_6)
- craving for sweet foods (cra\_4, cra\_5)

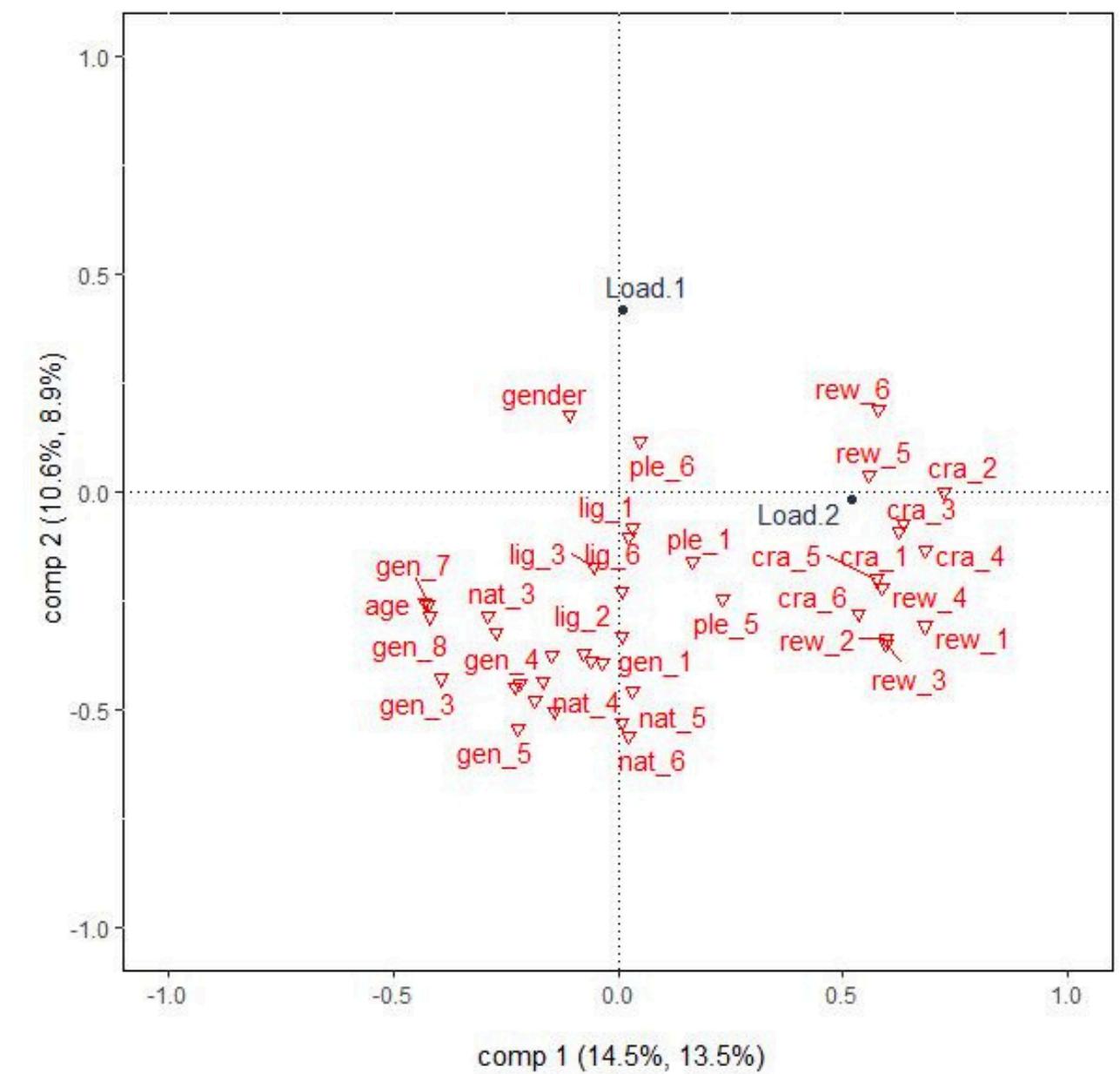


## Step 2: Yloadings-Z

Consumers (*high Load.2*) related to taste

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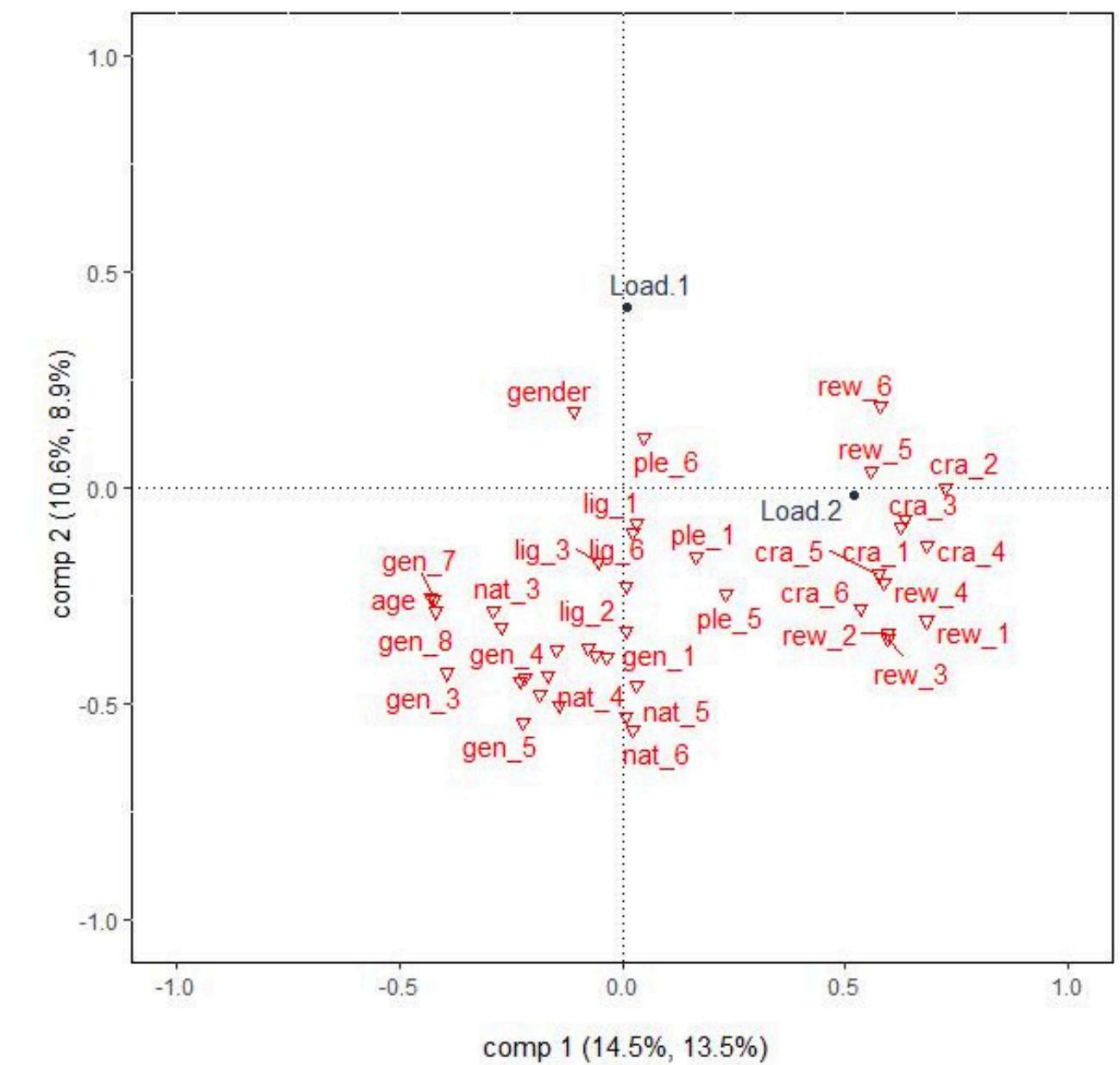
**Samples with low values of thick and full  
(t-f-l, t-f-o)**



## Step 2: Yloadings-Z

Consumers (*low Load.2, Load.1*) related to **health**

- general health interest (gen\_3, gen\_4)
- light product interest (lig\_2, lig\_3)
- natural product interest (nat\_4, nat\_5)

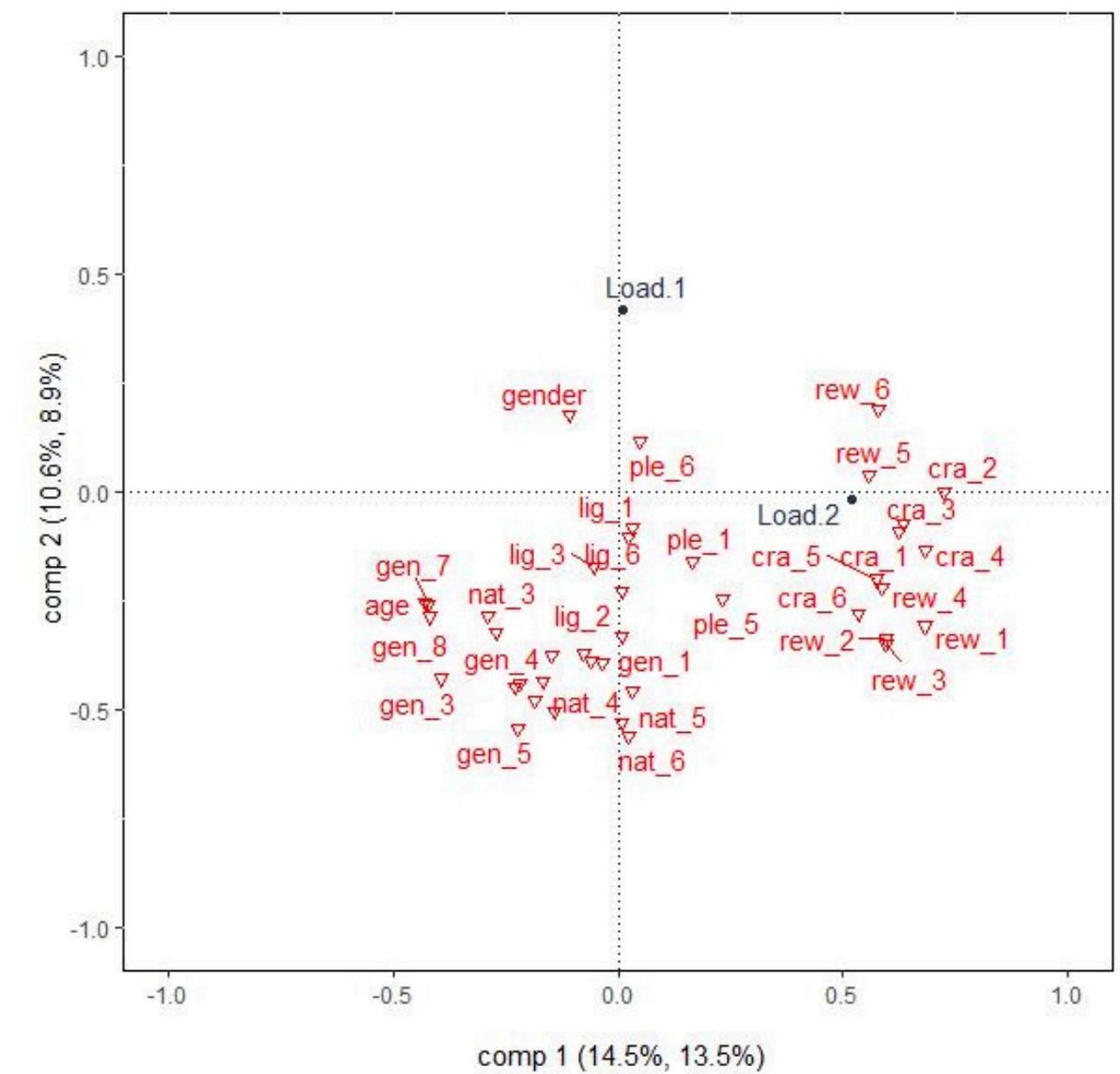


## Step 2: Yloadings-Z

Consumers (*low Load.2, Load.1*) related to **health**

- general health interest (gen\_3, gen\_4)
- light product interest (lig\_2, lig\_3)
- natural product interest (nat\_4, nat\_5)

**Flakes samples (T-F-I, T-F-o; t-F-I, t-F-o)**



# Remark

1. In both approaches (one step and two step), the **interpretation** of the consumer attributes vs the sensory attributes of the sample were by times **not easy**
2. The **L-PLS** and the **two-step PLS** regression approaches provide **similar results** when integrating sensory, and consumer information
3. The **two-step PLS** regression approach provides **more direct interpretation** of individual differences in liking

I. L-shape data: one-step vs two-step procedure

**II. Consumer segmentation**

III. Multiblock in L-shape data

# Yoghurt samples

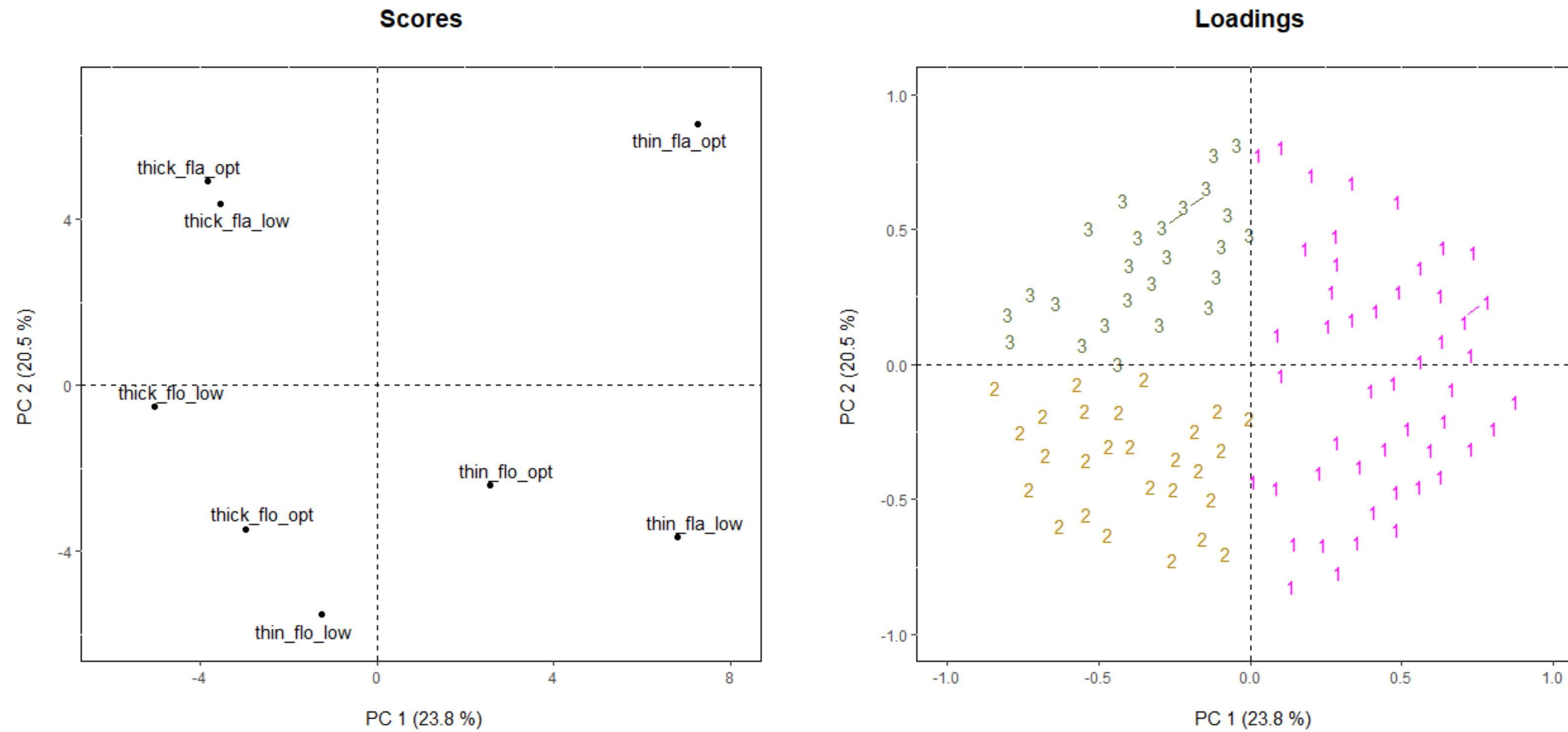
Sample	Viscosity	Particle size	Flavor intensity
thin_fla_low	Thin	Flakes	Low
thick_fla_low	Thick	Flakes	Low
thin_flo_low	Thin	Flour	Low
thick_flo_low	Thick	Flour	Low
thin_fla_opt	Thin	Flakes	Optimal
thick_fla_opt	Thick	Flakes	Optimal
thin_flo_opt	Thin	Flour	Optimal
thick_flo_opt	Thick	Flour	Optimal

# 1. Visual segmentation

ANOVA model: liking ~ product + consumer

	Mean Sq	Sum Sq	Df	F value	Pr (>F)
product	6779	474553	7	30.84	0.0000
consumer	1047	104735	100	4.76	0.0000
residuals	220	153902	700	-	-

# PCA on ANOVA residuals

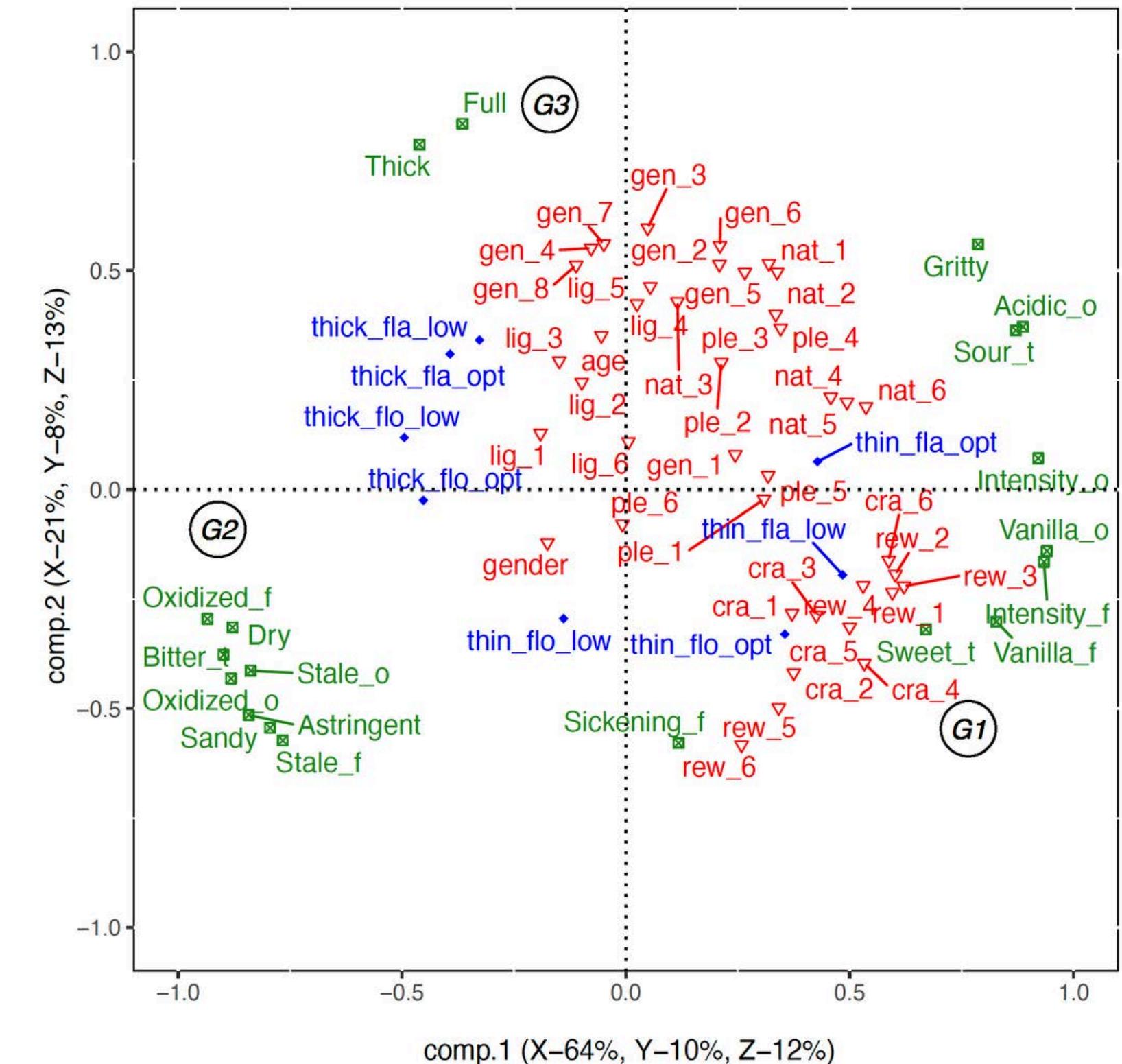


# Consumer segments

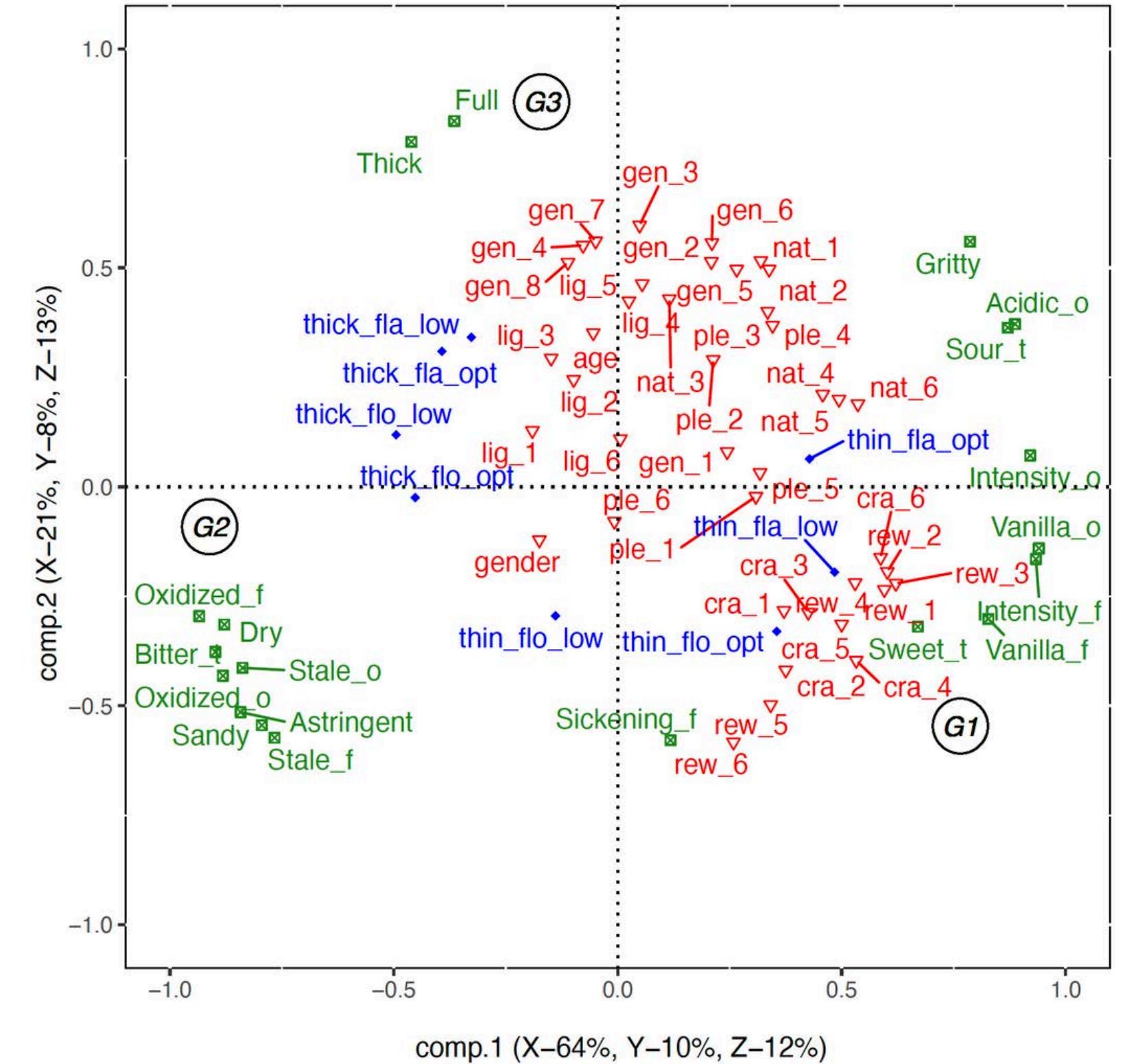
Segment 1	Segment 2	Segment 3
<i>thin</i> products	<i>flour</i> products	<i>thick, flakes</i> products
<i>thin_fla_low</i> , <i>thin_flo_opt</i> , <i>thin_fla_opt</i>	<i>thin_flo_low</i> , <i>thick_flo_opt</i> , <i>thick_flo_low</i>	<i>thick_fla_opt</i> , <i>thick_fla_low</i>

## 2. L-PLS (*Y average*) and segmentation

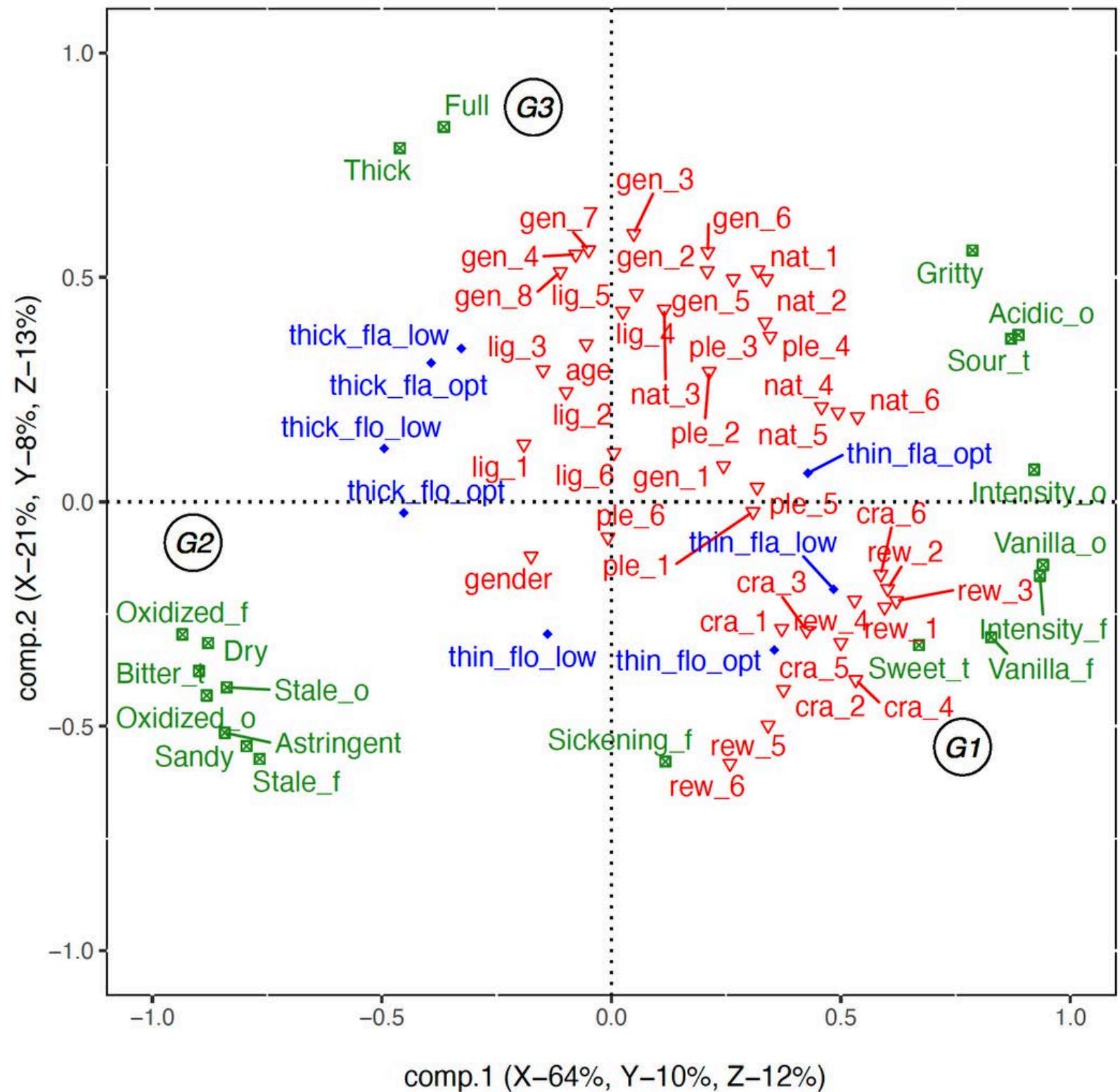
- Consumers **G1** liked **thin** yoghurts - **thin\_fla\_opt, thin\_fla\_low, thin\_flo\_opt** - **Sweet, Vanilla**
- craving for sweet foods: **cra\_2, cra\_4**
- food as a reward: **rew\_1, rew\_5**



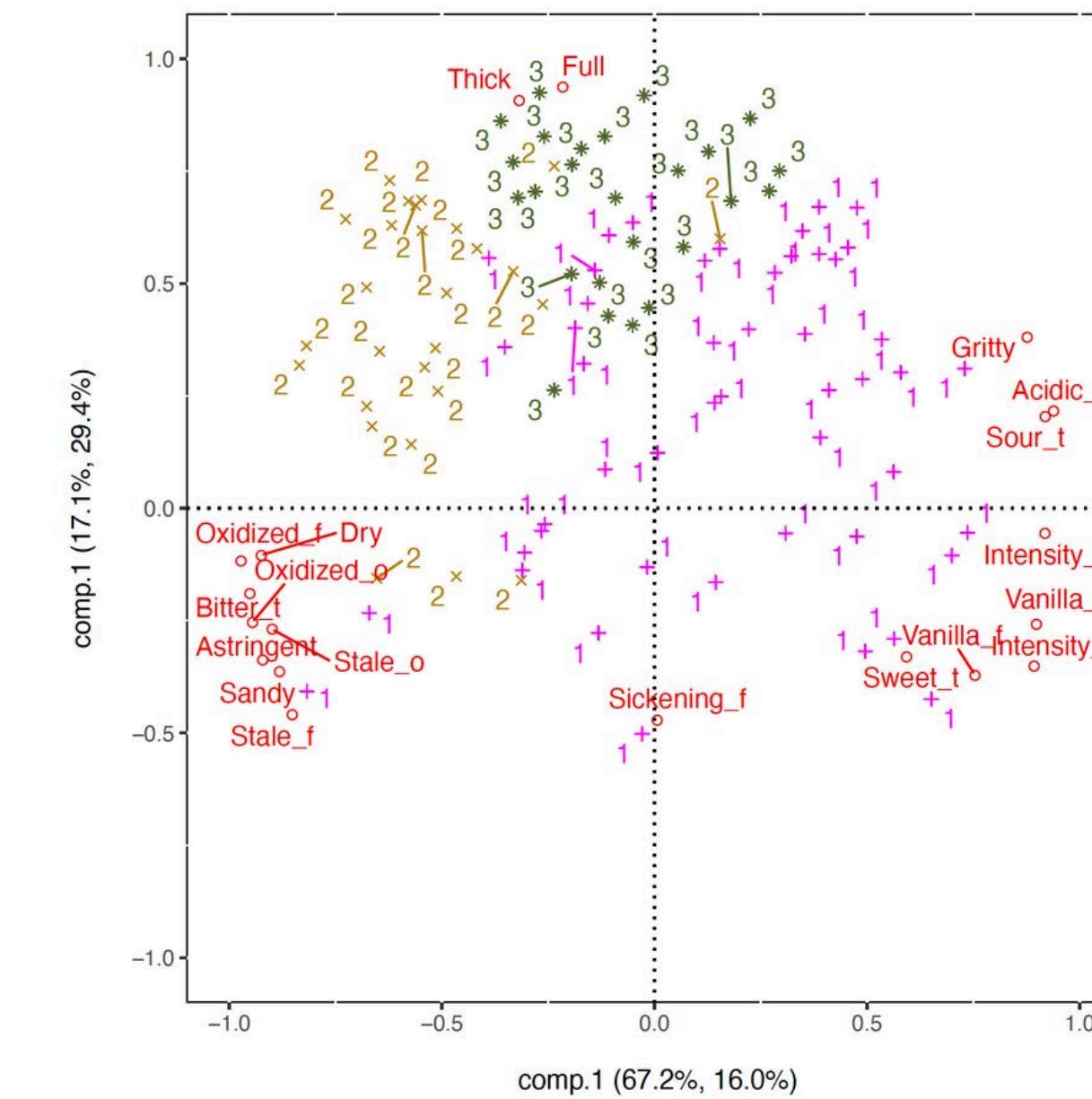
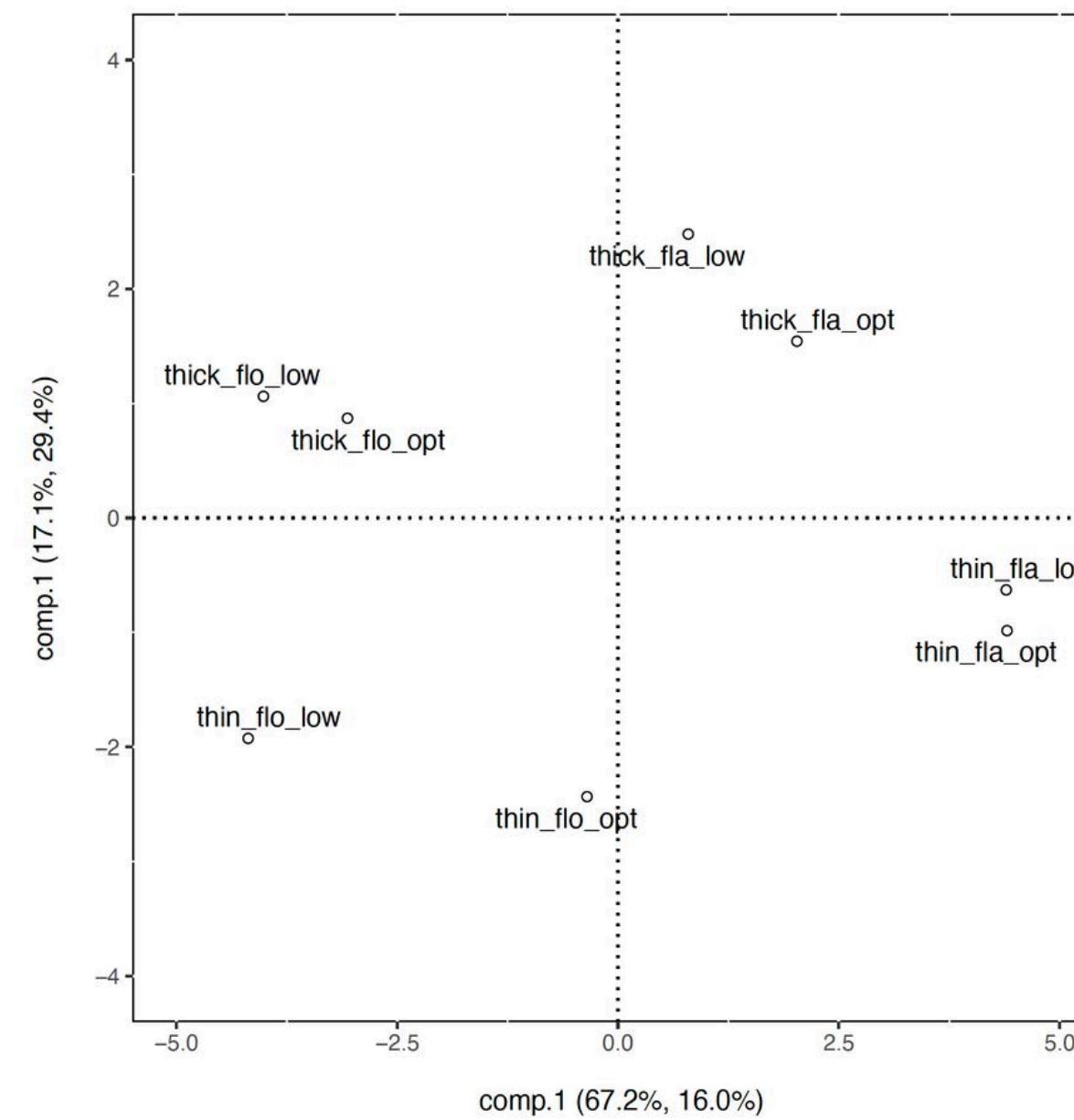
- Consumers **G2** - flour-added yoghurts - **thick\_flo\_low, thick\_flo\_opt, and thin\_flo\_low** - Bitter, Dry, Sandy, Astringent, Oxidized



- Consumers **G3** - **thick-flakes** yoghurts - **thick\_fla\_low**, **thick\_fla\_opt** - **Thick**, **Full**, **Gritty**
- general health interest: **gen\_3**, **gen\_7**
- light product interest: **lig\_3**, **lig\_4**

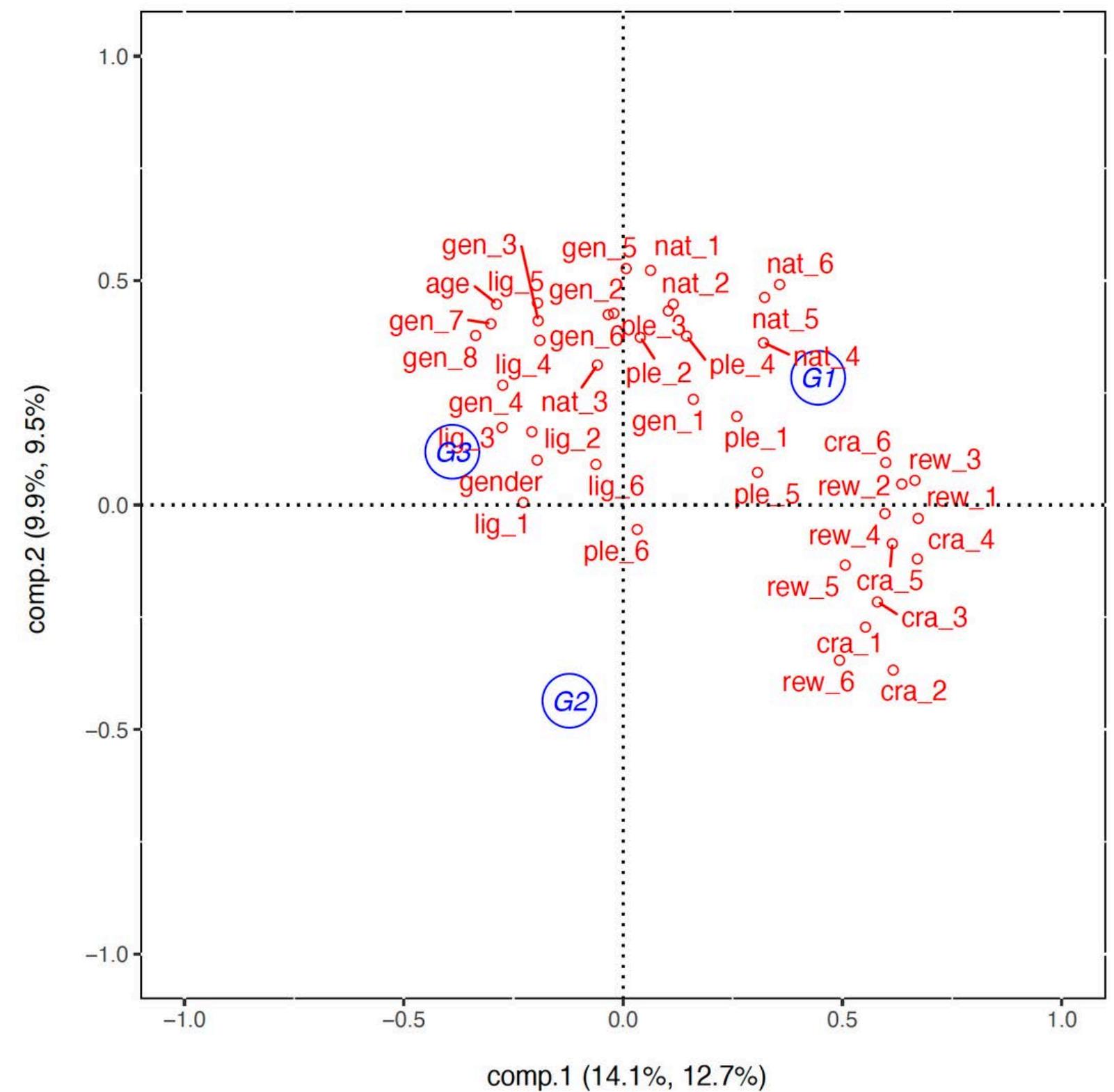


### 3. TSP (*Y ratings/dummy*) and segmentation



- **G1** - 'thin' - Gritty, flavours (Acidic\_o, Sour\_t, Sweet\_t, Vanilla\_o)
- **G2** - 'flour' - Dry, Sandy
- **G3** - 'thick-flakes' - Thick, Full

- G1 ‘thin’ - taste-related factor ***pleasure*** (ple\_1, ple\_4); health-related factor ***natural*** (nat\_4, nat\_5)
- G2 ‘flour’
- G3 ‘thick-flakes’ - health-related factor ***light*** (lig\_2, lig\_3), ***general*** (gen\_4)



# Remark

1. Overall, both **L-PLS** and **TSP** approaches provide **similar interpretation results**
2. The **TSP** approach has the **advantage of interpreting** the horizontal and vertical direction in the L separately using standard regression methods

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1. Overall, both **L-PLS** and **TSP** approaches provide **similar interpretation results**
2. The **TSP** approach has the **advantage of interpreting** the horizontal and vertical direction in the L separately using standard regression methods



**L-shape with multiblock data**

I. L-shape data: one-step vs two-step procedure

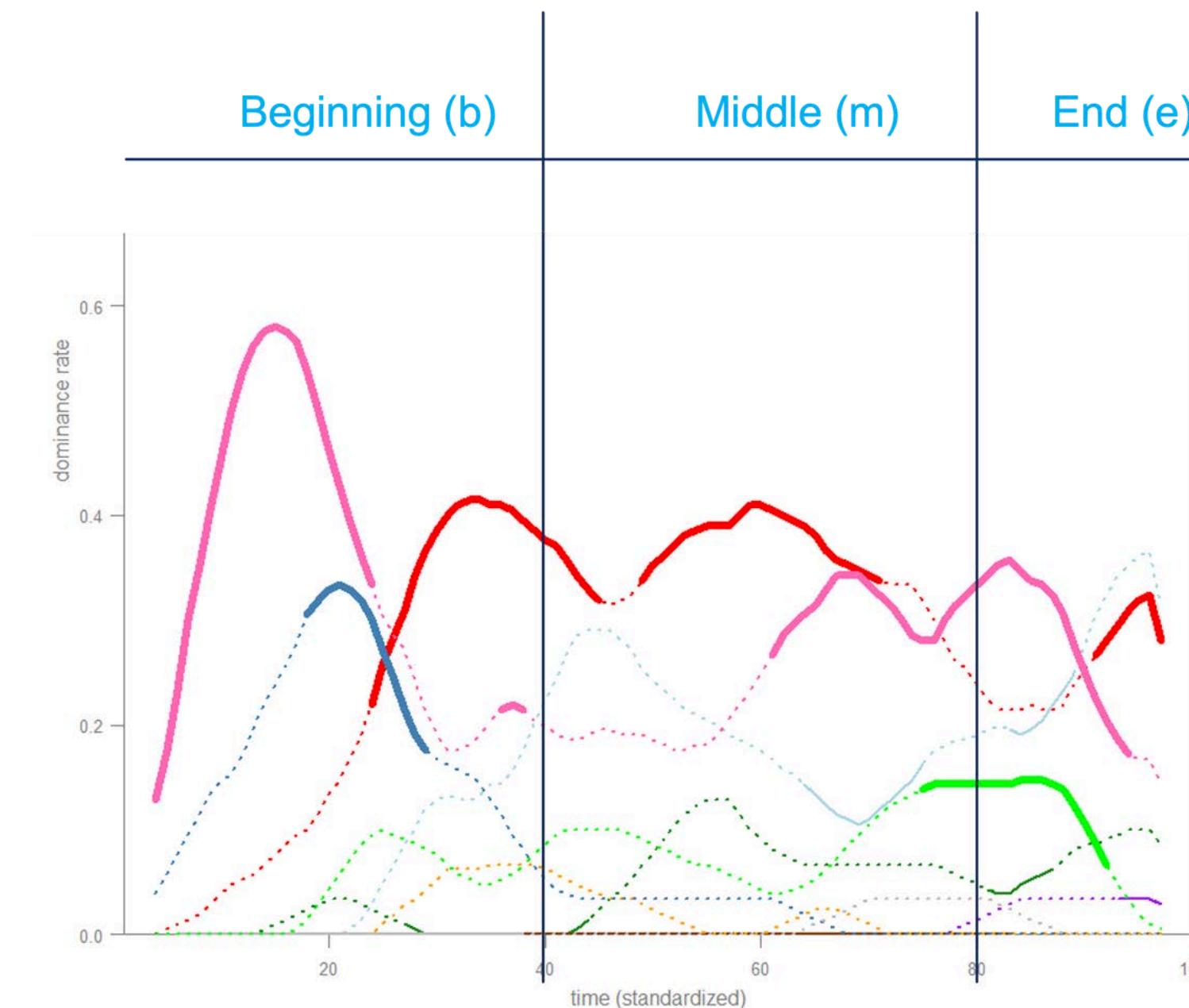
II. Consumer segmentation

**III. Multiblock in L-shape data**

# Multiblock data - X

## Dynamic sensory properties - X

- Sensory description in different stages of the eating process
  - beginning - **X1**
  - middle and end - **X2**



# Multiblock data - Z

## GENERAL HEALTH INTEREST

- 1 I am very particular about the healthiness of food.
- 2 I always follow a healthy and balanced diet.
- 3 It is important for me that my diet is low in fat.
- 4 It is important for me that my daily diet contains a lot of vitamins and minerals.
- 5.R I eat what I like and I do not worry about healthiness of food.
- 6.R I do not avoid any foods, even if they may raise my cholesterol.
- 7.R The healthiness of food has little impact on my food choices.
- 8.R The healthiness of snacks makes no difference to me.

## LIGHT PRODUCT INTEREST

- 1.R In my opinion, the use of light products does not improve one's health.
- 2.R I do not think that light products are healthier than conventional products.
- 3 I believe that eating light products keeps one's cholesterol level under control.
- 4.R In my opinion light products don't help to drop cholesterol levels.
- 5 I believe that eating light products keeps one's body in good shape.
- 6 In my opinion by eating light products one can eat more without getting too many calories.

## NATURAL PRODUCT INTEREST

- 1.R I do not care about additives in my daily diet.
- 2.R In my opinion, organically grown foods are no better for my health than those grown conventionally.
- 3.R In my opinion, artificially flavoured foods are not harmful for my health.
- 4 I try to eat foods that do not contain additives.
- 5 I would like to eat only organically grown vegetables.
- 6 I do not eat processed foods, because I do not know what they contain.

## CRAVING FOR SWEET FOODS

- 1.R In my opinion it is strange that some people have cravings for chocolate.
- 2.R In my opinion it is strange that some people have cravings for sweets.
- 3.R In my opinion it is strange that some people have cravings for ice-cream.
- 4 I often have cravings for sweets.
- 5 I often have cravings for chocolate.
- 6 I often have cravings for ice-cream.

## USING FOOD AS A REWARD

- 1 I reward myself by buying something really tasty.
- 2 I indulge myself by buying something really delicious.
- 3 When I am feeling down I want to treat myself with something really delicious.
- 4.R I avoid rewarding myself with food.
- 5.R In my opinion, comforting oneself by eating is self-deception.
- 6.R I try to avoid eating delicious food when I am feeling down.

## PLEASURE

- 1.R I do not believe that food should always be a source of pleasure.
- 2.R The appearance of food makes no difference to me.
- 3 It is important for me to eat delicious food on weekdays as well as weekends.
- 4 When I eat, I concentrate on enjoying the taste of food.
- 5.R I finish my meal even when I do not like the taste of food.
- 6 An essential part of my weekend is eating delicious food.

# Consumer attitudes - Z

- Attitudes to taste - Z1
- Attitudes to healthiness - Z2

# Main aims

- Investigate the application of **SO-TSP** in dealing with multiblock L-shape data
  - contributions of data blocks (**X<sub>1</sub>, X<sub>2</sub>**) and (**Z<sub>1</sub>, Z<sub>2</sub>**)
  - consumer segmentation

# Main results

**01.**

Likings on dynamic sensory perception

*SOPLS Y-X*

**02.**

Consumer segments

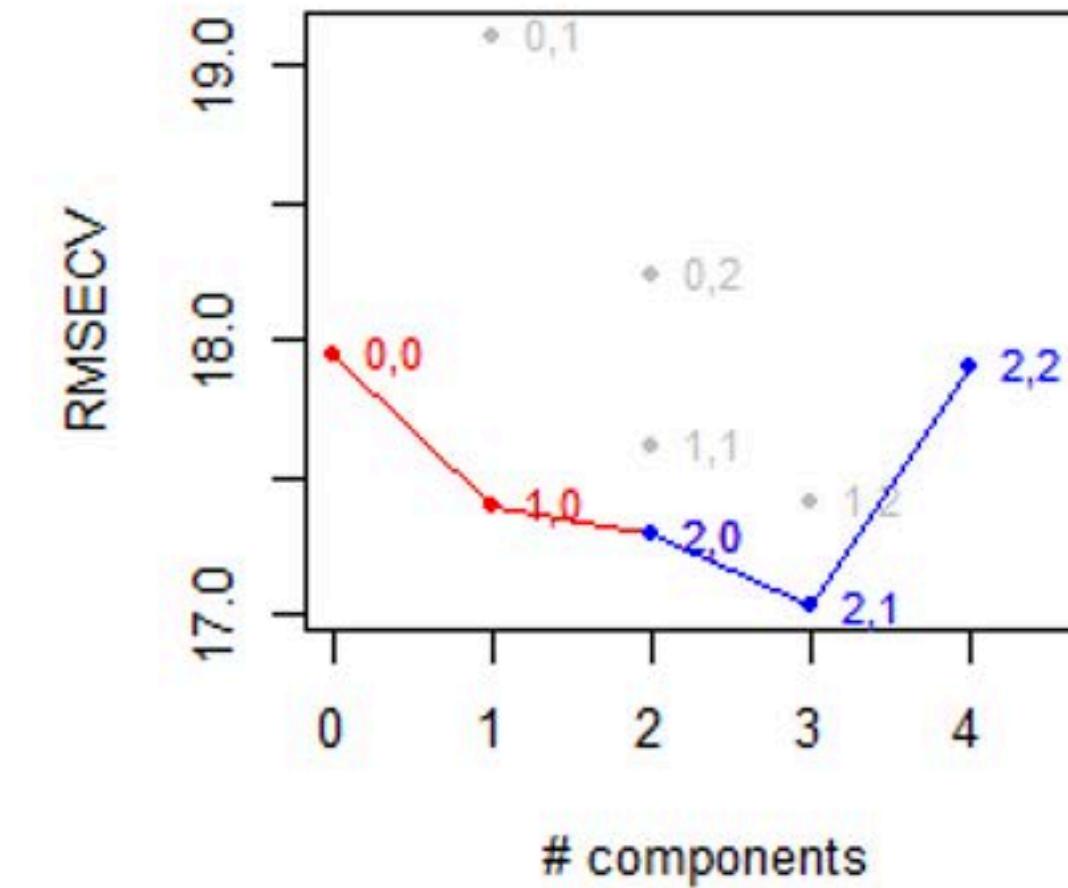
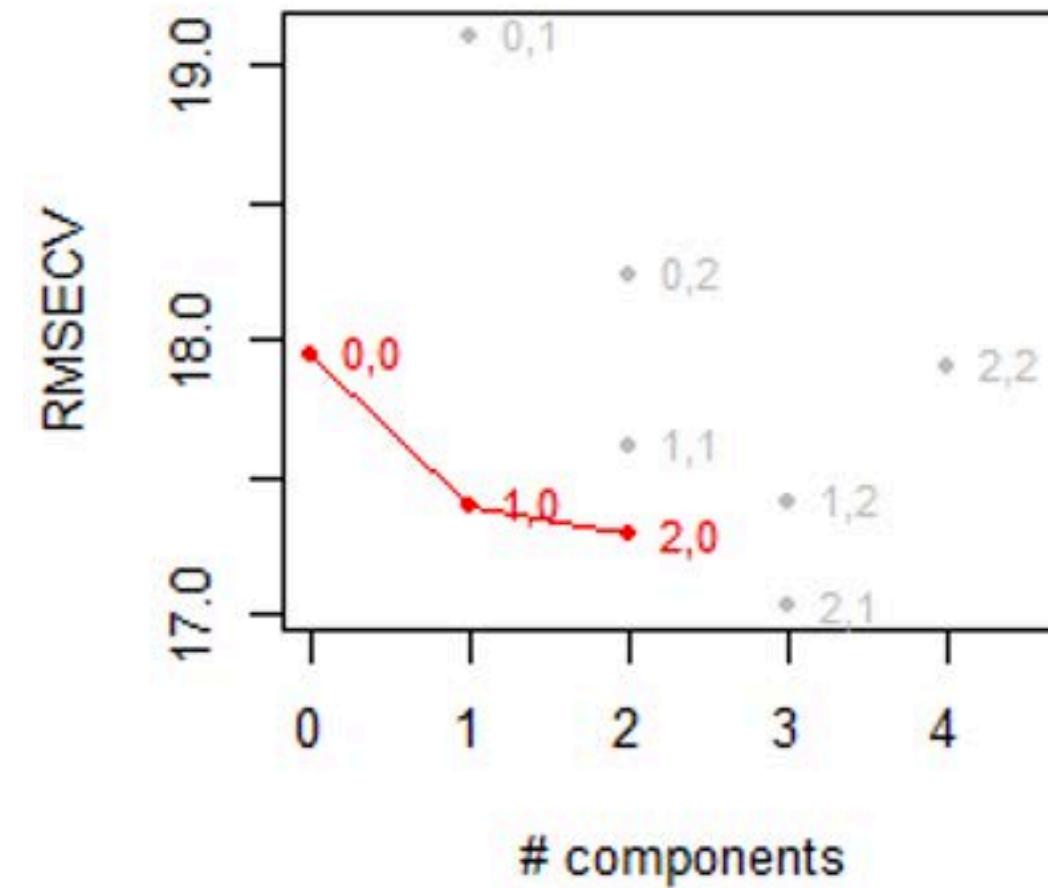
*Visual segmentation*

**03.**

Segments on consumer attitudes

*SOPLS Ydummy-Z*

# 1. Likings - dynamic sensory perception

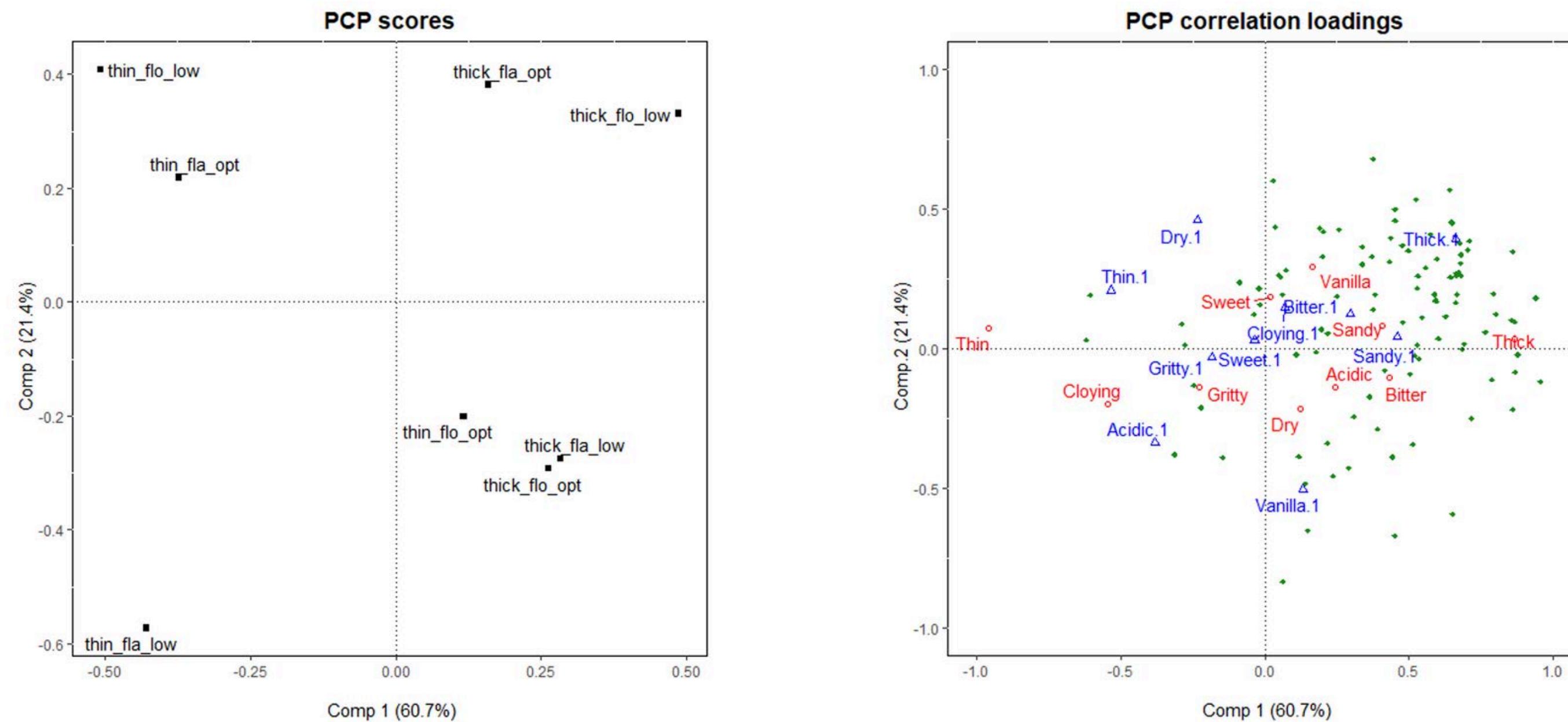


**X1** : beginning  
**X2** : middle and end

- 2 components of **X1** and 1 component of **X2** (RMSECV=17.02)
- The fitted model with **(2,1) components of X1 and X2** explains the 78.86% of total variances

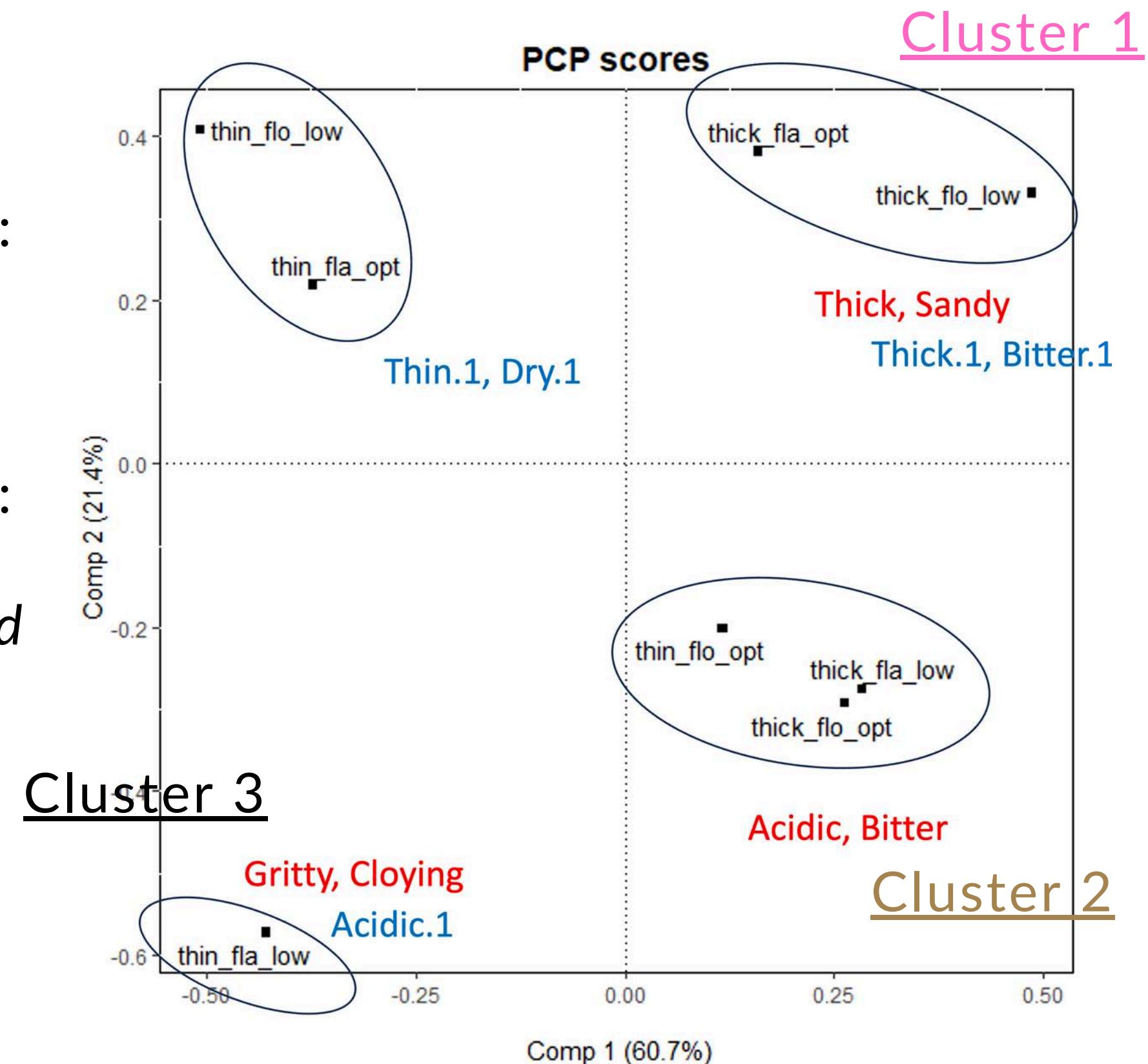
# 1. Likings - dynamic sensory perception

## The fitted model Y-X



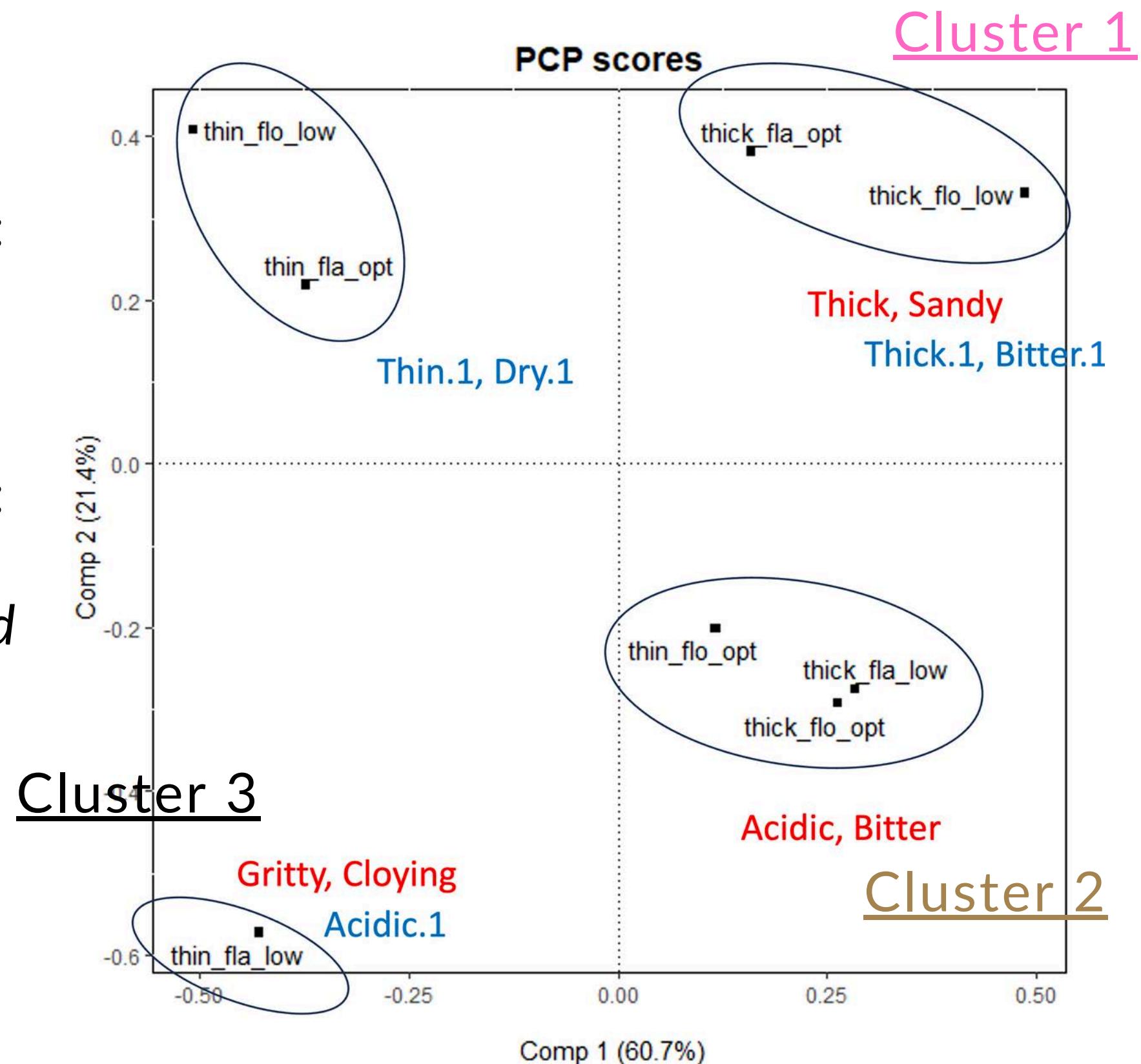
## 2. Visual segmentation

- **Cluster 1** ( $\text{Comp1} > 0$  and  $\text{Comp2} > 0$ ): liked products with **Thick**
- **Cluster 2** ( $\text{Comp1} > 0$  and  $\text{Comp2} < 0$ ): preferred products with **Bitter** at the beginning and **Vanilla** at the middle, end
- **Cluster 3** ( $\text{Comp1} < 0$ )



## 2. Visual segmentation

- **Cluster 1** ( $\text{Comp1} > 0$  and  $\text{Comp2} > 0$ ): liked products with **Thick**
- **Cluster 2** ( $\text{Comp1} > 0$  and  $\text{Comp2} < 0$ ): preferred products with **Bitter** at the beginning and **Vanilla** at the middle, end
- **Cluster 3** ( $\text{Comp1} < 0$ )



→ Ydummy variables for SOPLS Y-Z

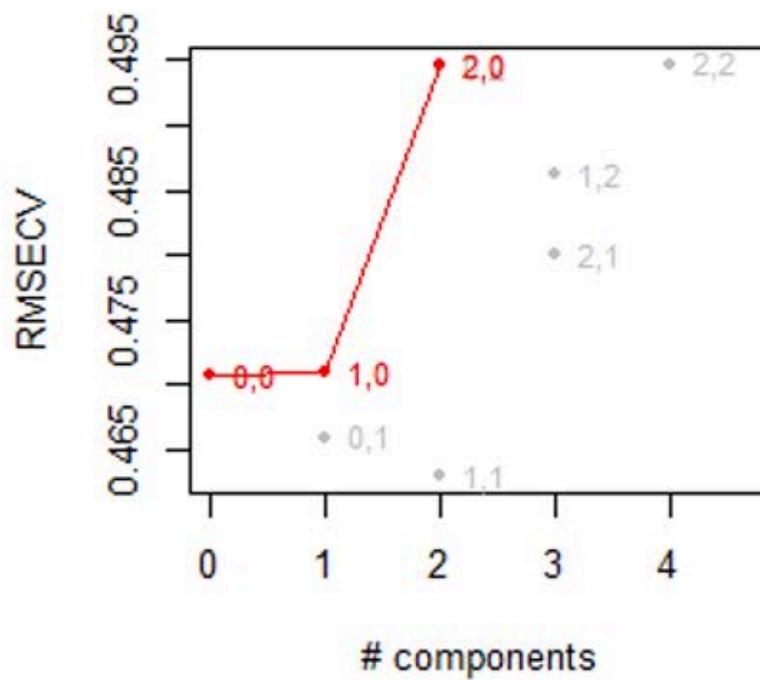
## 2. Visual segmentation

### Ydummy variables for SOPLS Y-Z

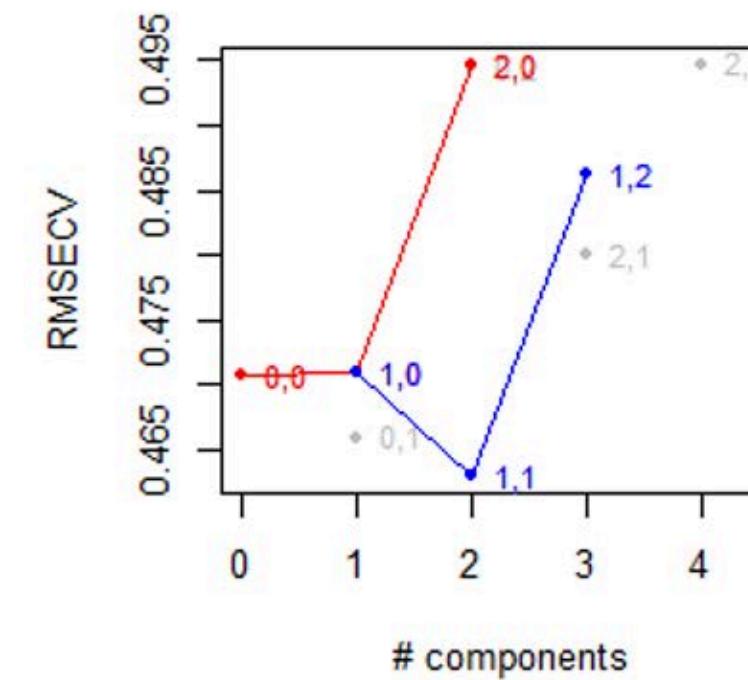
	clus1	clus2
1001	0	0
1002	1	0
1003	1	0
1004	1	0
1006	0	1
1007	1	0
1008	1	0
1009	0	1
1010	0	1
1011	0	0
1012	1	0

### 3. Segments - consumer attitudes

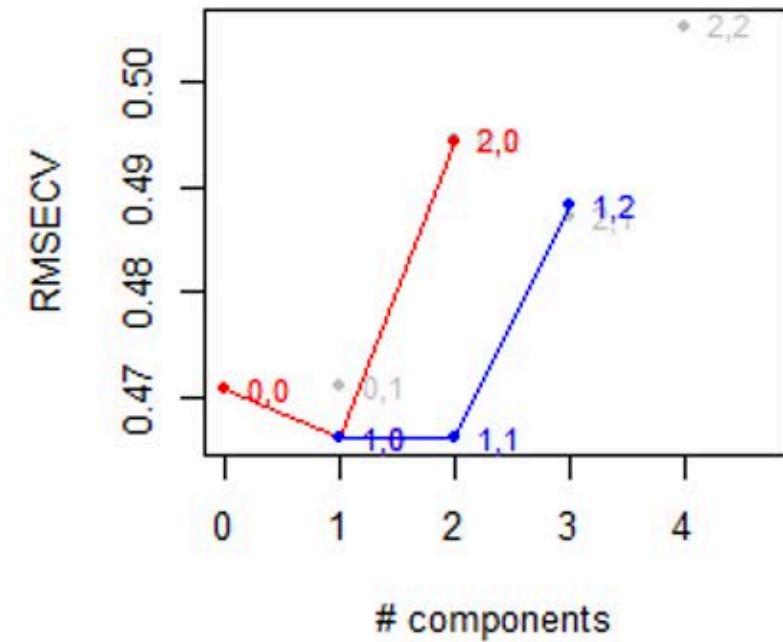
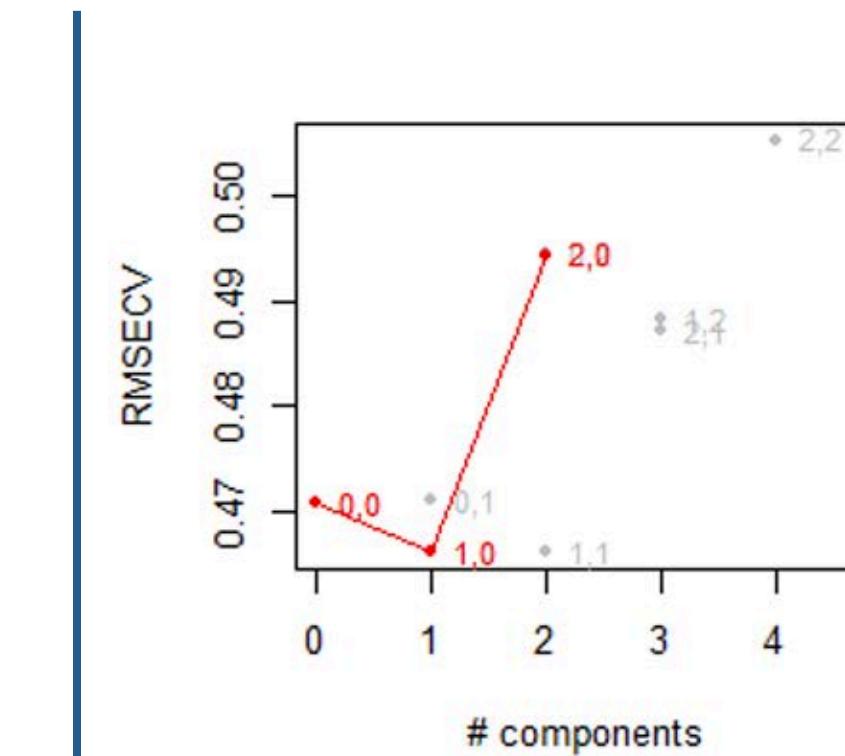
## Orders of consumer attitudes



**Health - Taste**

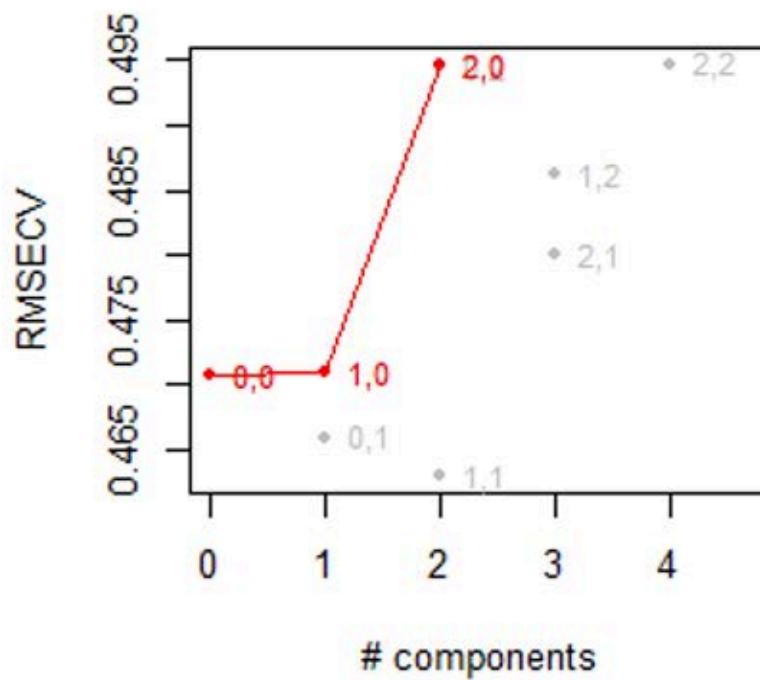


**Taste - Health**



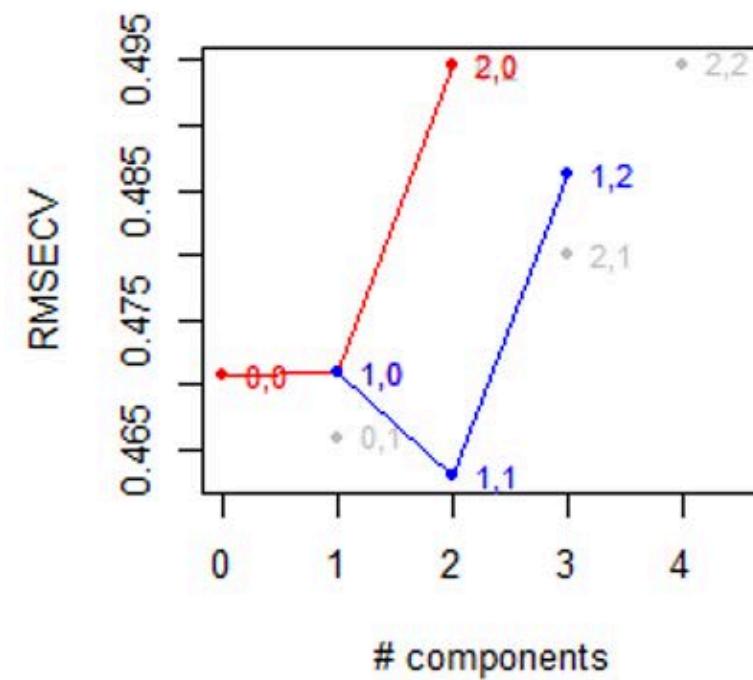
### 3. Segments - consumer attitudes

#### Orders of consumer attitudes



#### Health - Taste

- 1 component of Health
- 1 component of Taste
- RMSECV = 0.463

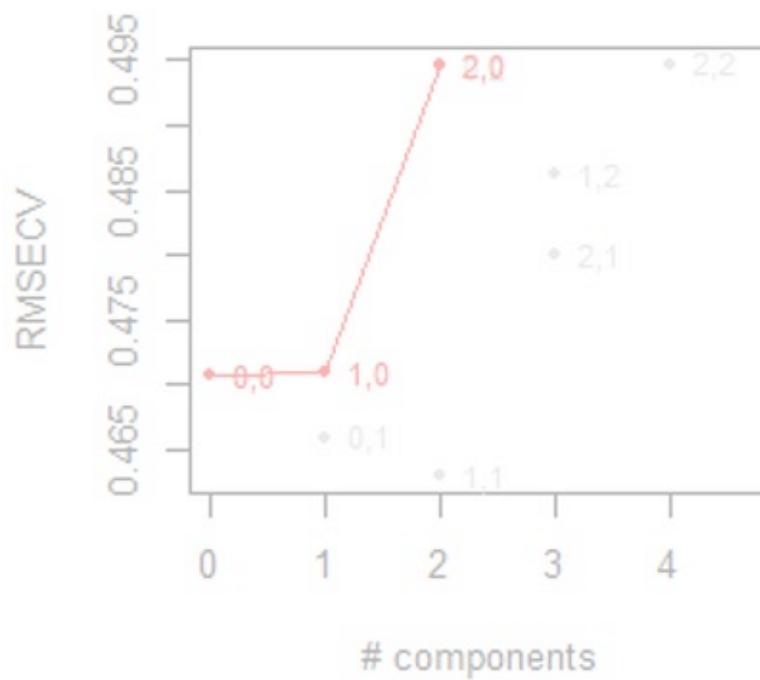


#### Taste - Health

- 1 component of Taste
- 0 component of Health
- RMSECV = 0.466

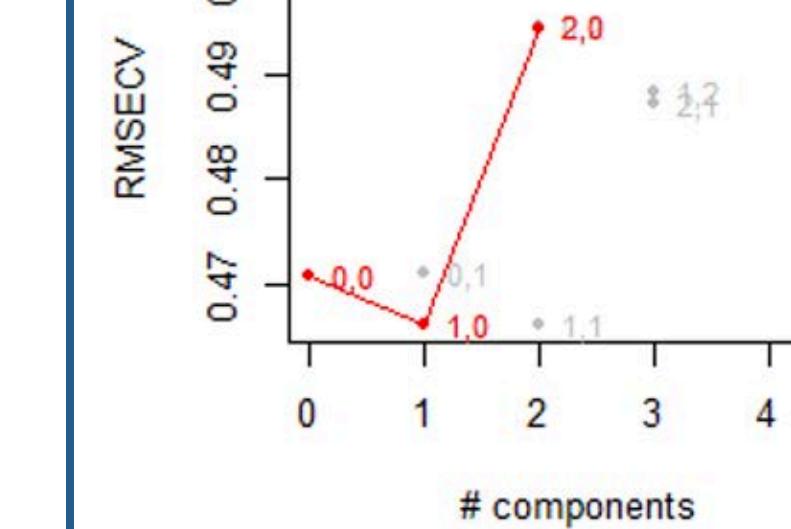
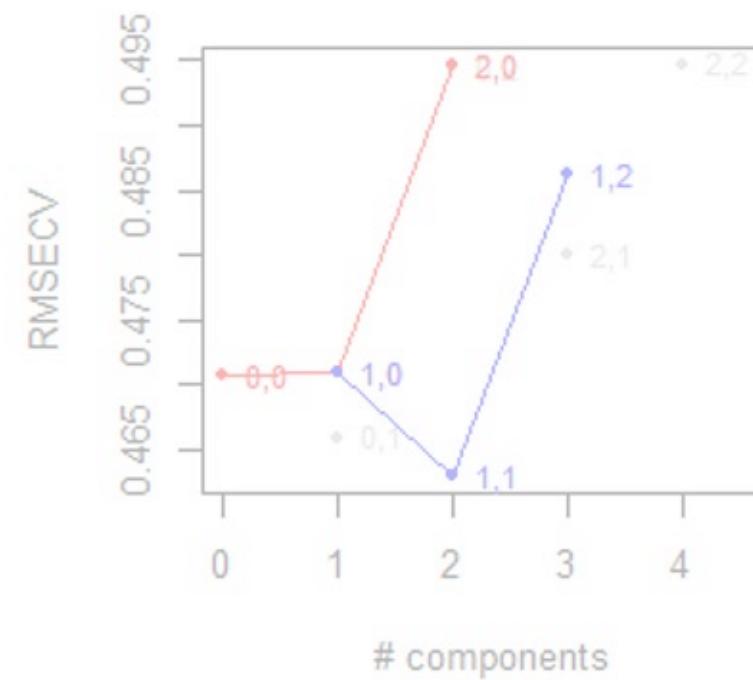
### 3. Segments - consumer attitudes

#### Orders of consumer attitudes



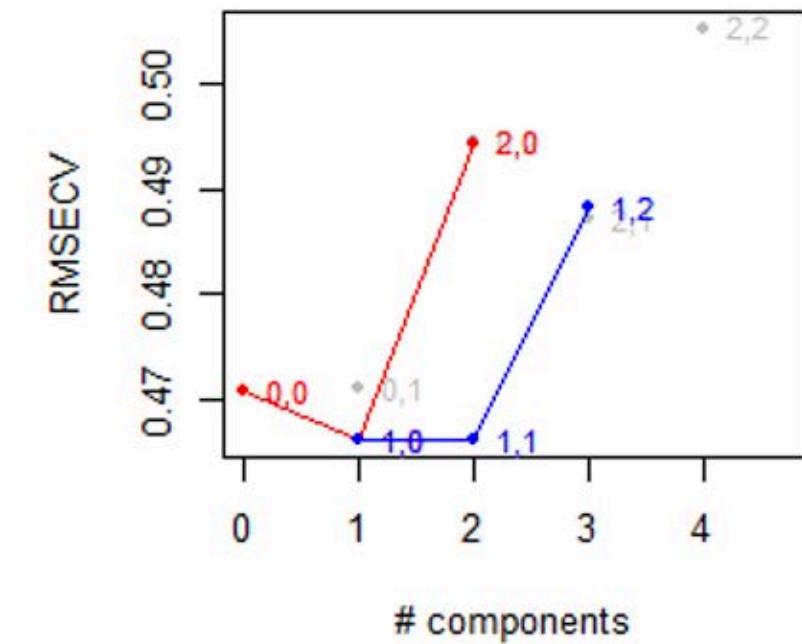
#### Health - Taste

- 1 component of Health
- 1 component of Taste
- RMSECV = 0.463

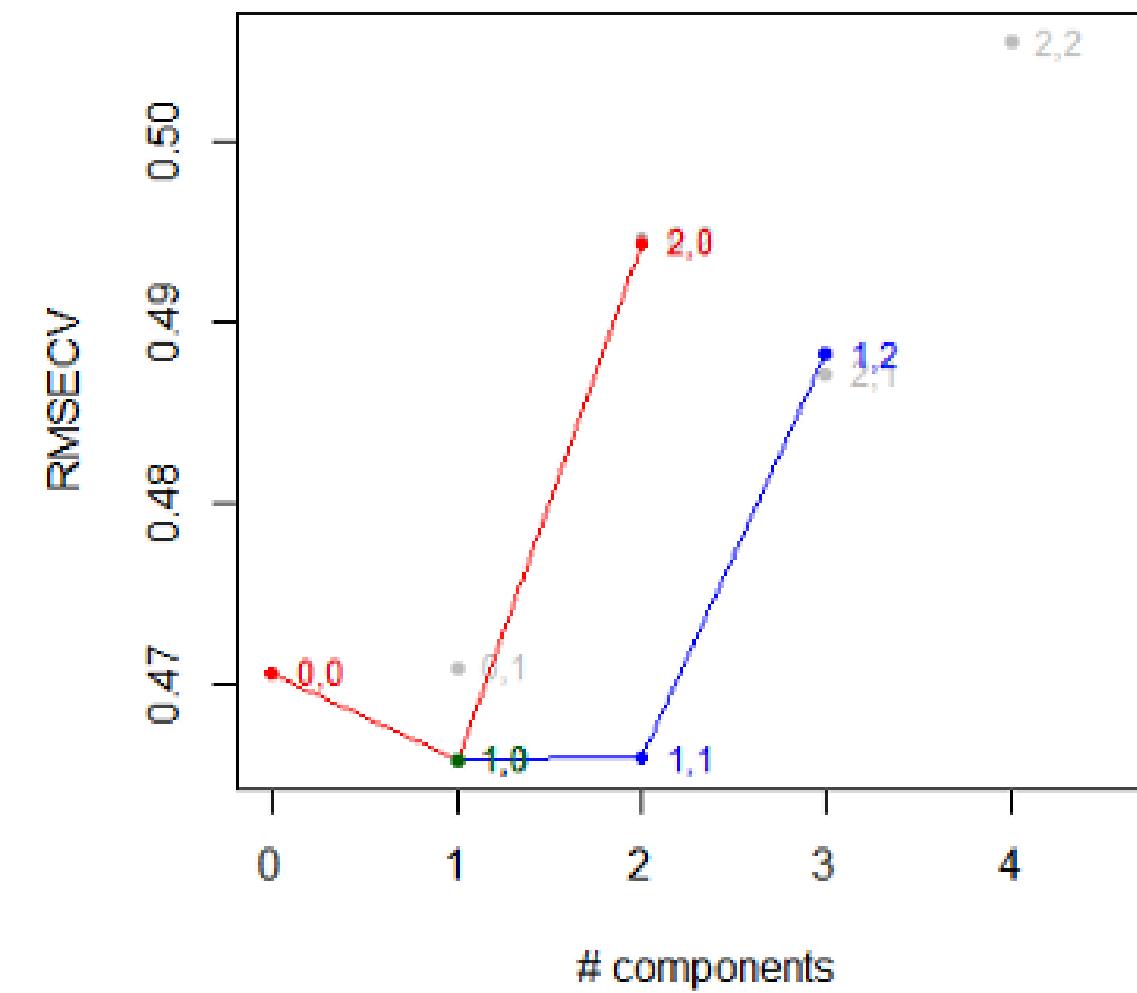
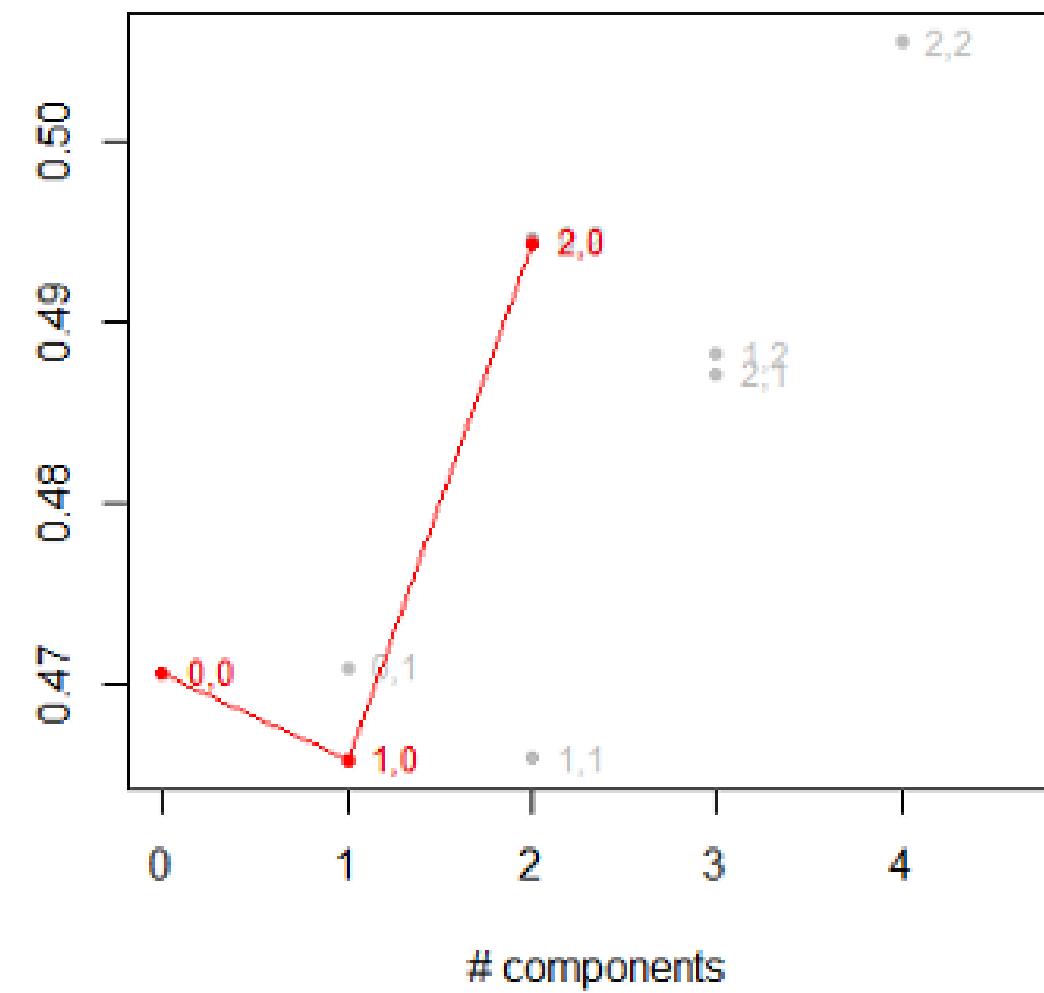


#### Taste - Health

- 1 component of Taste
- 0 component of Health
- RMSECV = 0.466



### 3. Segments - consumer attitudes

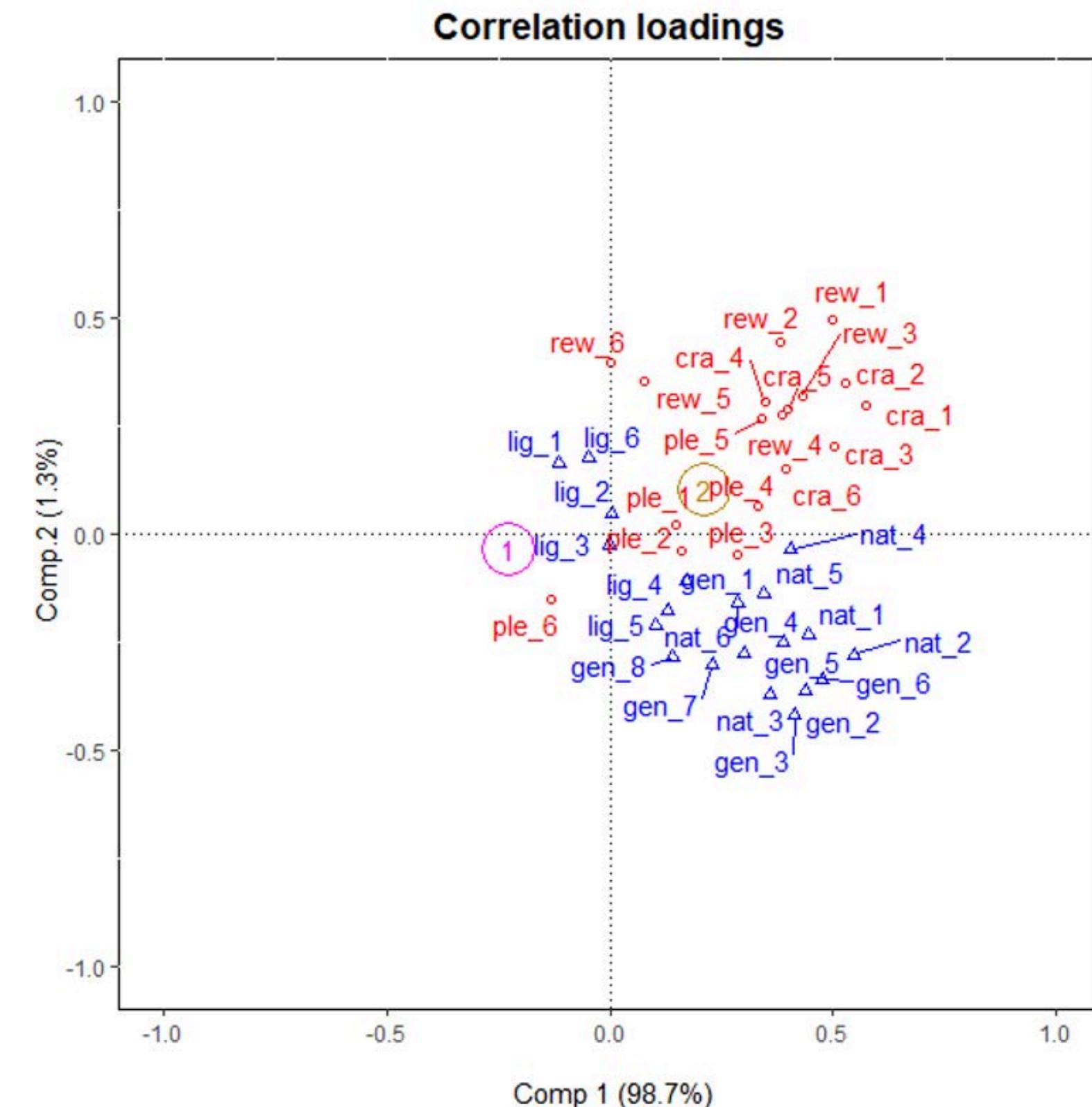


**Z1 : taste**  
**Z2 : health**

- 1 components of **Taste** and 0 component of **Health** ( $\text{RMSECV}=0.466$ )
- The fitted model with ***(1,0) components of Taste and Health*** explains the **13.97% of total variances**

### 3. Segments - consumer attitudes

- **Cluster 1** characterized by attitudes related to pleasure (*ple\_6*)
- **Cluster 2** related to pleasure (*ple\_4*, *ple\_1*) and craving for sweet foods (*rew\_4*)



### 3. Segments - consumer attitudes

- **Cluster 1** characterized by attitudes related to pleasure (*ple\_6*)
  - *ple\_6* “I finish my meal even when I do not like the taste of a food”
- **Cluster 2** related to pleasure (*ple\_4, ple\_1*) and craving for sweet foods (*rew\_4*)
  - *ple\_4* “It is important for me to eat delicious food on weekdays as well as weekends”
  - *ple\_1* “I do not believe that food should always be source of pleasure”
  - *rew\_4* “I avoid rewarding myself with food”

### 3. Segments - consumer attitudes

- **Cluster 1** characterized by attitudes related to pleasure (*ple\_6*)
  - *ple\_6* “I finish my meal even when I do not like the taste of a food”
- **Cluster 2** related to pleasure (*ple\_4, ple\_1*) and craving for sweet foods (*rew\_4*)
  - *ple\_4* “It is important for me to eat delicious food on weekdays as well as weekends”
  - *ple\_1* “I do not believe that food should always be source of pleasure”
  - *rew\_4* “I avoid rewarding myself with food”

→ Two consumer segments: *difference in attitudes to taste*

# Remark

1. SO-TSP highlights the *additional effects* of different blocks of sensory properties and consumer attitudes on different consumer segments
2. Possible limitations
  - When there are *many blocks to incorporate*, it may be not obvious which blocks to incorporate first
  - Cross-validation is difficult in the cases with *few and unique samples*. Care must be taken for not over-interpreting results

# R package - *lpls*

## **solvsa/lpls: Lpls data exploration and regression**

A package for performing endo or exo lpls

### Package details

<b>Author</b>	Solve Sæbø
<b>Maintainer</b>	Solve Sæbø <solve.sabo@nmbu.no>
<b>License</b>	GPL-2
<b>Version</b>	1.0.0
<b>Package repository</b>	<a href="#">View on GitHub</a>
Install the latest version of this package by entering the following in R:	
<b>Installation</b>	<pre>install.packages("remotes") remotes::install_github("solvsa/lpls")</pre>

# R package - *multiblock*

**multiblock: Multiblock Data Fusion in Statistics and Machine Learning**

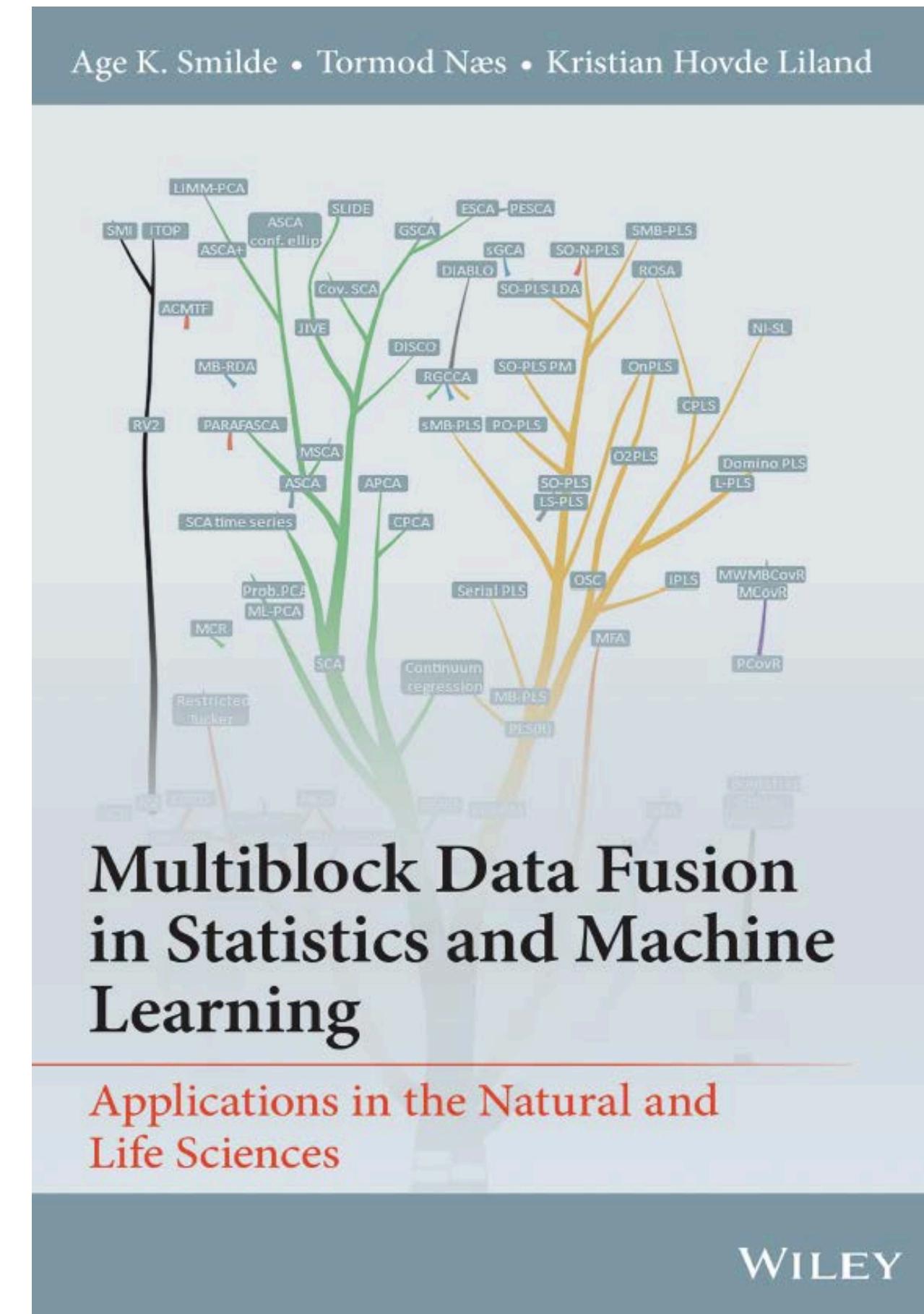
## Package details

<b>Author</b>	Kristian Hovde Liland [aut, cre] (< <a href="https://orcid.org/0000-0001-6468-9423">https://orcid.org/0000-0001-6468-9423</a> >), Solve Sæbø [ctb], Stefan Schrunner [rev]
<b>Maintainer</b>	Kristian Hovde Liland < <a href="mailto:kristian.liland@nmbu.no">kristian.liland@nmbu.no</a> >
<b>License</b>	GPL (>= 2)
<b>Version</b>	0.8.8.1
<b>URL</b>	<a href="https://khililand.github.io/multiblock/">https://khililand.github.io/multiblock/</a> <a href="https://github.com/khililand/multiblock/">https://github.com/khililand/multiblock/</a>
<b>Package repository</b>	<a href="#">View on CRAN</a>
<b>Installation</b>	Install the latest version of this package by entering the following in R:  <code>install.packages("multiblock")</code>

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- Martens, H., Anderssen, E., Flatberg, A., Gidskehaug, L. H., Høy, M., Westad, F., et al. (2005). **Regression of a data matrix on descriptors of both its rows and of its columns via latent variables: L-PLSR.** *Computational Statistics & Data Analysis*, 48(1), 103-123.
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- Smilde, A. K., Næs, T., & Liland, K. H. (2022). **Complex Block Structures with Focus on L-Shape Relations.** In A. K. Smilde, T. Næs & K. H. Liland, *Multiblock Data Fusion in Statistics and Machine Learning*: Wiley

# Book



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Comparison of different ways of handling L-shaped data for integrating sensory and consumer information

Daniele Asioli<sup>a</sup>, Quoc Cuong Nguyen<sup>b,c,\*</sup>, Paula Varela<sup>d</sup>, Tormod Næs<sup>d,e</sup>

**Investigating Consumer Heterogeneity in Multiblock L-shape Data by Combining SO-PLS Regression and Two-step Procedure**

Quoc Cuong Nguyen<sup>1,2\*</sup>

ORIGINAL ARTICLE

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Quoc Cuong Nguyen<sup>1,2</sup>  | Daniele Asioli<sup>3</sup> | Paula Varela<sup>4</sup>  | Tormod Næs<sup>4</sup> 

# Meet Our Teams



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PhD



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Associate Professor



**Tormod Næs**  
Professor



**Paula Varela**  
Professor



# Thank you!