RTBfoods Sensory Analysis Manual

Part 1: Training a panel in sensory analysis and implementing descriptive tests.

Part 2: Tutorial: How to process data in sensory analysis

Montpellier, December 2018

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This report has been written in the framework of RTBfoods project.

To be cited as:

Isabelle MARAVAL, Nelly FORESTIER-CHIRON, Christophe BUGAUD. (2018). *RTBfoods Sensory Analysis Manual. Part 1: Training a panel in sensory analysis and implementing descriptive tests. Part 2: Tutorial: How to process data in sensory analysis.* Montpellier, France: CIRAD-RTBfoods Project Report, 54 p. DOI: https://doi.org/10.18167/agritrop/00573

Ethics: The activities, which led to the production of this manual, were assessed and approved by the CIRAD Ethics Committee (H2020 ethics self-assessment procedure). When relevant, samples were prepared according to good hygiene and manufacturing practices. When external participants were involved in an activity, they were priorly informed about the objective of the activity and explained that their participation was entirely voluntary, that they could stop the interview at any point and that their responses would be anonymous and securely stored by the research team for research purposes. Written consent (signature) was systematically sought from sensory panelists and from consumers participating in activities.

Acknowledgments: This work was supported by the RTBfoods project https://rtbfoods.cirad.fr, through a grant OPP1178942: Breeding RTB products for end user preferences (RTBfoods), to the French Agricultural Research Centre for International Development (CIRAD), Montpellier, France, by the Bill & Melinda Gates Foundation (BMGF).

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1 PART 1: TRAINING A PANEL IN SENSORY ANALYSIS AND IMPLEMENTING DESCRIPTIVE TESTS.

Aim: Setting Up and Managing a Sensory Analysis Tasting Panel

1.1 Pre-selection / Recruitment

The aim of this section is to describe the initial selection process for recruiting an individual onto the tasting panel to establish a sensory profile in sensory analysis.

1.1.1 Control elements

A sensory analysis panel is a veritable "measuring device". As such, the results of the analyses depend on the quality of the panel's members. Recruiting people who are willing to take part on a panel must be handled with care.

A preliminary selection of candidates should be held during the recruitment phase to eliminate individuals who might be ill-suited to sensory analysis.

Panellists are recruited on a voluntary basis via a straightforward application or internally following a call from the laboratory, meaning they do not need to be paid. Care should be taken during recruitment to ensure there is an equal balance between men and women as well as good age distribution among the potential panellists (from 18 to 60 years).

The number of people to be recruited varies. For statistically correct results, there needs to be a minimum of eight panel members. It is highly desirable, however, for the panel to consist of at least 10 subjects who are qualified to carry out the test. It is necessary, therefore, to recruit and train between at least 12 and 15 people. In general terms, if you want the panel to consist of X subjects, it is advisable to recruit and train around 1.5X people.

1.1.2 Procedure

A questionnaire should be completed by anyone wishing to join the tasting panel (see Appendix 1: Pre-Selection Questionnaire for Tasting Panellists). The aim of this questionnaire is to obtain general information and to control the availability, interest and motivation of potential recruits. The information provided is processed under strictly confidential conditions in line with the relevant recommendations.

- Personal data

The personal data of interested individuals is rated in order to obtain an overview of the panel (distribution of sex, age, etc.) and to check the feasibility of integrating potential members into the panel (geographical location, etc.).

Accordingly, the questionnaire asks for the following details: surname and first name, e-mail address and telephone number, sex, age group, nationality and occupation.

- Availability

Future panellists must be available for training and subsequent assessments.

Individuals who do not live in the same town as the sensory analysis laboratory are not selected for practical reasons.

People who are available for at least three days a week, and who do not travel on a regular basis, should be selected.

- Eating habits

It is important to know whether candidates are averse to any of the food products that may be offered as part of an assessment for cultural or other reasons, meaning they cannot eat certain products.

In the questionnaire, we ask people what foods they do not wish to consume.

- Health

We ask candidates to tell us if they have any food allergies so we can avoid offering items they are allergic to.

Candidates will be informed about the outcomes based on the above criteria:

- Either they will be pre-selected and may be called to attend the general training phase;

- Or they are not pre-selected, in which case they may retake the pre-selection tests in the future if their conditions change.

1.2 General Training

New panellists must first follow the introductory and general training phase described in this section.

Each panellist must subsequently attend the mandatory annual training and various one-off training sessions set up by the sensory analysis team.

1.2.1 General introduction to the laboratory and tasting methodology

Introduction

The role of sensory analysis within the company must be explained at the first training session as a way to involve and motivate future subjects on the tasting panel.

A visit will be made to the premises with more detailed explanations about the tasting room and the procedures followed during sessions.

At this first session, the subjects are also introduced to the analysis and basic notions of sensory physiology. It is important to explain the role of the various sense organs and the nature of the sensory traits to which they are sensitive.

The first session will also be an opportunity to explain the general tasting instructions and recruitment process to candidates if their results on the various tests are positive (the terms of appointment, signatures needed, etc.). It is also used to set out the overall approach to monitoring the panellists (selection, training, validation, tests, etc.), the types of tests and the frequency of the sessions.

All these points will be addressed during a general introduction using a PowerPoint slideshow based on the presentation given during the training in Uganda (available online). This sets out the following:

- An overview of the laboratory and its activities
- The role and importance of sensory analysis
- Different types of sensory tests
- The panel
- Tasting methods

Retro-olfaction demonstration

Before the first tests, it is important to use a short exercise to show the panellists the distinction between smell, flavour and aroma and to clearly define them; and to explain the phenomena that occur during the olfaction process and tasting.

This retro-olfaction test demonstrates that the perception of a flavour in the mouth is a multimodal sensation. It consists of a set of taste, olfactory and trigeminal sensations (all the thermal, tactile and pain sensations).

It is important to underline and explain how air moves via the retro nasal passage (by the channels between the mouth and the nose, called choanae). The aromatic molecules are transported in this passage to the olfactory mucosa.

This test must be carried using a reasonably aromatic product (e.g. Tagada® strawberries or other sweets with a high aromatic intensity).

Give a sweet to everyone and explain the test process:

- Block the nose
- Place the product in the mouth and close the mouth
- Chew the product without opening the mouth
- Release the nostrils and take a breath of air through the mouth to assess the difference in perception

1.2.2 Performing sensory tests to select and train the panel

Six trials are set up to finalise the selection of panellists and train them.

These trials help candidates become accustomed to the methods and materials used in sensory analysis; to identify a shortcoming; and to assess a candidate's potential.

Basic flavour and sensation recognition test

An initial test to identify flavours and sensations is performed in order to determine the sensitivity of the candidates.

The aim of the test is to introduce subjects to the basic flavours – acidic, bitter, salty, sweet – and the sensation of astringency, and to assess their sensitivity.

The trainer will explain the difference between flavours and sensations, introducing the idea of astringency, an essential sensation in various matrices.

- Preparation protocol

See Appendix 2: Standard Solution Preparation Protocol for Flavour and Sensation Tests.

Prepare a 1.5 L solution (called a "stock solution" = Ss) of each basic flavour – acidic, bitter, salty and sweet – together with an astringent solution using the most neutral and most stable water possible:

Acidic = tartaric acid at a concentration of 3 g/L (i.e. 4.5 g in 1.5 L of water).

Bitter = quinine at a concentration of 0.06 g/L (i.e. 0.09 g in 1.5 L of water).

Salty = anhydrous sodium chloride at a concentration of 7.5 g/L (i.e. 11.25 g in 1.5 L of water).

Sweet = sucrose at a concentration of 60 g/L (i.e. 90 g in 1.5 L of water),

Astringent solution = potassium aluminium sulphate dodecahydrate at a concentration of 5 g/L (i.e. 7.5 g in 1.5 L of water).

Prepare the D7 dilution according to Table 1 below based on these solutions:

TABLE 1: PREPARATION OF DILUTIONS

Solution	Acidic		Bitter		Salty		Sweet		Astringent	
	Ss / 1.5 L	g/L	Ss / 1.5 L	g/L	Ss / 1.5 L	g/L	Ss / 1.5 L	g/L	Ss / 1.5 L	g/L
D1	63 mL	0.13	25 mL	0.0010	33 mL	0.16	33 mL	1.32	33 mL	0.11
D2	79 mL	0.16	35 mL	0.0014	47 mL	0.24	47 mL	1.88	47 mL	0.16
D3	98 mL	0.20	50 mL	0.0020	67 mL	0.34	67 mL	2.69	67 mL	0.23
D4	123 mL	0.25	72 mL	0.0029	96 mL	0.48	96 mL	3.84	96 mL	0.32
D5	154 mL	0.31	103 mL	0.0041	137 mL	0.69	137 mL	5.49	137 mL	0.46
D6	192 mL	0.38	147 mL	0.0059	196 mL	0.98	196 mL	7.84	196 mL	0.66
D7	240 mL	0.48	210 mL	0.0084	280 mL	1.40	280 mL	11.2	280 mL	0.94
D8	300 mL	0.60	300 mL	0.0120	400 mL	2.00	400 mL	16.0	400 mL	1.34

- Implementing the test

Prepare 12 glasses numbered 1 to 12 for each subject.

Serve two glasses of the D7 dilutions of each flavour and astringent sensation and two glasses of water in the order shown in Table 2.

TABLE 2: SERVING ORDER FOR RECOGNISING FLAVOURS AND SENSATIONS

Glass	1	2	3	4	5	6	7	8	9	10	11	12
Response	Bitter	Water	Sweet	Astringent	Acidic	Salty	Water	Acidic	Salty	Astringent	Sweet	Bitter

- Instructions

The subjects must taste the solutions in the order they are presented in, and may backtrack. They must ascertain the flavours and sensations in each glass and identify the glasses of water.

Each panellist must indicate his or her results on the Identification of Basic Flavours and Sensations form (see Appendix 3).

When all the panellists have completed the test, the facilitator undertakes a common correction.

Basic flavours classification test

The aim of this test is to train subjects in how to use an intensity scale by working on dilutions of salty and sweet flavours.

- Preparation protocol

Using the stock solutions that you prepared previously (Table 1), prepare a series of dilutions D1 to D6 of salty and sweet flavours.

- Implementing the test

For each subject, prepare six glasses from A to F for each series

Series 1: A1, B1, C1, D1, E1, F1 □□salty

Series 2: A2, B2, C2, D2, E2, F2 □□sweet

Serve the glasses in the order indicated in Table 3 below (one line per series):

TABLE 3: SERVING ORDER FOR FLAVOUR CLASSIFICATION TESTS

Series 1:

Glass	A1	B1	C1	D1	E1	F1
Order (dilution)	D2	D3	D1	D5	D6	D4
Response	Salty					

Series 2:

Glass	A2	B2	C2	D2	E2	F2
Order (dilution)	D1	D5	D4	D3	D2	D6
Response	Sweet					

- Instructions

The subject should classify the glasses for each series in ascending order of concentration and determine which flavour has been presented.

It is advisable to start by separating the three most concentrated solutions and then classify each of the groups separately before comparing the last of the least concentrated group with the first of the most concentrated.

Each panellist should indicate his or her results on the Classification test form (see Appendix 4).

When all the panellists have taken the test, the facilitator performs a common correction.

Threshold test for perception of basic flavours and sensations

The aims of this test are to determine each panellist's personal perception threshold for basic acidic and bitter flavours and astringency; to assess their sensitivity; and to train them in how to use an intensity scale. The test helps subjects become familiar with their own taste sensitivity.

- Preparation protocol

Using the stock solutions prepared previously (Table 1), prepare a series of dilutions D1 to D8 of acidic and bitter flavours and an astringent sensation.

- Implementing the test

Prepare 10 glasses numbered 1 to 10 for each series for each subject.

Series A: A1, A2, A3, A4, A5, A6, A7, A8, A9, A10 □ acidic

Series B: B1, B2, B3, B4, B5, B6, B7, B8, B9, B10 □ bitter

Series C: C1, C2, C3, C4, C5, C6, C7, C8, C9, C10 □ astringent

Eight glasses correspond to dilutions D1 to D8 of the solution; one glass contains a repeat dilution and one glass contains water. The glasses are presented in increasing order of concentration, and the glass of water is served randomly.

Serve the glasses in the order shown in Table 4 below (one line per series):

TABLE 4: SERVING ORDER FOR PERCEPTION THRESHOLD TEST

Series 1:

Glass	A1	A2	A3	A4	AT 5	A6	A7	AT 8	A9	A10
Order	D1	D2	D3	D4	Water	**D5**	**D5**	D6	D7	D8
Response	Acidic									

Series 2:

Glass	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Order	D1	D2	D3	D4	D5	Water	**D6**	**D6**	D7	D8
Response	Bitter									

Series 3:

Glass	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Order	D1	D2	D3	**D4**	**D4**	Water	D5	D6	D7	D8
Response	Astringent									

- Instructions

Subjects must taste the solutions in the order they are presented in without backtracking.

For each series, subjects must:

- Determine from which dilution they perceive a flavour or sensation.

- Determine how much dilution they can identify.

- Determine which glass contains the repeat dilution.

- Determine which glass contains water.

On the form Perception Threshold of Basic Flavours and / or Sensations (see Appendix 5), subjects rate the following for each series:

- 0: No perception (like water)

- X: perception without identifying the flavour or sensation

- XX: perception and identifies the flavour or sensation

- XXX, XXXX, etc.: perception of increasing intensity (the more the perception becomes intense, the more crosses there are).

Note: for the repeat dilution, record the same number of crosses.

When all the panellists have taken the test, the facilitator performs a common correction.

Triangular test

A triangular test is carried out to test the ability of candidates to discriminate.

This test can be performed on pure fruit juice purchased commercially.

- Preparation protocol

Prepare a drink of 10% diluted fruit juice using a pure fruit juice.

- Implementing the test

Prepare three solutions with the codes TUE, VVR and LNK as indicated in Table 5 below:

TABLE 5: CODING AND PREPARATION TRIANGULAR TEST

TUE	Solution 1: Pure drink
VVR	Solution 2: Pure drink
LNK	Solution 3: 10% diluted drink

Fill and serve the glasses in the following order:

Panellist 1: TUE VVR LNK
Panellist 2: TUE LNK VVR
Panellist 3: VVR TUE LNK
Panellist 4: VVR LNK TUE
Panellist 5: LNK TUE VVR
Panellist 6: LNK VVR TUE
Etc.

- Instructions

Subjects must smell and taste the samples and determine which one they perceive as being different.

Each panellist indicates his or her results on the Triangular Test form (see Appendix 6).

When all the panellists have completed the test, the facilitator performs a common correction.

The outcome of this test gives an indication of each panellist's ability to discriminate. This will be assessed during the matrices training (see Part 2 – Tutorial: How to Process Data in Sensory Analyses).

Smell recognition test

The panel's training also includes an olfactory test.

The aims of this test are to teach subjects how to assess and identify smells; to teach them to use the appropriate vocabulary; and to improve their individual abilities.

Feeling and identifying smells makes it easier to memorise them; panellists will then be able to detect them better in a matrix.

- Implementing the test

The test is carried out with four different smells from natural products bought in a shop / market.

Put the products in opaque glass bottles as shown in Table 6 below.

TABLE 6: SERVING ORDER FOR BOTTLES OF SMELLS

A	Citrus
B	Soil
C	Fruit
D	Spice

- Instructions

The panellists must identify the smell in each bottle by indicating its name or corresponding family (e.g. apple or fruit family, pepper or spice family, etc.).

Each panellist indicates his or results on the Smell Recognition Test form (see Appendix 7).

When all the panellists have finished the test, a joint correction is carried out by the facilitator.

Subjects who undertake these tests must not have performed other sensory tests on detecting or assessing smells or odorous compounds at least 20 minutes prior to the trial.

Describing a fruit puree

The aim of this exercise is to check whether the subjects have an objective opinion about the product presented to them.

- Implementing the test

Each subject is served a plate containing ~ 30 g of fruit puree.

- Instructions

Subjects are asked to describe the fruit puree in their own words. They must give the descriptors that come to mind for the following categories: visual, smells, texture in the mouth, flavours, sensations and aromas.

At the end of the session, a round table is held with everyone who was present at the session to discuss the vocabulary and to highlight the most relevant descriptors together.

We will then be able to assess the ability of the subjects to describe a product, their verbal creativity and their ability to explain terms.

1.2.3 Processing data from the general training

Basic flavour recognition and sensation test

If a panellist makes at least six mistakes out of the 12 answers (flavours, sensation, water) on this first test, they must leave the panel.

Basic flavours classification test and threshold test for perception of basic flavours and sensations

If a panellist makes at least two mistakes on the five flavours and sensation to be identified when performing these two tests, he or she must retake Test 1 on recognising basic flavours and sensations.

Smell recognition test

If a panellist identifies a maximum of only one smell on this test, he or she must leave the panel.

Outcomes

If a candidate is selected, he or she joins the tasting panel. The "administrative" part is then put in place (see Appendix 8: Terms of Appointment and Confidentiality). He or she will subsequently be invited to carry out the matrix training tests. Every panellist who is authorised to remain on the tasting panel will take this general training once a year.

When a candidate is not selected, he or she will be able to retake the selection tests in the future.

Feedback is given to tasters in all cases.

When a panellist decides that he or she no longer wants to be part of the tasting panel for any reason, a written request (by email or post) must be sent to the head of the sensory analysis laboratory.

The head of the laboratory may terminate a panellist's contract if he or she does not undertake any tasting sessions for a period of two years.

1.3 Matrix Training

- Tasting conditions

Tastings must be carried out in specially designed rooms with individual testing booths. The atmosphere of the room must be controlled (light, smell, temperature, humidity and noise pollution), and any anomaly must be noted.

A glass of water should be made available to all panellists so they can rinse their mouth between the different samples.

- Types of rating scale

Different types of scale may be used in sensory analysis. In the context of this project, a graded scale from 0 to 10 (using only whole numbers) should be used by each taster to record the intensity of each descriptor.

1.3.1 Session 1: Generating a vocabulary

The products are analysed using sensory descriptors that can be acquired via two methods: a pre-established list that is available in the literature or the autonomous generation of descriptors. If the descriptors are not available in the bibliography, a group of qualified subjects must generate them.

Contrasting samples (e.g. 3-5) of the product to be tasted are presented. Coded A, B, C etc., they are served in the same order to all the panellists to facilitate discussion.

The entire panel that has been selected and passed the general training is brought together for the study and presented with the products. Each panellist must independently and qualitatively generate a list of one-dimensional descriptors for all the products presented.

Subjects are asked to use their own words to describe the product that is presented to them. They must give the descriptors that come to mind for the different categories – visual, smells, texture, flavours, sensations and aromas – and write them on a blank sheet of paper.

The group will then work by consensus to select the most relevant and most commonly-stated descriptors; to group together synonyms and antonyms; and to eliminate hedonic, irrelevant or quantitative terms.

The terms selected are the descriptors which, after the sorting-out process described above, have been validated by over 70% of the panel.

A maximum of 20 descriptors should be selected.

1.3.2 Session 2: Drawing up the tasting form

The aim of this session is to draw up the tasting form (see Appendix 10: Tasting Form) with the definitions, assessment protocol and rating scale (limits and intermediates) for the three to five products previously contrasted.

Each descriptor must be defined according to a precise method of characterisation. A table then has to be drawn up with the selected jury that includes the definition and assessment protocol for each descriptor as well as the limits for a scale that has been chosen previously (see Appendix 11: Assessment Protocol and Definition).

A list of definitions based on ISO standard NF 5492-2009 is provided in Appendix 12 to help facilitators implement the tasting form.

1.3.3 Session 3: Using the scale

Examples of three or four benchmark products will be presented to the panel members so they can self-calibrate according to the limits of the rating scale.

Panellists are asked to rate the descriptors used in the previous session by applying the agreed protocol.

A joint discussion and correction is carried out by the facilitator.

1.3.4 Session 4: Individual notation on the scale

For the same three or four representative reference products, the panellists are asked to rate the descriptors individually on the selected tasting form.

When all the panellists have taken the test, a joint discussion and correction is led by the facilitator in order to recalibrate the panellists who were not able to situate themselves on the scale.

1.3.5 Session 5: Panel performance

The same test is carried out twice, when it will be possible to assess the performance of the panel on the basis of three criteria: repeatability, agreement with the panel and discrimination.

The assessment of the panel's performances will be carried out as indicated in Part 2: Tutorial: How to Process Data in Sensory Analyses.

1.4 Implementing the Test

A product-specific protocol must be drawn up to perform the test. There is no particular protocol and, depending on your product, you will need to decide on the protocol that will be implemented based on the following:

- The methods for preparing the sample (cooking time and temperature, cutting up the sample to be served, its homogeneity, etc.)

- The variable maturation of the sample (tasting day, etc.)

- Ease of service (samples served one-by-one or all together, etc.)

- The tasting temperature (cooling the sample, for example, is known to harden the pulp of cooked products)

- The maximum number of products presented per session (a maximum of four is recommended)

- The number of repetitions (on the same day or on different days or no repetition of tasting, etc.)

Defining these criteria determines the order in which the samples are presented, the number of samples presented per session, the way they are served, and the number of repetitions on the same day or over several days.

The products to be analysed must in all cases be offered to the tasters anonymously. They should be identified by a three-digit or three-letter code and served in random order.

Appendix 9 shows an example of a tasting by each panellist of four products prepared, served and tasted randomly.

The codes given in Appendix 9 should not be used for more than one session. Each pair of samples / repetitions corresponds to a random code and must be tasted in a specific, predetermined order.

1.5 Appendices

1.5.1 Annex 1

cirad UMR QualiSud	**Survey for pre-Selection of sensory panelist**	RTB foods

The information you provide will all be treated in strictly confidentiality.
Please indicate or tick your answer.

CIVIL STATUS:
Name : .....
First Name : .....
E-mail : .....
Phone : .....
Sexe : □ Male □ Female
Age : □ ≤ 20 years old □ 21-30 years old □ 31-40 years old □ 41-50 years old □ 51-60 years old □ ≥ 61 years old
Nationality : .....
Career : .....

DISPONIBILITIES :
Which are your disponibilities during week ?
□ Monday □ Tuesday □ Wednesday □ Thursday □ Friday
At what time are you really not free during day ?.....

EATING HABITS :
Which food you don t eat ? .....

HEALTH :
Are you allergic to some food ? □ Yes □ No
If you are, which kind of food ? .....

The laboratory thanks you for having accepted to answer this survey and hopes to be able to count you very soon in its panel of tastings.

1.5.2 Annex 2

Preparation protocol standard solution for flavor / impression tests

Prepare a solution of 1.5 L (called "stock solution" = Sm) of each basic flavor: sour, bitter, salty, sweet, and an astringency solution such as, using Volvic® water:

- Sour = tartaric acid – concentration : 3 g/L (4,5 g for 1,5 L of water).
- Bitter = quinine – concentration : 0,06 g/L (0,09 g for 1,5L of water).
- Salty = sodium chloride anhydrous – concentration : 7,5 g/L (11,25 g for 1,5L of water).
- Sweet = sucrose – concentration : 60 g/L (90 g for 1,5L of water),
- Astringency = aluminium potassium sulfate dodecahydraté ($KAl(So_4)_2.12H_2O$) - concentraion 5 g/L (7,5 g for 1,5L).

From these solutions, eight dilutions are prepared according to Table 1:

TABLE 1: PREPARATION OF DILUTIONS

Dilution	Sour		Bitter		Salty		Sweet		Astringency	
	Sm / 1,5 L	g/L	Sm / 1,5 L	g/L	Sm / 1,5 L	g/L	Sm / 1,5 L	g/L	Sm / 1,5 L	g/L
D1	63 mL	0,13	25 mL	0,0010	33 mL	0,16	33 mL	1,32	33 mL	0,11
D2	79 mL	0,16	35 mL	0,0014	47 mL	0,24	47 mL	1,88	47 mL	0,16
D3	98 mL	0,20	50 mL	0,0020	67 mL	0,34	67 mL	2,69	67 mL	0,23
D4	123 mL	0,25	72 mL	0,0029	96 mL	0,48	96 mL	3,84	96 mL	0,32
D5	154 mL	0,31	103 mL	0,0041	137 mL	0,69	137 mL	5,49	137 mL	0,46
D6	192 mL	0,38	147 mL	0,0059	196 mL	0,98	196 mL	7,84	196 mL	0,66
D7	240 mL	0,48	210 mL	0,0084	280 mL	1,40	280 mL	11,2	280 mL	0,94
D8	300 mL	0,60	300 mL	0,0120	400 mL	2,00	400 mL	16,0	400 mL	1,34

1.5.3 Annex 3

cirad / UMR QualiSud	**Identification of basic taste**	RTB foods

Name : **Date :** **Poste :**

The 4 flavors (sweet, salty, acid, bitter) are repeated 2 times, there are 2 glasses of water

example :

Nb of the glass	1	2	3	4	5	6	7	8	9	10
answers	salty	acid	water	sweet	acid	bitter	water	salty	bitter	sweet

test :

Nb of the glass	1	2	3	4	5	6	7	8	9	10
answers										

1.5.4 Annex 4

cirad / UMR QualiSud	**Ranking Test**	RTBfoods

Name : **Date :** **Poste :**

Classification of taste / impression by increasing intensity

6 dilutions of the same taste / impression are presented to you; you must rank them from the least concentrated to the most concentrated and determine which taste or impression you recognize.

It is advisable to start by separating the three least concentrated solutions from the most concentrated ones and then to classify each of the groups separately. Compare the last of the group of less concentrated with the first of the most concentrated.

Test 1

test n°		A1	B1	C1	D1	E1	F1
1	increasing order						
1	taste						

Test 2

test n°		A2	B2	C2	D2	E2	F2
2	increasing order						
2	taste						

1.5.5 Annex 5

cirad UMR QualiSud	**Threshold of perception of fundamental tastes or impressions**	RTB foods

Name : **Date :** **Poste :**

8 dilutions of the same taste or impression are presented to you, from the less concentrated to the more concentrated.
A glass of water is through them and one of the dilutions is repeated.
Never go back to the glass before.

Notation :
- 0: no perception (like water)
- X: perception without identification of the taste or the impression
- XX: perception and identification of taste or impression
- XXX, XXXX, ...: perception of increasing intensity (the more the perception becomes intense, the more the number of crosses increases).
Note: For repeated dilution, note the same number of crosses.

EXAMPLE :

Nb of glass	1	2	3	4	5	6	7	8	9	10
answer	0	X	X	XX	XXX	XXX	0	XXXX	XXXXX	XXXXXX
taste/impression/water				salty			water			

TEST :

Nb of glass	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
answer										
taste/impression/water										

Nb of glass	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
answer										
taste/impression/water										

Nb of glass	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
answer										
taste/impression/water										

1.5.6 Annex 6

TRIANGULAR TEST

Three samples are presented to you.

Two come from the same product, the third one from another product. In this test, you have to smell all of them and then taste them in the order of presentation indicated.

What is the sample that you perceive as different?

Why?

1.5.7 Annex 7

cirad UMR QualiSud	**Test of identification of odors**	RTBfoods

You have to identify the odors from each bottle.

Results table:

name :			**date :**		**poste :**
Identification of odors					
Put a cross in the appropriate column					
Sample Nb	Do you perceived an odor ?		Do you know this odor ?		Name of smell, description or association	Comments
	yes	no	yes	no		

1.5.8 Annex 8

UNDERTAKING OF CONFIDENTIALITY CONTRACT

I, the undersigned .....

Engage myself to:

- Be part of the sensory panel

And according to this:

- I have to be present when I am convened to tasting sessions or to inform, as soon as possible, the person in charge of the analysis in case I am not able to participate because of imperative reasons

- I must not disclose to a third party, to any natural or legal person, any information, regardless of its nature (client names, sampling names, results of analysis, hedonic evaluation…), that would be known either during tasting sessions or debriefing meetings.

- I must report any problem or malfunctioning to the person in charge of the session.

My manager aknowledges:

- That he/she has a scientific interest in my tasting activity, and allows me the required time to realize my tasting sessions.

For any reason, this contract may be stopped by any of the parties by post mail or email addressed to the scientific manager, subject to finishing the ongoing tests.

These arrangements automatically apply from the date of signature of the present contract and for a period of one year with tacit renewal.

For all due intents and purposes

The judge (preceded by the words "Read and approved")
Date: Signature:

The judge's manager (preceded by the words "Read and approved")
Family Name: Given Name:
Date: Signature:

The sensory analysis officer (preceded by the words "Read and approved")
Family Name: Given Name:
Date: Signature:

1.5.9 Annex 9

XLSTAT 2018.6.53568 - Plans d'expériences pour l'analyse sensorielle - Microsoft Excel 14.07213

EXEMPLE :

Juges : 15

Produits : 4

Produits/Juge : 4

Evaluation du plan

Codes produits :

1	PLH
2	FRL
3	XBP
4	HZX

ORDRE: Tableau Juges x Rangs

	R1	R2	R3	R4
J1	PLH	FRL	HZX	XBP
J2	HZX	PLH	XBP	FRL
J3	PLH	FRL	HZX	XBP
J4	XBP	PLH	HZX	FRL
J5	FRL	PLH	XBP	HZX
J6	HZX	PLH	XBP	FRL
J7	HZX	FRL	XBP	PLH
J8	XBP	HZX	FRL	PLH
J9	PLH	XBP	FRL	HZX
J10	FRL	XBP	PLH	HZX
J11	XBP	HZX	FRL	PLH
J12	HZX	XBP	FRL	PLH
J13	FRL	XBP	PLH	HZX
J14	PLH	FRL	HZX	XBP
J15	XBP	HZX	PLH	FRL

1.5.10 Annex 10

Matooke

Date: ***Name :***

		Sample 1	Sample 2	Sample 3
Appearence	Yellow			
	Homogeneity of colour			
Texture in mouth	Firmness			
	Moisture			
	Smoothness			
Texture by touch	hardness			
	Moldability			
	Stickiness			
Taste	Sweetness			
	Sourness			
Impression	Astringency			
Aroma	Matooke			
	Pumpkin			
	Grassy			

1.5.11 Annex 11

Sensory attributes of boiled banana

Attribute Family	Attribute	Definition	Evaluation protocol	Rating scale
Sensory Texture	Firmness	Force required to obtain deformation, penetration or rupture of the banana	Put in the mouth a piece of banana and Evaluate the force necessary to obtain the deformation of the product between the teeth during the first compression	0: Soft 10: Firm
	Chewiness	Energy or number of chews necessary to chew the banana to make it ready to be swallowed	Place the sample in the mouth, chew it at the rate of one chewing per second and assess the number of chews before swallowing (NB: chew the same amount of banana)	number of chews
	Mealiness	Mechanical property linked to cohesion and the presence of fine particles in the product during chewing	Put a piece of banana in your mouth and assess the presence of mealiness particles during chewing	0: Low 10: Strong
	Stickiness	Force required to peel off the fraction of product adhering to the interior of the oral cavity	Press a piece of banana between the molars and appreciate the adhesion of the product	0: Low 10: Strong
Taste	Sweetness	Elemental flavor caused by dilute aqueous solutions of various substances such as sucrose or aspartame	Put a piece of banana in your mouth, chew it and swirl it around your tongue to detect the sweet flavor	0: Low 10: Strong
Mouth impression	Moist	Perception of the amount of water absorbed or released by the product	Once the flavors are detected, moisture is felt by turning the product in the mouth	0 : Dry 10: Moist

1.5.12 Annex 12: Vocabulary – Sensory analysis

- acidity / acid taste

basic taste produced by dilute aqueous solutions of most acid substances (e.g. citric acid and tartaric acid)

- sourness / sour taste

Basic taste, gustatory complex sensation, generally due to presence of organic acids

- bitterness / bitter taste

basic taste produced by dilute aqueous solutions of various substances such as quinine or caffeine

- saltiness / salty taste

basic taste produced by dilute aqueous solutions of various substances such as sodium chloride

- sweetness / sweet taste

basic taste produced by dilute aqueous solutions of natural or artificial substances such as sucrose or aspartame

- astringent

Impression / complex sensation, accompanied by shrinking, drawing or puckering of the skin or mucosal surface in the mouth, produced by substances such as kaki tannins or sloe tannins

- body

consistency, compactness of texture, fullness, richness, flavour or substance of a product

- transparent

allowing light to pass and distinct images to appear

- opaque

not allowing the passage of light

- glossy / shiny

a shiny or lustrous appearance resulting from the tendency of a surface to reflect light energy at one angle more than at others

- texture

“in the mouth” all of the mechanical, geometrical, surface and body attributes of a product perceptible by means of kinaesthesis and somesthesis receptors and (where appropriate) visual and auditory receptors from the first bite to final swallowing

NOTE 1 Over the course of mastication, perception is influenced by the physical transformations that occur from contact with the teeth and palate and mixture with saliva.

Auditory information may contribute to judgement of texture and may predominate with dry products.

NOTE 2 The “mechanical attributes” are those related to the reaction of the product to stress. They are: hardness, cohesiveness, viscosity, elasticity and adhesiveness.

The “geometrical attributes” are those related to the size, shape and arrangement of particles within a product. They are: denseness, granularity and conformation.

The “surface attributes” are those related to the sensations produced in the mouth by moisture and/or fat in and near the surface of the product.

The “body attributes” are those related to the sensations produced in the mouth by moisture and/or fat in the substance of the product and the way in which these constituents are released.

- hardness

mechanical textural attribute relating to the force required to achieve a given deformation, penetration, or breakage of a product

NOTE 1 In the mouth, it is perceived by compressing the product between the teeth (solids) or between the tongue and palate (semi- solids).

NOTE 2 The main adjectives corresponding to different levels of hardness are:

— “soft”: low level, e.g. cream cheese;
— “firm”: moderate level, e.g. olive;
— “hard”: high level, e.g. boiled sweets.

- cohesiveness

mechanical textural attribute relating to the degree to which a substance can be deformed before it breaks, including the properties of fracturability, chewiness and gumminess

- fracturability

mechanical textural attribute related to cohesiveness and hardness and to the force necessary to break a product into crumbs or pieces

NOTE 1 It is evaluated by suddenly squeezing a product between the incisors (front teeth) or fingers.

NOTE 2 The main adjectives corresponding to different levels of fracturability are:

— “cohesive”: very low level, e.g. caramel, chewing gum;
— “crumbly”: low level, e.g. corn muffin, cake;
— “crunchy”: moderate level, e.g. apple, raw carrot;
— “brittle”: high level, e.g. peanut brittle, brandy snaps;
— “crispy”: high level, e.g. potato crisps/chips, cornflakes;
— “crusty”: high level, e.g. crust of fresh French-style bread;
— “pulverulent”: very high level, immediately disintegrating into powder upon biting, e.g.

overcooked egg yolk.

- chewiness

mechanical textural attribute related to the amount of work required to masticate a solid product into a state ready for swallowing

NOTE The main adjectives corresponding to different levels of chewiness are:

— "melting": very low level, e.g. ice cream;
— "tender": low level, e.g. young peas;
— "chewy": moderate level, e.g. fruit gums (confectionery);
— "tough": high level, e.g. old beef, bacon rind.

- gumminess

mechanical textural attribute related to the cohesiveness of a tender product

NOTE 1 In the mouth, it is related to the effort required to disintegrate the product to the state ready for swallowing.

NOTE 2 The main adjectives corresponding to different levels of gumminess are:

— "short": low level, e.g. shortbread;
— "mealy": moderate level, e.g. some potatoes, cooked dry haricot beans;
— "pasty": moderate level, e.g. chestnut puree, flour paste;
— "gummy": high level, e.g. overcooked oatmeal, edible gelatine.

- viscosity

mechanical textural attribute relating to resistance to flow

NOTE 1 It corresponds to the force required to draw a liquid from a spoon over the tongue, or to spread it over a substrate.

NOTE 2 The main adjectives corresponding to different levels of viscosity are:

— "fluid": low level, e.g. water;
— "thin": moderate level, e.g. olive oil;
— "unctuous" or "creamy": moderate level, e.g. double cream, heavy cream;
— "thick" or "viscous": very high,

e.g. sweetened condensed milk, honey.

- consistency

mechanical attribute detected by stimulation of the tactile or visual receptors

- elasticity / springiness / resilience

mechanical textural attribute relating to: the rapidity of recovery from a deforming force; and the degree to which a deformed material returns to its original condition after the deforming force is removed

NOTE The main adjectives corresponding to different levels of springiness are:

— “plastic”: absence, e.g. margarine;
— “malleable”: moderate level, e.g. marshmallow;
— “elastic”; “springy”; “rubbery”: high level, e.g. cooked squid, clams, gums.

- adhesiveness

mechanical textural attribute relating to the force required to remove material that sticks to the mouth or to a substrate

NOTE 1 The main adjectives corresponding to different levels of adhesiveness are:

— “tacky”: low level, e.g. marshmallow;
— “clinging”: moderate level, e.g. peanut butter;
— “gooey”, “gluey”: high level, e.g. caramel sundae topping, overcooked rice;
— “sticky”, “adhesive”: very high level, e.g. toffee.

NOTE 2 The adhesiveness of a product may be experienced in various ways, e.g.

— *to palate* — force required to remove product completely from the palate, using the tongue, after complete compression of the sample between tongue and palate;
— *to lips* — degree to which the product sticks/adheres to the lips — the sample is placed between the lips, compressed once slightly and released to assess adhesiveness;
— *to teeth* — amount of product adhering on/in the teeth after product mastication;
— *to itself* — force required to separate individual pieces with the tongue, when the sample is placed in the mouth;
— *manually* — force required to separate individual pieces adhering to each other using the back of a spoon.

- denseness

geometrical textural attribute relating to perception of the compactness of a cross-section of a product after biting completely through it

NOTE The main adjectives corresponding to different levels of denseness are as follows:

— “light”: low, e.g. whipped topping;
— “heavy”, “dense”: high, e.g. chestnut cream, traditional English-style Christmas pudding.

- granularity

geometrical textural attribute relating to the perception of the size, shape and amount of particles in a product

NOTE The main adjectives corresponding to different levels of granularity are as follows:

— “smooth”, “powdery”: absence,

e.g. icing sugar, dry cornflour;

— “gritty”: low level, e.g. some pears;
— “grainy”: moderate level, e.g. semolina;
— “beady”: having small, spherical particles, e.g. tapioca pudding;
— “granular”: having angular, hard particles, e.g. demerara sugar;
— “coarse”: high level, e.g. cooked rolled oatmeal;
— “lumpy”: high level with larger, irregular particles, e.g. cottage cheese.

- conformation

geometrical textural attribute relating to the perception of the shape and the orientation of particles in a product

NOTE The main adjectives corresponding to different conformations are as follows:

— “cellular”: spherical or ovoid particles consisting of thin walls surrounding liquid or gas, e.g. orange;
— “crystalline”: angular, similarly sized, symmetrical, three- dimensional particles, e.g. granulated sugar;
— “fibrous”: long particles or strands oriented in the same direction, e.g. celery;
— “flaky”: loose layers that separate easily, e.g. cooked tuna, croissant, flaky pastry;
— “puffy”: hard or firm outer shells filled with large, often uneven, air pockets, e.g. cream puff, puffed rice.

- moisture

surface textural attribute that describes the perception of water absorbed by or released from a product

NOTE The main adjectives corresponding to different levels of moistness are as follows:

Surface attributes:

— “dry”: absence, e.g. cream cracker;
— “moist”: moderate level, e.g. peeled apple;
— “wet”: high level, e.g. water chestnut, oyster.

Body attributes:

— “dry”: absence, e.g. cream cracker;
— “moist”: moderate level, e.g. apple;
— “juicy”: high level, e.g. orange;
— “succulent”: high level, e.g. meat;
— “watery”: water-like perception,

e.g. watermelon.

- fattiness

textural attribute relating to the perception of the quantity or the quality of fat on the surface or in the body of a product

NOTE The main adjectives corresponding to the perception of fattiness are as follows:

— “oily”: perception of soaking and running fat, e.g. salad with dressing;
— “greasy”: perception of exuding fat, e.g. bacon, chips, French fries;
— “fatty”: perception of high fat proportion in a product, oily, greasy, e.g. lard, tallow.

2 PART 2: TUTORIAL: HOW TO PROCESS DATA IN SENSORY ANALYSIS

Aim: To Assess the Performance of the Panel

2.1 Assessing the Panel's Performance

Subjects in a quantitative descriptive analysis test should not issue judgments based on their preferences. They should only characterise products according to their sensory perception, as though it were **an instrument of measurement**.

As with any other measuring device, it is important that the data produced is reliable. It follows that measuring the performance of a panel and its panellists is a key issue in sensory analysis. In practical terms, performance is viewed from two perspectives: the individual performance of the panellists and the performance of the panel as a whole.

The notion of performance, which is widely discussed in the literature, is usually divided into three concepts: repeatability, agreement and discrimination between the panellists (ISO 8586-1, 1993).

These three performance-related concepts will be addressed here from a so-called one-dimensional angle: one sensory descriptor at a time. The goal will be to obtain detailed information on panel performance for each sensory descriptor.

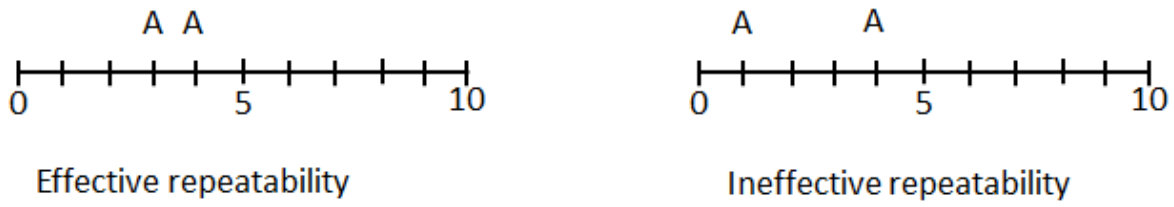
2.1.1 Definitions

Repeatability

When repeatedly presenting the same stimulus, the measurements must be as close as possible to each another. In sensory analysis, the accuracy of the measurement is also called the **repeatability**.

We say that the repeatability is effective if the deviation between two observations is less than or equal to 2 on a rating scale of 0 to 10.

Illustration of the concept of repeatability for a product assessed by a panellist (A)



Effective repeatability

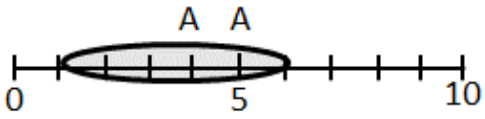
Ineffective repeatability

Agreement

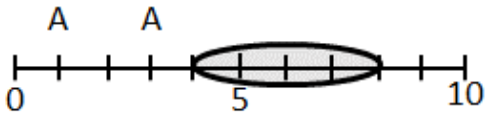
Agreement between the panellists measures the homogeneity of the responses obtained for the same stimulus by the different tasters. This characteristic results from the fact that the panel, unlike the majority of "standard" measurement tools, consists of several sub-units of independent

measurements: the panellists. Agreement denotes the overlapping of the scores given by the panellist for identical products.

Illustration of the concept of agreement for a product assessed twice by a panellist (A) and the panel (the shaded ellipse represents the average of the scores ± standard deviation).



Effective agreement



Ineffective agreement

We say that the agreement is effective if 70% of the deviation (absolute value) between the average of the panel and the average of the panellist (for an identical product assessed twice) is lower than the standard deviation of the panel.

In the example above,

First case: effective agreement

Absolute value [70% x (3.5^{α} – 4.5^{β})] = 0.7, i.e. < 2.5^{π} ($^{\alpha}$ panel average, $^{\beta}$ panellist average, $^{\pi}$ panel standard deviation)

Second case: Ineffective agreement

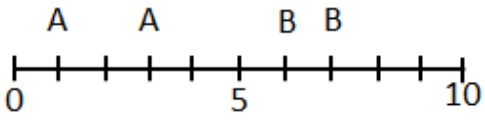
Absolute value [70% x (6.0^{α} – 2.0^{β})] = 4.0, i.e. > 2.0^{π} ($^{\alpha}$ panel average, $^{\beta}$ panellist average, $^{\pi}$ panel standard deviation)

Discrimination

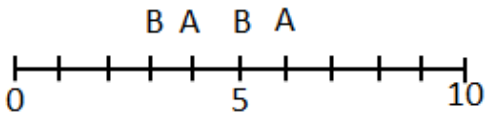
Discrimination is the ability to detect a difference in intensity between two or more two samples for a given descriptor. It indicates whether panellists were able to differentiate the products in the study or not.

Discrimination is related to the notion of repeatability since it becomes more difficult to be discriminating when the level of repeatability is low. But it is also possible for a panellist who is less repeatable than another to be more discriminating. Typically, someone for whom all the scores given were 0 is highly repeatable but not at all discriminating, whereas a person who is not very repeatable but who uses the full scale to make his or her scores may be discriminating.

Illustration of the concept of discrimination for two products (A and B) assessed twice by a panellist.



Effective discrimination



Ineffective discrimination

The ability to discriminate for a given descriptor is generally assessed by means of the product effect of an analysis of variance model. **The product F values and the p-values associated with the product effect reflect the ability to discriminate.**

Note: The product F values are preferred to those of the p-values because they allow panellists to be sorted by decreasing performance even for a limited number of observations (which is often our case). The p-value will be used only to assess the ability of the panel (in its entirety) to discriminate.

2.1.2 Using Excel to assess the performance (repeatability and agreement) of a panel

In this section, we will see how to assess the performance of a panel using Excel based on an example. In this example, the panel consists of eight panellists; three products (A, B, C) are tasted twice; and 10 sensory attributes were chosen based on previous sessions (vocabulary generation and use of the rating scale).

Entering the raw data

Open the Excel file assessment of repeatability and agreement_initial data.xls.

1. In the Sample tab, enter the data for the samples to be tasted.

Variety	Sample code	Repetition	Tasting code
Hybrid 201	**A**	**1**	**A1**
Hybrid 201	**A**	**2**	**A2**
Fougamou	**B**	**1**	**B1**
Fougamou	**B**	**2**	**B2**
Ney Poovan	**C**	**1**	**C1**
Ney Poovan	**C**	**2**	**C2**

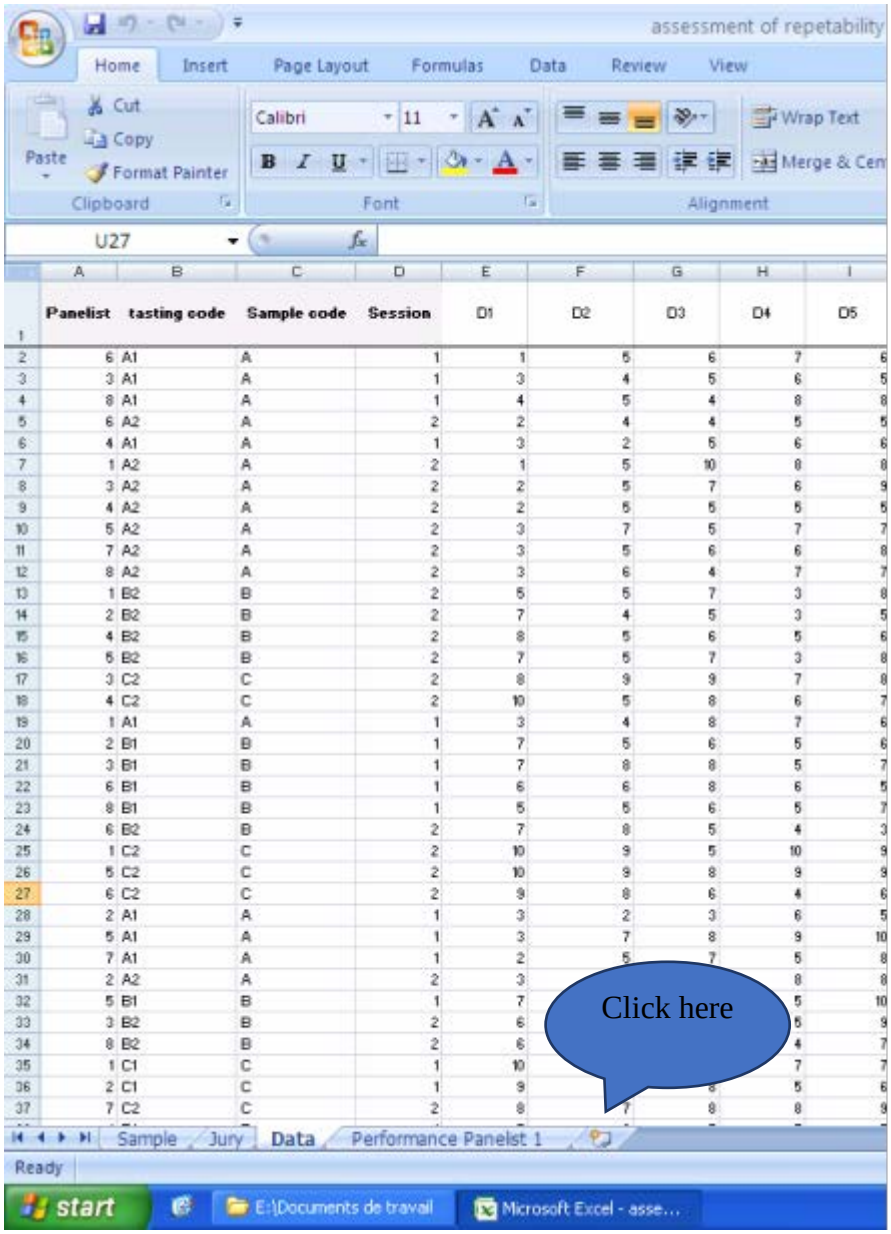
2. In the Panel tab, enter the data about the panellists (last name, first name, panellist code).
3. In the Data tab, enter the results of the tasting sessions.

- Note the attributes from cell E1. In the example, the attributes are D1 to D10.
- Enter the scores given by each panellist for each product at each session. At this stage, the order you enter the data by panellist, product and session is not important. In the example, the data was entered randomly.

Sorting the raw data

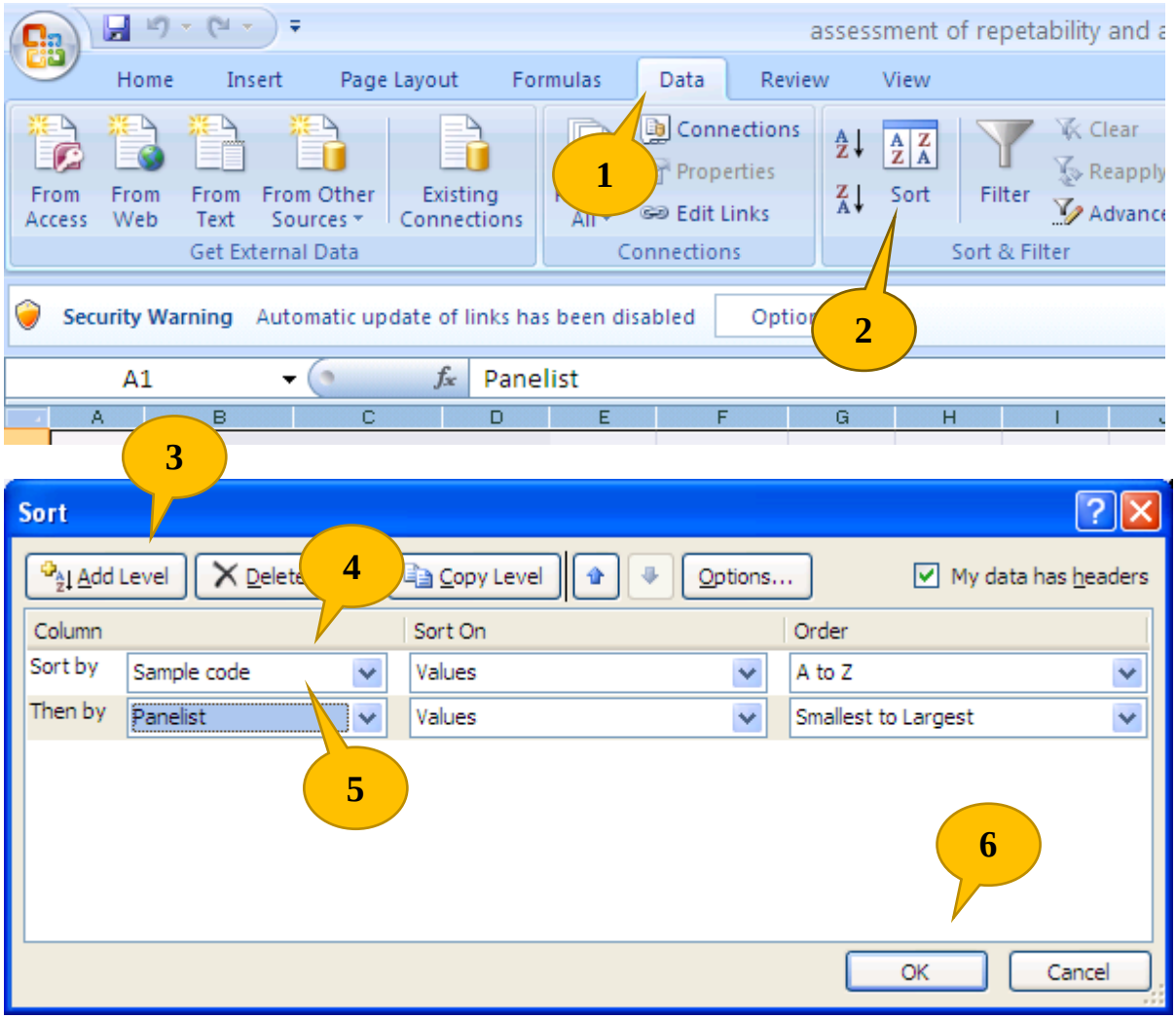
Raw data should be sorted by product and panellist:

1. Open a new tab.



A new tab Sheet1 appears.

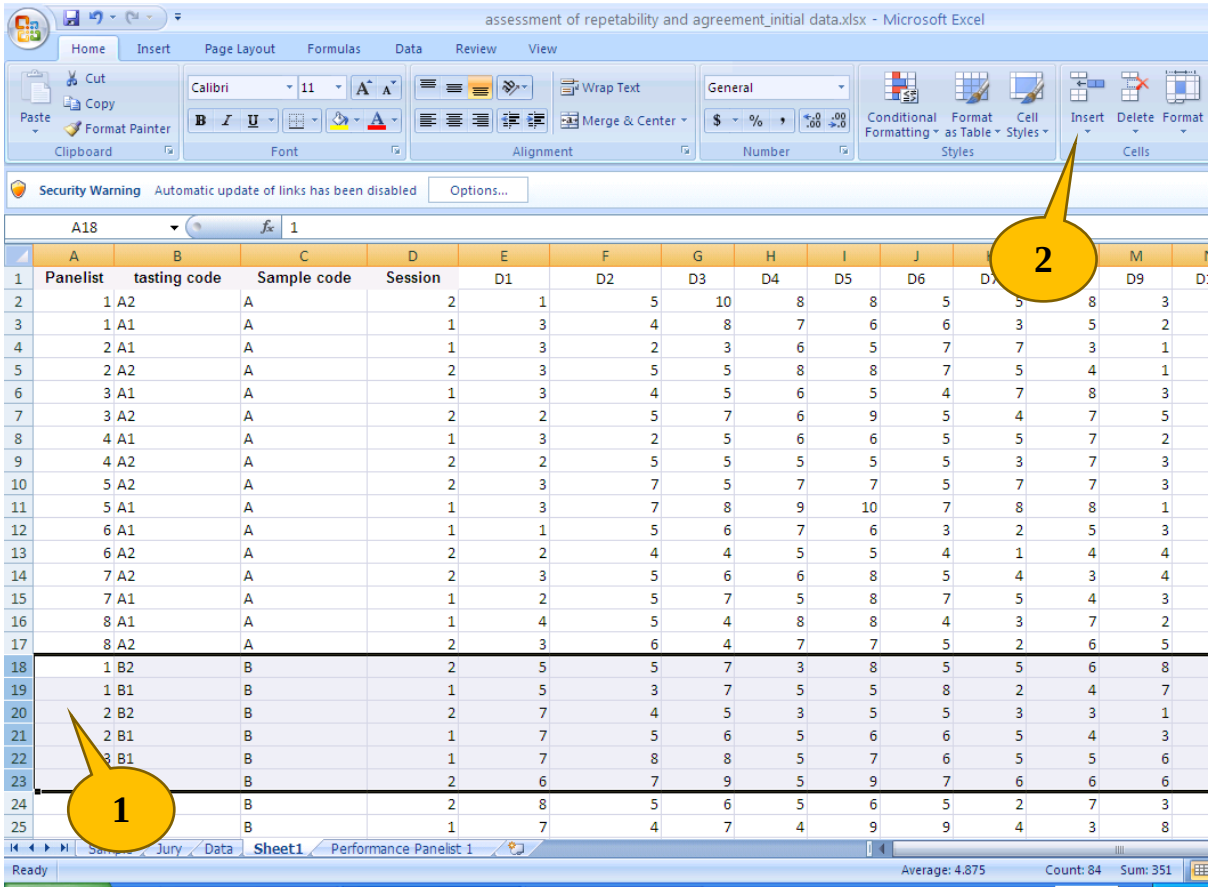
2. Select all the data in the table in the Data tab and copy and paste in the Form1 tab.
3. Select all the data in the table in the Sheet1 tab, then go to the sorting tools: click on Data (1) followed by Sort (2) and Add level (3), then display Sample code (4) before displaying Panellist (5) then OK (6).



View the panel's descriptive statistics

The panel's descriptive statistics must be calculated by product and for each descriptor: the average, standard deviation, minimum and maximum:

1. Insert 6 lines after each product (A, B, C): select lines 18 to 23 (1) and click on Insert (2). Repeat for lines 40 to 45.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Panelist	tasting code	Sample code	Session	D1	D2	D3	D4	D5	D6	D7	D8	D9
2	1	A2	A	2	1	5	10	8	8	5	5	8	3
3	1	A1	A	1	3	4	8	7	6	6	3	5	2
4	2	A1	A	1	3	2	3	6	5	7	7	3	1
5	2	A2	A	2	3	5	5	8	8	7	5	4	1
6	3	A1	A	1	3	4	5	6	5	4	7	8	3
7	3	A2	A	2	2	5	7	6	9	5	4	7	5
8	4	A1	A	1	3	2	5	6	6	5	5	7	2
9	4	A2	A	2	2	5	5	5	5	5	3	7	3
10	5	A2	A	2	3	7	5	7	7	5	7	7	3
11	5	A1	A	1	3	7	8	9	10	7	8	8	1
12	6	A1	A	1	1	5	6	7	6	3	2	5	3
13	6	A2	A	2	2	4	4	5	5	4	1	4	4
14	7	A2	A	2	3	5	6	6	8	5	4	3	4
15	7	A1	A	1	2	5	7	5	8	7	5	4	3
16	8	A1	A	1	4	5	4	8	8	4	3	7	2
17	8	A2	A	2	3	6	4	7	7	5	2	6	5
18	1	B2	B	2	5	5	7	3	8	5	5	6	8
19	1	B1	B	1	5	3	7	5	5	8	2	4	7
20	2	B2	B	2	7	4	5	3	5	5	3	3	1
21	2	B1	B	1	7	5	6	5	6	6	5	4	3
22	3	B1	B	1	7	8	8	5	7	6	5	5	6
23			B	2	6	7	9	5	9	7	6	6	6
24			B	2	8	5	6	5	6	5	2	7	3
25			B	1	7	4	7	4	9	9	4	3	8

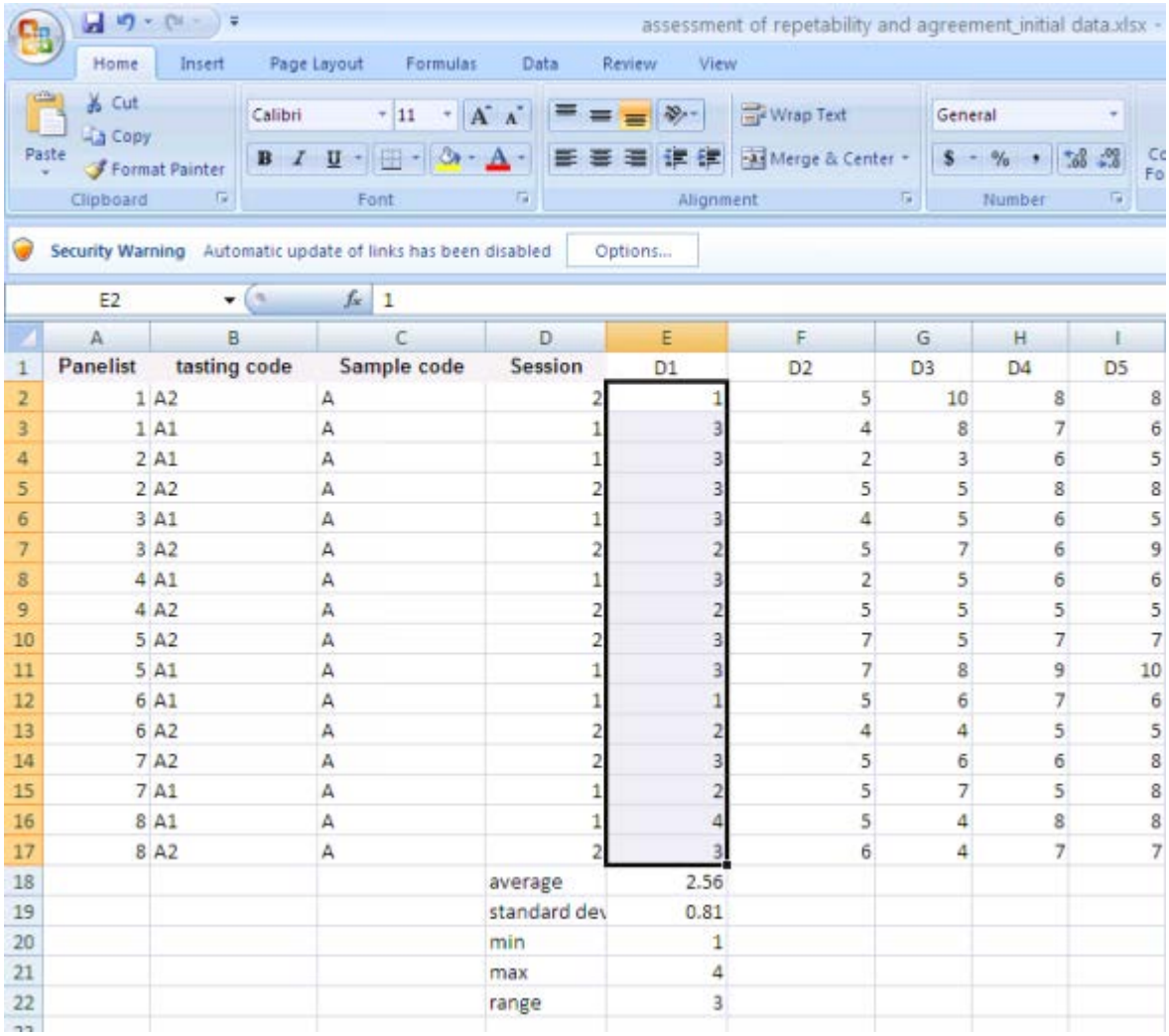
1

2. Calculate the average, standard deviation, minimum, maximum and deviation (max – min) for product A and the D1 descriptor:

- In cell E18, enter "=average(E2:E17)"
- In cell E19, enter "standarddeviation(E2:E17)"
- In cell E20, enter "min(E2:E17)"
- In cell E21, enter "max(E2:E17)"
- In cell E22, enter "E21-E20"

3. Copy and paste the cell range (E18:E22) for all the descriptors (F18:N22) for product A.

4. Copy and paste the cell range (D18:N22) for product B (D40:N44) and product C (D62:N66).



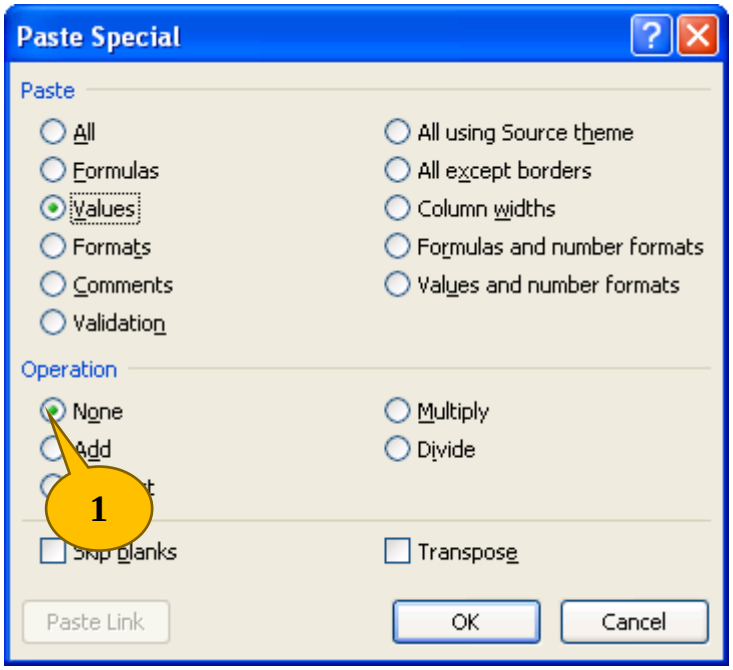
	A	B	C	D	E	F	G	H	I
1	Panelist	tasting code	Sample code	Session	D1	D2	D3	D4	D5
2	1	A2	A	2	1	5	10	8	8
3	1	A1	A	1	3	4	8	7	6
4	2	A1	A	1	3	2	3	6	5
5	2	A2	A	2	3	5	5	8	8
6	3	A1	A	1	3	4	5	6	5
7	3	A2	A	2	2	5	7	6	9
8	4	A1	A	1	3	2	5	6	6
9	4	A2	A	2	2	5	5	5	5
10	5	A2	A	2	3	7	5	7	7
11	5	A1	A	1	3	7	8	9	10
12	6	A1	A	1	1	5	6	7	6
13	6	A2	A	2	2	4	4	5	5
14	7	A2	A	2	3	5	6	6	8
15	7	A1	A	1	2	5	7	5	8
16	8	A1	A	1	4	5	4	8	8
17	8	A2	A	2	3	6	4	7	7
18				average	2.56				
19				standard dev	0.81				
20				min	1				
21				max	4				
22				range	3				

5. The contents of the Sheet1 tab must be similar in presentation to those of the Sorting data tab that was used for the example (here eight panellists, three products tasted twice and 10 attributes).

View the performances of the first panellist

The aim here is to display the repeatability and agreement results for panellist 1. The data for product A is first retrieved:

1. Copy (Ctrl-C) the cell range (A2:N3) in the Sheet1 tab (or Sorting data) and paste (Ctrl-V) this range into the Performance panelist1 tab in cell A2.
2. Copy the cell range (E18:N19) in the Sheet1 tab and paste the values (1) in this range into the Performance panelist1 tab in cell E7.
3. Copy the cell range (E20:N22) in the Sheet1 tab and paste the values in this range into the Performance panelist1 tab in cell E11.



4. Repeat steps 1 to 3 for products B and C.

Reading and interpreting the results of the performance of the first panellist

Let's look at the results shown in Table 1 (C44:N49) and 2 (C74:N75).

1. Table 1 shows whether the panellist was repeatable and in agreement with the panel for each product and descriptor.

Sample code	Repetition	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
A1	Repetability	yes	yes	yes	yes	yes	yes	yes	no	yes	yes
A2	Agreement	yes	yes	no	yes	yes	yes	yes	yes	yes	yes
B1	Repetability	yes	yes	yes	yes	no	no	no	yes	yes	yes
B2	Agreement	no	yes	yes	yes	yes	yes	yes	yes	yes	yes
C1	Repetability	yes	no	yes	no	yes	yes	no	no	yes	yes
C2	Agreement	yes	yes	no	yes	yes	yes	yes	yes	yes	yes

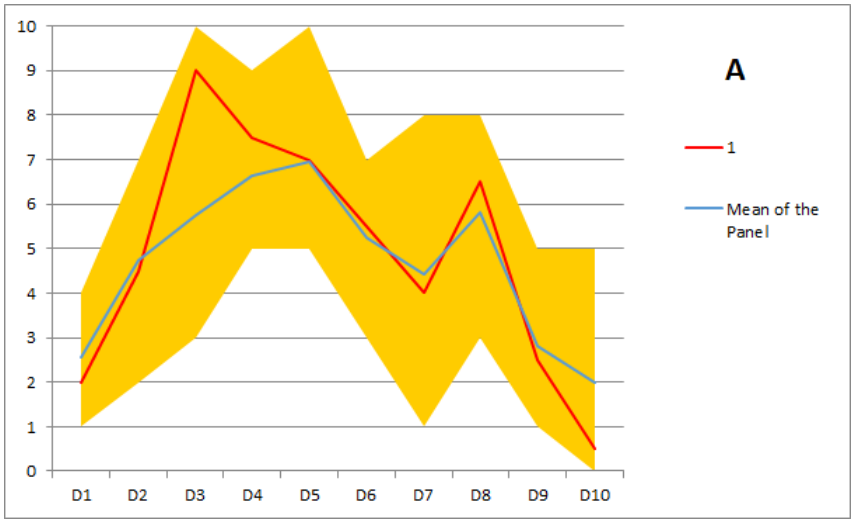
Table 2 indicates whether the panellist was repeatable and in agreement with the panel for all products and for each descriptor.

- The panellist is considered repeatable for a descriptor if he or she was repeatable for over 50% of the products tasted, i.e. here for at least two of the three products.
- The panellist is considered in agreement with the panel for a descriptor if he or she was in agreement with the panel for over 50% of the tasted products, i.e. here for at least two of the three products.

Table 2	Repetition	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
	Repetability	yes	yes	yes	yes	yes	yes	no	no	yes	yes
	Agreement	yes	yes	no	yes	yes	yes	yes	yes	yes	yes

Panellist 1 is repeatable for all the sensory attributes except D7 and D8, and is in agreement with the panel for all the attributes except D3.

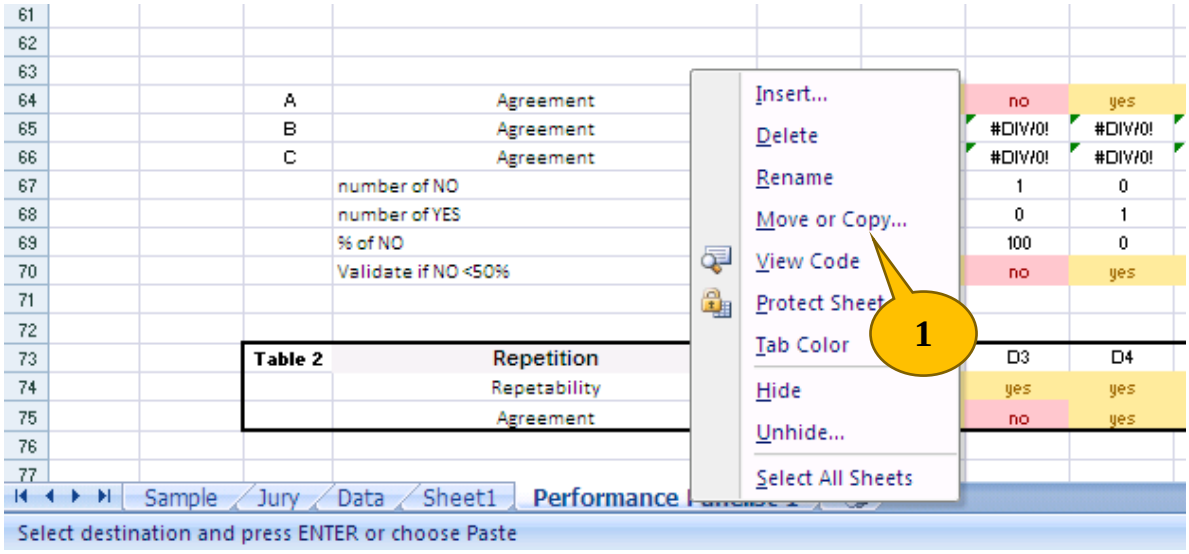
3. Charts A, B and C show the results of panellist 1 in relation to the panel for each product and descriptor: in red is the average of the scores of the two repetitions (for products A, B or C) for panellist 1; in black is the average of the scores of the two repetitions for the panel; and in yellow is the range of the scores of all the panellists (maximum – minimum).



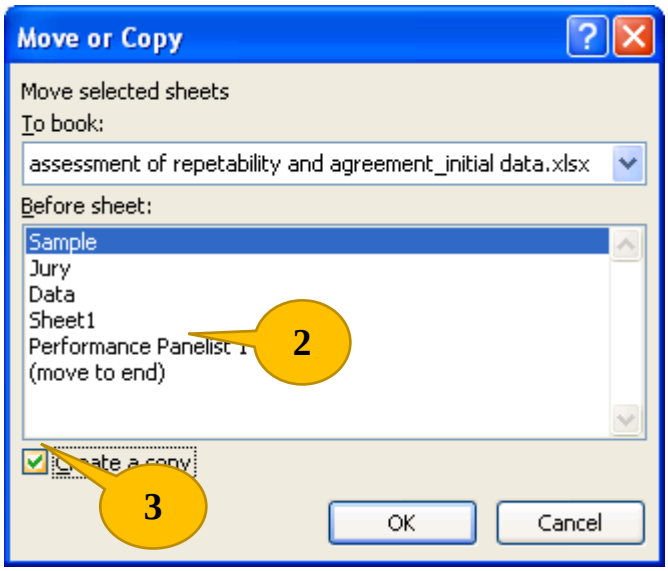
Show the performances of all panellists

The goal is to display one tab per panellist:

1. On the Performance panellist 1 tab, right click then click on Move or Copy (1)



2. A window appears: click on (move to end) (2) then tick Create a copy (3) and OK.



3. Rename the tab: double click left on the Performance Panellist 1 (2) tab and modify Performance Panellist 2.
4. Copy the cell range (A4:N5) in Sheet1 (or Sorting data) tab and paste this range into the Performance Panellist 2 tab in cell A2. Repeat for products B and C. The performance results for panellist 2 are now ready.
5. Repeat steps 1 to 4 as many times as there are panellists.

A summary table gathering the performances of all the panellists is proposed:

6. Open a new tab called Panel.
7. Copy and paste the values from Table 2 for each panellist into this tab.
8. Sort them from the first column. You will obtain the following table:

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	number of no
Agreement J1	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	9
Agreement J2	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J3	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J4	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J5	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J6	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	9
Agreement J7	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J8	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Repetability J1	yes	yes	yes	yes	yes	yes	no	no	yes	yes	8
Repetability J2	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Repetability J3	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Repetability J4	yes	no	yes	yes	yes	no	yes	yes	yes	yes	8
Repetability J5	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	9
Repetability J6	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Repetability J7	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	9
Repetability J8	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	9

9. Calculate the number of "Yes" responses per panellist and performance criterion: in cell L2, enter =NB.SI.ENS(B2:K2;"yes"); copy and paste this cell into the cell range (L3:L9) and (L11:L18).
10. You will obtain the following summary table available in a new file: assessment of repeatability and agreement_final data.xls.

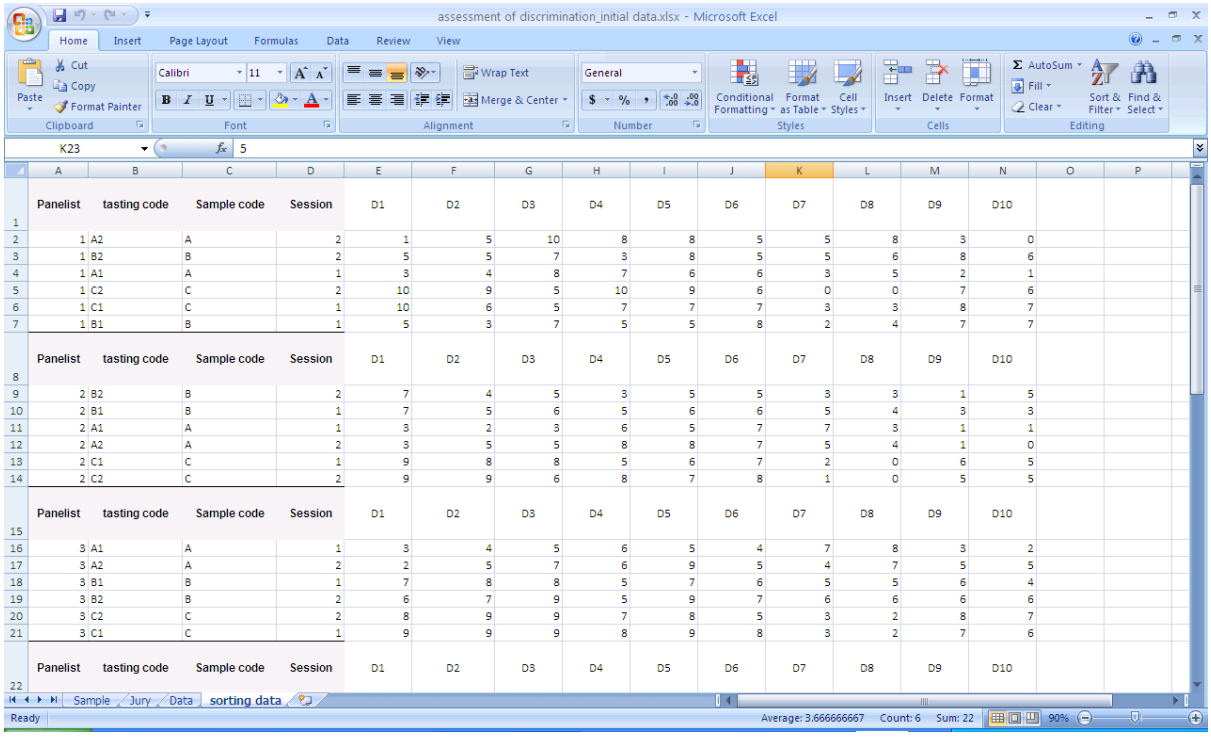
2.1.3 Assessing a panel's ability to discriminate using XLSTAT

We are going to assess a panel's discrimination ability by calculating the product F values associated with the product effect of an analysis of variance model. The software used here to calculate the product F values is XLSTAT, but any other statistical software is valid.

Prepare the data tables for the variance analysis

1. Open the Excel file assessment of discrimination_initial data.xls.
2. Open a new tab Sheet1 (see Section 22).
3. Select all the data from the table in the Data tab and copy and paste in the Sheet1 tab.
4. Sort the data from the Panellist column (see Section 22).
5. Insert a line above each panellist and copy and paste the line of variable labels.

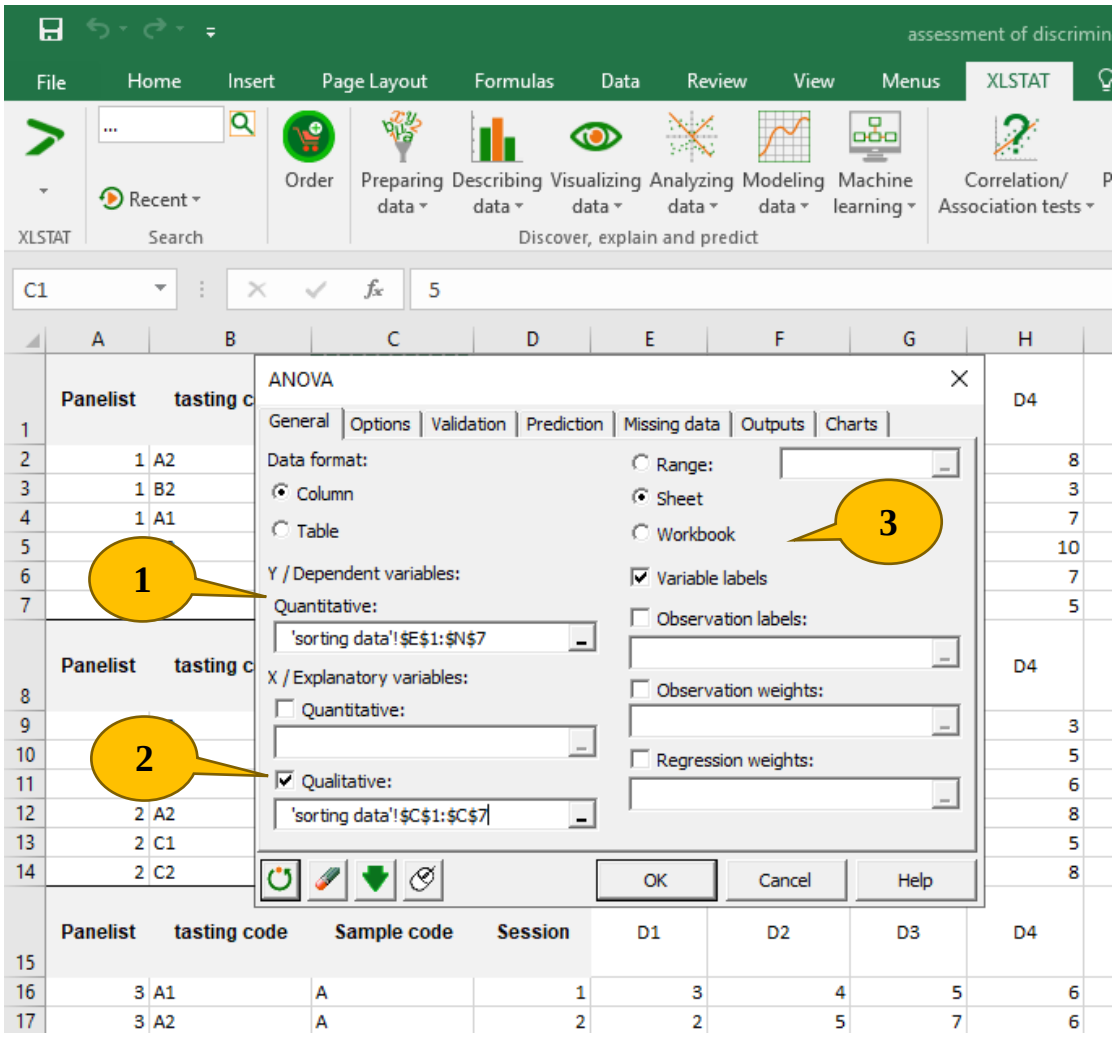
The final tab, renamed Sorting data, must be in this form:



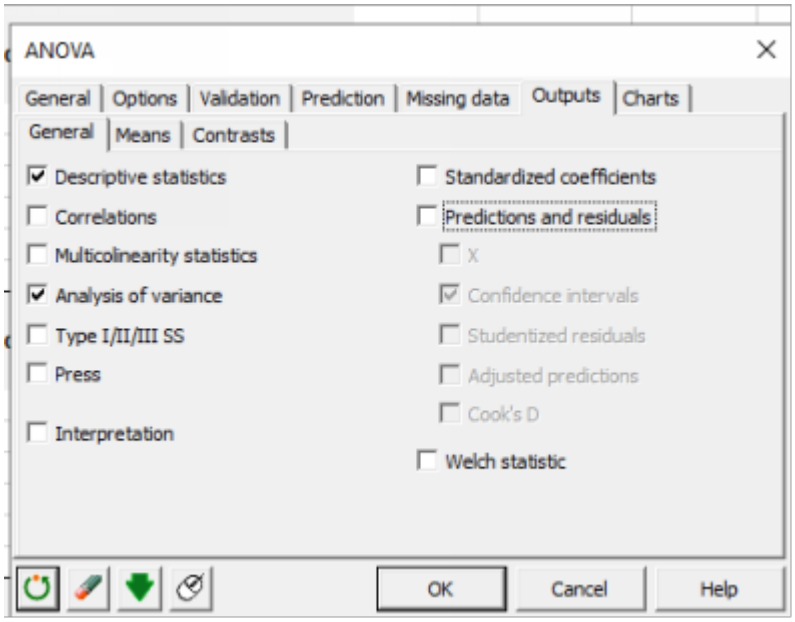
Panelist	tasting code	Sample code	Session	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
1	A2	A	2	1	5	10	8	8	5	5	8	3	0
1	B2	B	2	5	5	7	3	8	5	5	6	8	6
1	A1	A	1	3	4	8	7	6	6	3	5	2	1
1	C2	C	2	10	9	5	10	9	6	0	0	7	6
1	C1	C	1	10	6	5	7	7	7	3	3	8	7
1	B1	B	1	5	3	7	5	5	8	2	4	7	7
Panelist	tasting code	Sample code	Session	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
2	B2	B	2	7	4	5	3	5	5	3	3	1	5
2	B1	B	1	7	5	6	5	6	6	5	4	3	3
2	A1	A	1	3	2	3	6	5	7	7	3	1	1
2	A2	A	2	3	5	5	8	8	7	5	4	1	0
2	C1	C	1	9	8	8	5	6	7	2	0	6	5
2	C2	C	2	9	9	6	8	7	8	1	0	5	5
Panelist	tasting code	Sample code	Session	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
3	A1	A	1	3	4	5	6	5	4	7	8	3	2
3	A2	A	2	2	5	7	6	9	5	4	7	5	5
3	B1	B	1	7	8	8	5	7	6	5	5	6	4
3	B2	B	2	6	7	9	5	9	7	6	6	6	6
3	C2	C	2	8	9	9	7	8	5	3	2	8	7
3	C1	C	1	9	9	9	8	9	8	3	2	7	6
Panelist	tasting code	Sample code	Session	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10

Perform ANOVAs for the panel as a whole

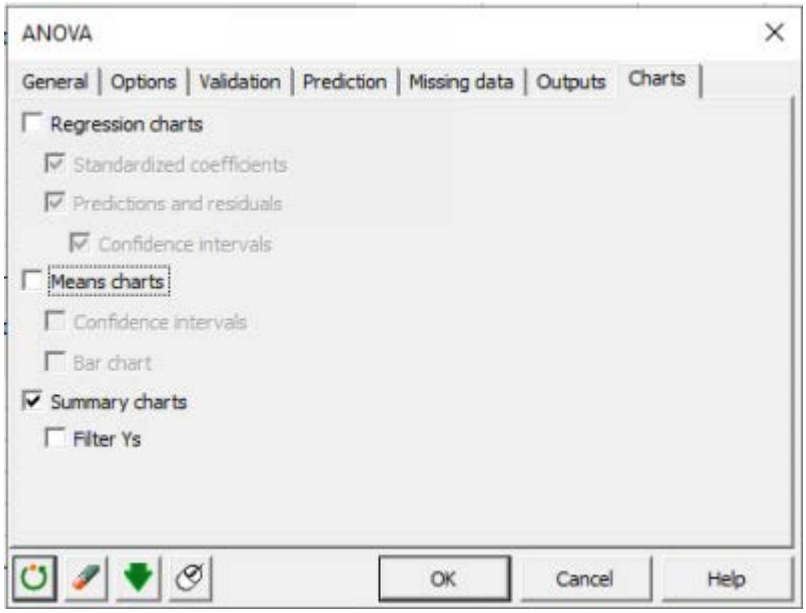
1. Open XLSTAT, then Data modelling followed by ANOVA. A new window appears.
2. In the General tab, select the range of cells (E1:N49) for quantitative dependent variables (1).
3. Select the cell range (C1: C49) for qualitative explanatory variables (2).
4. Tick Variable labels (3).



5. In the Outputs tab, tick only Descriptive statistics and Analysis of variance.



6. In the Charts tab, tick only Summary charts and then OK.



7. In the new sheet called ANOVA, a summary table is displayed for the analysis of variance for all the descriptors at the end of the results (L535:540).
8. Rename cell Pr>F with Panel discrimination.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
R^2	0,927	0,474	0,174	0,448	0,015	0,298	0,133	0,629	0,459	0,594
F	286,918	20,243	4,754	18,241	0,345	9,545	3,459	38,188	19,111	32,963
Discrimination panel	< 0,0001	< 0,0001	0,013	< 0,0001	0,710	0,000	0,040	< 0,0001	< 0,0001	< 0,0001

9. Copy and paste the lines of the variable label and Panel discrimination into a new sheet called product F. Note that only the descriptor D5 could not be discriminated by the panel (p-value > 0.05).

Performing ANOVAs for each panellist

Start with Panellist No. 1.

1. Go to the Sorting data sheet.
2. Open XLSTAT, then Data modelling followed by ANOVA. A new window appears.
3. In the General tab, select the range of cells (E1:N7) for Quantitative dependent variables.
4. Select the cell range (C1:C7) for Qualitative explanatory variables.
5. Select the range of cells (B1:B7) for Comments labels.
6. Tick variables labels.
7. In the Outputs tab, tick only Descriptive statistics and Analysis of variance.
8. In the Charts tab, tick only Summary charts then OK.
9. In the new sheet called ANOVA1, a summary table is displayed of the analysis of variance for all the descriptors at the end of the results (L536:541)
10. Rename cell F Discrimination J1.

Synthèse pour tous les Y :										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
R^2	0,970	0,672	0,889	0,761	0,215	0,195	0,389	0,705	0,957	0,970
Discrimination J1	49,000	3,071	12,000	4,786	0,412	0,364	0,955	3,591	33,333	48,000
Pr > F	0,005	0,188	0,037	0,117	0,695	0,722	0,478	0,160	0,009	0,005

11. Copy and paste the line F panellist 1 in product F.
12. Perform ANOVAs for all the other panellists by repeating steps 1 to 11.
13. The summary table showing all the values of F is in this form.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	
p-value panel	< 0,0001	< 0,0001	0,013	< 0,0001	0,710	0,000	0,040	< 0,0001	< 0,0001	< 0,0001	médiane
Discrimination J1	49,0	3,1	12,0	4,8	0,4	0,4	1,0	3,6	33,3	48,0	4,2
Discrimination J2	100,0	7,6	3,0	1,8	0,4	6,5	6,8	24,5	13,4	13,4	7,2
Discrimination J3	37,3	31,5	6,2	19,0	0,3	1,5	2,5	46,5	7,4	1,9	6,8
Discrimination J4	87,5	1,5	9,5	3,2	1,5	0,5	0,3	5,5	4,0	6,9	3,6
Discrimination J5	100,0	2,3	1,3	10,5	0,1	0,3	7,6	19,5	1,4	6,3	4,3
Discrimination J6	65,3	7,8	0,5	0,3	1,5	7,8	0,3	2,8	4,7	5,3	3,8
Discrimination J7	21,5	2,1	7,0	15,5	0,3	2,0	1,3	1,5	1,5	0,8	1,8
Discrimination J8	37,3	1,1	61,0	9,3	0,2	18,5	1,1	97,0	1,2	12,2	10,8

14. Calculate the median for each panellist: in cell L3 enter '=median(B3:K3); copy and paste this cell into the cell range (L4:L10).
15. All the results are available in the file assessment of discrimination final data.xls.

<u>Interpreting the results:</u>

- The panel as a whole is capable of differentiating the three products except for the D5 attribute (p-value > 0.05). Either the three products were not sufficiently different for this attribute or the panellists did not understand the meaning of this attribute. A special tasting session on this attribute may be carried out if deemed relevant.
- In terms of the panellists, the higher the product F value, the more the panellist is able to discriminate the products for such an attribute. There is no threshold value for deciding whether a panellist is able to discriminate or not. In the example, calculating the median makes it possible to sort the panellists by decreasing performance according to their median F. It turns out that panellist No. 8 is the top performer and panellist No. 7 the lowest.

2.1.4 Decision rules

Let's merge the final tables of the panellists' performances (Sections 28 and 33).

Suppose we obtain the following results:

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	number of Yes
Agreement J1	yes	yes	no	yes	no	yes	no	no	yes	yes	6
Agreement J2	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J3	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	9
Agreement J4	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J5	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	9
Agreement J6	yes	yes	yes	yes	no	yes	no	yes	yes	no	7
Agreement J7	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J8	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Repetability J1	yes	yes	yes	yes	yes	yes	no	no	no	yes	7
Repetability J2	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Repetability J3	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	9
Repetability J4	yes	no	yes	no	yes	no	yes	no	no	yes	5
Repetability J5	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	9
Repetability J6	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Repetability J7	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	9
Repetability J8	yes	yes	yes	yes	yes	yes	yes	no	no	yes	8
p-value panel	< 0,0001	< 0,0001	0,013	< 0,0001	0,710	0,000	0,040	< 0,0001	< 0,0001	< 0,0001	médiane
Discrimination J1	49,0	3,1	12,0	4,8	0,4	0,4	1,0	3,6	33,3	48,0	4,2
Discrimination J2	100,0	7,6	3,0	1,8	0,4	6,5	6,8	24,5	13,4	13,4	7,2
Discrimination J3	37,3	31,5	6,2	19,0	0,3	1,5	2,5	46,5	7,4	1,9	6,8
Discrimination J4	87,5	1,5	9,5	3,2	1,5	0,5	0,3	5,5	4,0	6,9	3,6
Discrimination J5	100,0	2,3	1,3	10,5	0,1	0,3	7,6	19,5	1,4	6,3	4,3
Discrimination J6	65,3	7,8	0,5	0,3	1,5	7,8	0,3	2,8	4,7	5,3	3,8
Discrimination J7	21,5	2,1	7,0	15,5	0,3	2,0	1,3	1,5	1,5	0,8	1,8
Discrimination J8	37,3	1,1	61,0	9,3	0,2	18,5	1,1	97,0	1,2	12,2	10,8

Sort the panellists by level of performance

Let's sort the panellists according to each performance criterion from the highest to lowest:

1. Sort the first two tables Agreement and Repeatability on the basis of the number of Yes responses.
2. Sort the Discrimination table based on the median.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	number of Yes
Agreement J2	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J4	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J7	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J8	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Agreement J3	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	9
Agreement J5	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	9
Agreement J6	yes	yes	yes	yes	no	yes	no	yes	yes	no	7
Agreement J1	yes	yes	no	yes	no	yes	no	no	yes	yes	6
Repetability J2	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Repetability J6	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	10
Repetability J3	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	9
Repetability J5	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	9
Repetability J7	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	9
Repetability J8	yes	yes	yes	yes	yes	yes	yes	no	no	yes	8
Repetability J1	yes	yes	yes	yes	yes	yes	no	no	no	yes	7
Repetability J4	yes	no	yes	no	yes	no	yes	no	no	yes	5
p-value panel	< 0,0001	< 0,0001	0,013	< 0,0001	0,710	0,000	0,040	< 0,0001	< 0,0001	< 0,0001	médiane
Discrimination J8	37,3	1,1	61,0	9,3	0,2	18,5	1,1	97,0	1,2	12,2	10,8
Discrimination J2	100,0	7,6	3,0	1,8	0,4	6,5	6,8	24,5	13,4	13,4	7,2
Discrimination J3	37,3	31,5	6,2	19,0	0,3	1,5	2,5	46,5	7,4	1,9	6,8
Discrimination J5	100,0	2,3	1,3	10,5	0,1	0,3	7,6	19,5	1,4	6,3	4,3
Discrimination J1	49,0	3,1	12,0	4,8	0,4	0,4	1,0	3,6	33,3	48,0	4,2
Discrimination J6	65,3	7,8	0,5	0,3	1,5	7,8	0,3	2,8	4,7	5,3	3,8
Discrimination J4	87,5	1,5	9,5	3,2	1,5	0,5	0,3	5,5	4,0	6,9	3,6
Discrimination J7	21,5	2,1	7,0	15,5	0,3	2,0	1,3	1,5	1,5	0,8	1,8

3. The panellists at the bottom of the table are the worst performers.

Decision and recommendation rules

1. **A panellist performs well in terms of repeatability if he or she is repeatable for at least 70% of the descriptors.** In the example given, he or she must have at least seven yes responses for the 10 descriptors. In the opposite case (at least four no responses), he or she is asked to take a new training session with three new products (identical or not to those of the previous sessions) that are repeated once.

- In the example above, panellist No. 1 will be assessed during a new session; he or she will be informed in advance of the difficulties he or she has encountered in terms of repeatability for attributes 3, 5, 7 and 8.

2. **A panellist performs well in terms of agreement with the panel if he or she is in agreement for at least 70% of the descriptors.** In the example given, he or she must have at least seven yes responses. In the opposite case (at least 4 no responses), he or she is asked to take a new training session repeated once with identical products to the previous ones.

- In the example above, panellist No. 4 will be assessed during a new session; he or she will be informed in advance of the difficulties he or she encountered in terms of agreement with the panel for attributes 2, 4, 6, 8 and 9.

3. We have not set any rules for the discrimination criterion. However, we recommend that the panel facilitator talks with panellists who have difficulties in discriminating products about the use of the rating scale, specifically about the attributes that may have been discriminated by the panel.

- In the example above, the panel facilitator will meet panellist No. 7 and talk to him or her about the ability to use the entire rating scale.
- As the panel was not able to discriminate attribute 5, the individual performances of the panellists are not challenged.

2.2 Basic Charts from a QDA / Descriptive Test

The aim here is to provide basic charts using the results from the final tasting test (see Section 4, Part 1): radar and bar chart.

Take the example given in the radar.xls Excel file. In this example, six products were tasted by eight panellists.

2.2.1 Preparing the final data table

1. Open the Data tab
2. Calculate the average for products A to F:

- In cell D52, enter "=average(D2:D9)".
- Do the same to calculate the average for the other products.
- Copy and paste the cell range (D52:D57) for all the descriptors (E52:M57).
- The following summary table is obtained:

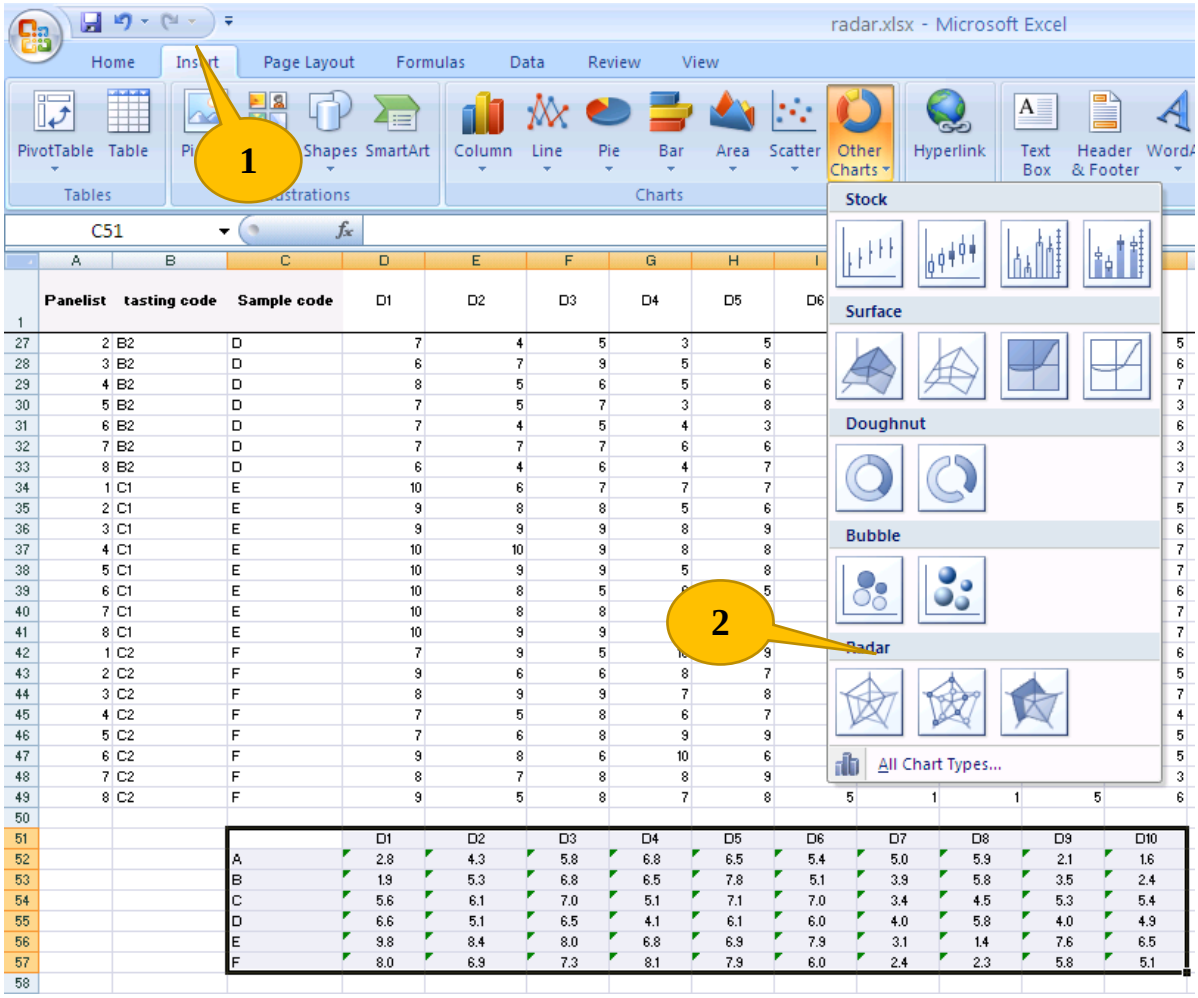
3. Copy and paste the range of cells (E18:E22) for all the descriptors (F18:N22).

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
A	2,8	4,3	5,8	6,8	6,5	5,4	5,0	5,9	2,1	1,6
B	1,9	5,3	6,8	6,5	7,8	5,1	3,9	5,8	3,5	2,4
C	5,6	6,1	7,0	5,1	7,1	7,0	3,4	4,5	5,3	5,4
D	6,6	5,1	6,5	4,1	6,1	6,0	4,0	5,8	4,0	4,9
E	9,8	8,4	8,0	6,8	6,9	7,9	3,1	1,4	7,6	6,5
F	8,0	6,9	7,3	8,1	7,9	6,0	2,4	2,3	5,8	5,1

2.2.2 Radar

The radar can be used to quickly view and compare the sensory traits of the products according to the scores obtained by the panel for all the attributes.

1. Select the cell range (C51: M57).
2. In the Insert tab (1), look for the radar icon (2).

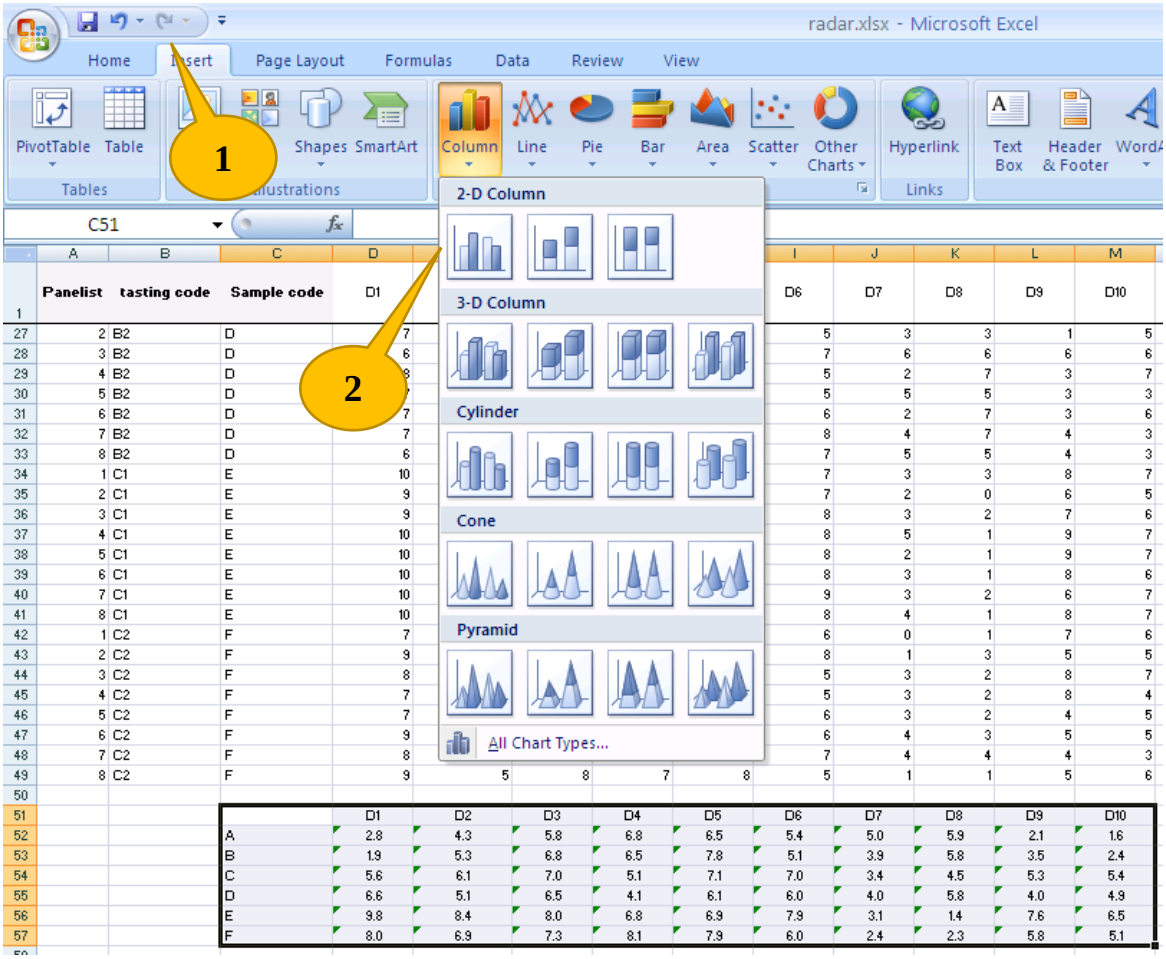


3. Enlarge the image as follows; add a title to the chart and increase the font size of the labels and captions.

2.2.3 Bar chart

The bar chart can be used to view the differences in scores between the products by attribute.

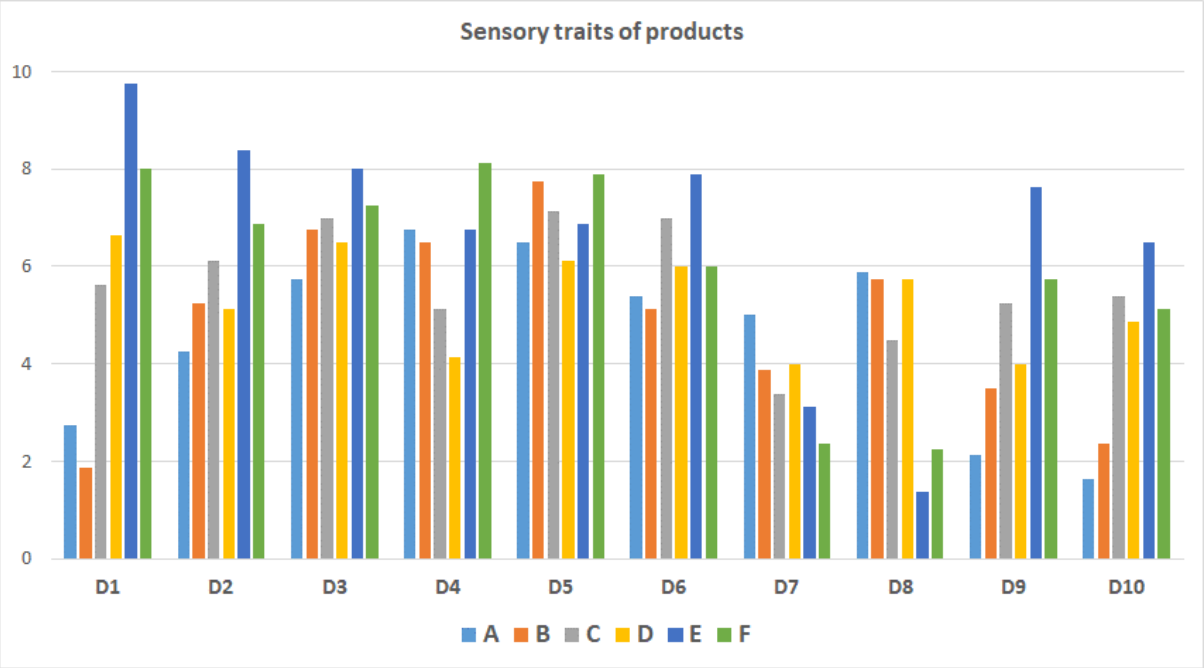
1. Select the cell range (C51:M57)
2. In the Insert tab (1), look for the bar chart icon (2). In our Excel 2016 version, click on a small icon (3) to access the bar chart you want (2).



Panelist	tasting code	Sample code	D1	D6	D7	D8	D9	D10
2	B2	D	7	5	3	3	1	5
3	B2	D	6	7	6	6	6	6
4	B2	D	8	5	2	7	3	7
5	B2	D	7	5	5	5	3	3
6	B2	D	7	6	2	7	3	6
7	B2	D	7	8	4	7	4	3
8	B2	D	6	7	5	5	4	3
1	C1	E	10	7	3	3	8	7
2	C1	E	9	7	2	0	6	5
3	C1	E	9	8	3	2	7	6
4	C1	E	10	8	5	1	9	7
5	C1	E	10	8	2	1	9	7
6	C1	E	10	8	3	1	8	6
7	C1	E	10	9	3	2	6	7
8	C1	E	10	8	4	1	8	7
1	C2	F	7	6	0	1	7	6
2	C2	F	9	8	1	3	5	5
3	C2	F	8	5	3	2	8	7
4	C2	F	7	5	3	2	8	4
5	C2	F	7	6	3	2	4	5
6	C2	F	9	6	4	3	5	5
7	C2	F	8	7	4	4	4	3
8	C2	F	9	5	8	7	8	5	1	1	5	6

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
A	2.8	4.3	5.8	6.8	6.5	5.4	5.0	5.9	2.1	1.6
B	1.9	5.3	6.8	6.5	7.8	5.1	3.9	5.8	3.5	2.4
C	5.6	6.1	7.0	5.1	7.1	7.0	3.4	4.5	5.3	5.4
D	6.6	5.1	6.5	4.1	6.1	6.0	4.0	5.8	4.0	4.9
E	9.8	8.4	8.0	6.8	6.9	7.9	3.1	1.4	7.6	6.5
F	8.0	6.9	7.3	8.1	7.9	6.0	2.4	2.3	5.8	5.1

3. Enlarge the image as follows; add a title to the chart and increase the font size of the labels and captions.



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