Sensory analysis: Overview of methods and application areas

**Part 4: Classic descriptive tests & new rapid methods**

**Classic descriptive tests**
- Descriptive analysis with following quality evaluation
- Polarized sensory positioning (PSP)
- Simple descriptive test
- Check all that apply (CATA)
- Sorted Napping®
- Sorting
- Conventional profiling
- Consensus profile
- Free choice profile
- Flash profiling

**New rapid methods**
- Projective mapping
- Partial Napping®
- Sorted Napping®
Besides discrimination tests, the analytical tests also include descriptive sensory analyses. Descriptive tests are intended to register and measure human perceptions and sensations during the consumption of foods. Classically, this is initially carried out qualitatively with the aid of sensory descriptions (sensory vocabulary) and subsequently – depending on the method – quantitatively with intensity ratings for each described attribute. These attribute descriptions are used to compare similar products, i.e. products from one category. In combination with popularity tests, this can be used to determine which product characteristics lead to the rejection or acceptance of the product among consumers.

For a long time, conventional descriptive analysis methods formed the link between market research, marketing, and product development; however, they are also used in quality assurance, i.e. during product profile checks in quality standards and for monitoring storage stability and best-before dates. In order to make the results as objective as possible, only trained sensory assessors are used for these methods, resulting in relatively high time and cost expenditure.

More recently, numerous rapid sensory profiling methods or short-term methods have emerged; in these, consumers directly describe the products that are presented and undertake hedonic ratings in the same test. These frequency-based methods include the CATA method (check all that apply) and numerous similarity measurement methods. The results are often less precise.

The following Expert report is intended to provide an overview of longstanding and new descriptive methods. Reference is made to the respective specialist literature for further information.

**Classic descriptive tests**

According to the definition by Stone/Sidel (2004), profile analyses represent a quantitative description of sensory product characteristics that is based on the sensory physiological perception of qualified persons. One of the prerequisites for participation is that the sensory assessors are also product users. The selected sensory assessors are trained following a sensory screening or a suitability test. The training process usually consists of switching between group discussions and individual tests. The participants develop or are familiarised with terms used to describe attributes and how to apply them. Once the assessors are able to characterise the products in terms of their appearance, odour, taste, and texture, intensities are allocated to these verbal descriptions so that the qualitative description is supplemented with a quantitative indication. Reference samples are often used with the intention of enabling the assessors’ perceptions to be standardised. Complete quantitative calibration in this process is not realistic; instead, the objective is to reduce the sites for participation is that the sensory assessors are also product users. The selected sensory assessors are trained following a sensory screening or a suitability test. The training process usually consists of switching between group discussions and individual tests. The participants develop or are familiarised with terms used to describe attributes and how to apply them. Once the assessors are able to characterise the products in terms of their appearance, odour, taste, and texture, intensities are allocated to these verbal descriptions so that the qualitative description is supplemented with a quantitative indication. Reference samples are often used with the intention of enabling the assessors’ perceptions to be standardised. Complete quantitative calibration in this process is not realistic; instead, the objective is to reduce the YDULDFQHEWZHQQWVWHWVHVHUXUDWLQIV7KHHQWLHUWUDLQLQQVXDOO\WDNHEWZHQQDQGRXUVDQDGQFKHFNLJQWKHCVQV\SDHQOUHOLEOLW\.

The essential methods of descriptive sensory analysis are described in the following. These include the very time-consuming, classic, intensity-based methods such as the Sensory QDA® and the SpectrumTM method. Descriptive tests in which the testers use their individual vocabulary, Fig. 1:

![Fig. 1: Example of a test form for the ‘simple descriptive test’](image-url)
Sensory analysis: Overview of methods and application areas

Descriptive test' such as free choice profiling (free choice sensory profile) and flash profiling, are also counted among the profiling methods and are aimed at achieving increased efficiency with comparable result quality. Widespread descriptive methods also include the 'simple descriptive test' and the 'descriptive test with integrated rating'.

Simple descriptive test (DIN 10964-2014)

The objective is to describe all or just individual product aspects (such as appearance, odour, taste, texture/consistency) by means of attributes.

Application areas: The method can be used to characterise product has changed raw materials, recipe changes and production-related changes on sensory product characteristics. It is also used during the sensory assessor and panel training.

Execution: Both trained and untrained sensory assessors can be used for this method. What is important is that the sensory assessors are able to describe their sensory perceptions accurately and understandably. Comprehensive sensory assessor familiarisation is therefore crucial. However, there should be at least three sensory assessors, and the test can be carried out as both an individual and a group test. The terms used to describe the product can be freely selected by the sensory assessors or selected from a high number of food groups and may prove helpful in selecting descriptors that have to be unencumbered by hedonic evaluations. Fig.1 shows an example of a test form for the 'simple descriptive test'.

Conventional profiling (DIN 10967-1-1999)

Objective is used to qualitatively describe and quantify products in terms of their characteristics.

**Fig. 2: Examples of test forms for the profiling test**

**Fig. 3: Intensity scale in the form of a linear scale**
This method is **used** in product development and optimisation, when comparing several products or also for monitoring the product qualities defined in the context of product standards.

**Execution:** In order to create a conventional profile, it is first necessary to collect descriptive terms. The lists of terms subsequently have to be structured, in which case similar terms are combined and hedonic attributes are eliminated. In the second step, the intensity of the attributes is rated within the framework of the individual assessment. The sensory assessors must therefore have extensive sensory knowledge and be able to describe the registered product characteristics accurately. They must additionally be able to recognise the defined attributes and express their intensity. The minimum number of sensory assessors is usually six persons in order to obtain a result that can be interpreted. The sensory assessor training and preparation are very time-consuming. The final result is determined by totalling the individual results and subsequently forming the arithmetic mean. Statistical evaluation of the test is usually carried out by means of a variance analysis and a main component analysis.

The results can be visualised in tabular or graphical form. Examples of test forms and result visualisations are shown in Figs. 2, 3 and 4. The conventional profiling methods also include the QDA® and Spectrum® methods, which originate from America. Both are proprietary processes that may only be used in cooperation with the respective institutes. The main difference between the two methods is the training procedure, which is relatively short in the case of QDA® and relatively long in the case of Spectrum®. Refer to the respective specialist literature for details concerning this.

**Consensus profile (DIN 10967-2-2000)**

**Objective:** 7KHFQVHQVXVSUROHPHWKRGRULIJLQDWHVIURPWKH]ODMTRLU]O, is used to describe and quantify sensory product characteristics.

**Application areas** include the characterisation of product standards, the comparison of several product standards, sensory assessor training (sensory panel training).
**Execution:** In terms of the selection and condensation of attributes, the methodological procedure for the consensus profile is identical to that of conventional profiling. All sensory assessors also rate the same product-relevant attributes in this method as well. The two profile methods differ due to the fact that, with the consensus profile, the sensory assessors discuss their results in the group once the individual intensity descriptions have been recorded in the individual test, and then develop a joint, overall result in consensus. Final evaluation is therefore carried out through a group discussion rather than by means of statistical methods and calculations from the respective individual assessments. The result is visualised as in conventional profiling. According to DIN, it should usually be possible to merge the assessments of at least six sensory assessors. Other sources and practical experience have shown that it is sensible to use sensory panels with an odd number of seven to 13 sensory assessors and to limit the number of products to be tested to around twelve samples.

The criticism levelled against this method refers particularly to the sensory assessors themselves, as they may possibly mutually influence one another due to the group discussion in the round table, with the result that they adopt their neighbour's assessments rather than forming their own. Conducting the test in individual booths, at individual test tables or at a test table with partition walls may remedy this and can help to first record individual assessments before the group discussion begins.

**Free choice profiling (DIN 10967-3-2001)**

**Objective:** Like the other profiling methods, the 'free choice sensory profile' or 'free choice profiling' is used to describe and quantify sensory product characteristics. In this process, an attempt is made to reduce the extensive training effort and the high time and cost expenditure of the conventional assessment methods somewhat.

**Application areas:** 'Free choice profiling' can be used to describe individual product attributes or to register the complete array of product characteristics.

**Execution:** While conventional profiling assessments necessitate intensive sensory panel training and a high level of standardisation, which above all involves developing and learning a common vocabulary for describing the product, the 'free choice profiling' method forgoes these. The reason given by proponents of this method is that intensive sensory assessor training prevents sufficient consideration from being given to consumer perceptions.

The following procedure is characteristic of a free choice profiling method:

1. No lengthy sensory assessor training is required, as sensory assessors with no or little training, usually consumers with good perceptive capabilities, are used. The members of the sensory panel must have sensory skills and be able to verbalise sensations. Standardising the terms is not necessary in this method. This means that the joint selection and condensation of the descriptive terms are forgone, because each sensory assessor uses his/her own descriptions of the attributes for product characterisation.

2. The quantitative description of the attributes can be carried out on an individual intensity scale, or the scale is specified by the assessment director.

3. Evaluation is carried out with the aid of a special multivariate statistical method called the generalised Procrustes analysis (GPA), which enables the derivation of a consensus configuration from two or more data sets. However, this data evaluation method is more complex compared to the standard statistical methods that are used to evaluate conventional profiling assessments.

The less training the sensory assessors have undergone, the more sensory assessors are required to obtain statistically validated results. The number of sensory assessors is usually eight to 30, but more participants can also be involved.
Flash Profiling

The objective is to offer food producers a quick method for obtaining decision-relevant sensory information. The products are analysed in direct comparison. Instead of intensity ratings on a scale, rankings according to the intensity of each attribute are established.

**Application areas:**

- Flash profiling is especially suitable for comparing products quickly on the basis of their significant sensory characteristics or differences.

**Execution:**

As in the free choice profiling method, the sensory assessors are also at liberty to choose the number, the meaning and the sequence of their descriptive terms. By waiving uniform terminology, extensive training processes are forgone. In contrast to free choice profiling, all sensory assessors are not provided with all of the samples to be tested consecutively, but at the same time, in a different assessing system, they then test all of the products in parallel, characteristic by characteristic, and rank each attribute in order of its intensity. This results in descriptor-centric profiling in inter-product comparison. Finally, all of the products in the product set to be tested have been described as regards their intensity in terms of their sensory characteristics and in relation to one another. Again, the results are evaluated and interpreted by means of the generalised Procrustes analysis (GPA), which is also used in free choice profiling.

Descriptive analysis with following quality evaluation (DIN 10969-2001)

The objective of the descriptive analysis with following quality evaluation is to first of all determine the intensities of previously defined analysis criteria or attributes of products and to then transfer the results to a rating or quality statement.

**Application areas:**

Above all, this sensory method is used in the context of cross-company product tests or quality tests. DLG quality tests for food and beverages are examples of descriptive analysis with following quality evaluation. Companies can use this method internally to assess products in the event of raw material changes or when using new processing technologies, to check the best-before date and the influences of packaging and storage on the product quality.

The execution of the analysis is generally subdivided into three sub-areas, where steps 1 and 2 are extensively described.
from the standard. Specifying complete lists with attribute descriptions is also conceivable. If completely new products
exist for DLG quality tests for food and beverages. These bring together all of the information that is relevant for
the test. They encompass both the sensory test attributes (such as e.g. appearance, odour, taste, consistency/texture)
descriptive attributes that describe the respective products or possible product defects (e.g. dull, pappy, slimy, hard,
dull, pappy, slimy, hard, etc.). The intensities or the extent of the identified product faults are rated with
the aid of a scale. The quality number can be determined according to the description of the attributes and the indication
of the award level achieved, in the form of the gold, silver or bronze DLG award, or indicates when no DLG award can be
assigned due to the existing quality defects. Trained sensory assessor panels are used in the context of the DLG quality
tests. The sensory assessors are qualified through their professional training in the area of product knowledge and product
manufacturing, are also provided with sensory training by DLG and are regularly reviewed with regard to their specialist
knowledge in the context of a defined monitoring procedure. (For further details in this regard, refer to DLG Expert report
'Sensory analysis: Overview of methods and application areas – DLG sensory analysis' at https://www.dlg.org/en/food/
topics/dlg-expert-reports.

New rapid sensory profiling methods

More and more, however, cost and time pressure in innovations as well as increasingly shorter product life cycles
are necessitating the quicker availability of relevant information for decision-making. Short-term methods, called rapid
profiling methods, exist for DLG quality tests. These bring together all of the information that is relevant for
the test. They encompass both the sensory test attributes (such as e.g. appearance, odour, taste, consistency/texture)
descriptive attributes that describe the respective products or possible product defects (e.g. dull, pappy, slimy, hard,
dull, pappy, slimy, hard, etc.). The intensities or the extent of the identified product faults are rated with
the aid of a scale. The quality number can be determined according to the description of the attributes and the indication
of the award level achieved, in the form of the gold, silver or bronze DLG award, or indicates when no DLG award can be
assigned due to the existing quality defects. Trained sensory assessor panels are used in the context of the DLG quality
tests. The sensory assessors are qualified through their professional training in the area of product knowledge and product
manufacturing, are also provided with sensory training by DLG and are regularly reviewed with regard to their specialist
knowledge in the context of a defined monitoring procedure. (For further details in this regard, refer to DLG Expert report
'Sensory analysis: Overview of methods and application areas – DLG sensory analysis' at https://www.dlg.org/en/food/
topics/dlg-expert-reports.

Check all that apply (CATA)

The check all that apply method is a frequency-based method and is therefore an interesting alternative to intensity-based test methods in descriptive sensory analysis.

<table>
<thead>
<tr>
<th>Sample 378</th>
<th>Sample 565</th>
<th>Sample 410</th>
</tr>
</thead>
<tbody>
<tr>
<td>sweet</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sour</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>umami</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>fruity</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>green, freshly cut grass</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>spicy</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>musty</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Fig. 6: Test form for a CATA test (example)
This method is essentially familiar due to its versatile use in market and consumer research surveys, whereby web-based checklists are often used. A higher number of testers is necessary for this method in order to achieve an appropriate degree of meaningfulness.

**Objective:** The CATA method is used for the sensory description of food, which can be carried out both with trained sensory assessors and also with untrained consumers, and is often paired with hedonic assessments in a single testing process.

**Application areas:** Above all, the CATA method is suitable for verbally describing foods of low complexity or for comparing samples that differ more extensively from one another in internal surveys. It is also often used in consumer research to verbally record consumers' associations when consuming products.

**Execution:** The CATA method is regarded as one of the 'verbal-based' methods, because it is concentrated on the sensory description of one or more presented products. The sensory assessors are usually provided with a list of specified descriptors, from which they check all that apply to the food to be tested (= check all that apply). The sequence of the terms should correspond roughly to the time of occurrence during testing or tasting. Long lists of descriptors lead to the fact that individual terms are used more rarely. On the whole, however, longer and shorter lists lead to similar results (Jaeger et al., 2015). Figure 6 shows an example of a CATA test form for comparing several products. No intensities are indicated in the context of the CATA method. The result shows how many sensory assessors use each term to describe the product. The relevance of the term options is measured based on the frequency of response and is evaluated accordingly. In addition to internal product description, the results of CATA tests can also be used in communication. In this case, the attributes that are selected most frequently by consumers can be used to prepare the formulation of sensory claims.

**Similarity measurements**

Similarity measurements are used for the sensory comparison of products in terms of their relative similarity to one other. They are methods that can be successfully implemented even in small companies.

**Application areas:** On the one hand, similarity measurements are used to compare a company’s own products with competing products. In the context of product development, it may also be of interest to determine which prototypes of a new product are most similar in sensory terms. On the other hand, however, similarity measurements can also be used to pre-select samples for a consumer test in order to select those that differ significantly from among numerous product prototypes, for instance. The results of similarity measurements can also be linked with hedonic data and therefore provide interesting answers for market research.

**Execution:** Untrained sensory assessors can be, and often are, used to determine and visualise the relative sensory similarity of products. The methods are often combined with simple sensory descriptions. The following assessment methods use the above described principle and therefore belong to the similarity measurement group:

- **Sorting:** In sorting, the sensory panel, which can consist of sensory experts or also consumers depending on the competing products, is presented with a list of different descriptors (e.g., ‘tomato juice’) and sorts or categorises these into various groups according to their sensory similarity. The sorting process...
Sensory analysis: Overview of methods and application areas

is carried out relatively quickly and is based on a holistic product analysis. Individual, intuitive sensory categorisation on the part of the sensory assessors is characteristic in this case, because each sensory assessor decides for himself/herself how many product groups are formed and the sensory criteria according to which grouping is carried out (Fig. 7). In order to subsequently visualise the relative similarity of the products, that data that is collected is used to produce a two- or three-dimensional image using the statistical method of multidimensional scaling (MDS). This establishes a sensory 'landscape' of the product group. Verbalised sensory characterisation of the sample groups subsequent to sorting is possible, but does not belong to sorting in methodological terms, with the result that the interpretation of the results is subject to a certain degree of subjectivity. This test is easy and quick to conduct; its information content is limited. The result is global information about the similarity structure of the products in a product category. This method is often used prior to actual product development, because it is used above all to identify opportunities and gaps in the market for new products.

- **Projective mapping:** In this method, untrained sensory assessors position all of the samples on a sheet of paper according to their similarity. This means that HDFK WHVWPHU GLUHFROQ SURGXFHV DO LQGLY LG similarity plot. Data analysis is carried out by means of multidimensional scaling, generalised procrustes analysis, main component analysis or multiple factor analysis.

- **Napping®:** 1DSSLQ® is a further development of projective mapping. In this method, too, each sensory assessor positions all of the products that are presented at the same time relative to one other on a sheet of paper (usually a rectangular sheet of paper measuring FPZKLKFLVLQWHQGHWRUHSUHVHQWDWZRLG dimensional space. In this process, products that are similar in sensory terms are positioned close to one other and different products are positioned far away from one another. On average, a maximum of 12 samples are presented to the nine to 15 sensory panel members per session. It is ideal if additional terms for describing the respective product characteristics are recorded E1PHDVQIRXWUD1DVKSURQ8LQ83IOORZLQW1DSLQ process so that the product arrangements can be LWQWHU5HGWDFRUGLQ8VWHLJ5STN81QW7K7VHQVRUDVYLVVRURWFRQFHOUDWHQWKBPRWLPWSRWFDUFWHLVWLFVURDPDLPXPR1GYHGHYULSWRUVLDOVRUHFPPH0Q7KHPHDLQ8X0S1DS1DSSLQ differentiated compared to sorting, because the coordinates of the coordinate system and therefore its position can be assigned to each product on the sheet of paper, thus enabling sensory characterisation across all sensory
modalities (appearance, texture, aroma, taste). Data evaluation is carried out exclusively by means of hierarchical multiple factor analysis.

- **Partial Napping**: This refers to the Napping process that is carried out separately for each sensory modality and is therefore more focused than general Napping.

- **Sorted Napping**: In sorted Napping, the Napping process is supplemented by a sorting task. Once individual products have been positioned based on their similarity, samples with the same sensory characteristics are consequently clustered (product groups) and then described verbally in terms of their characteristic sensory attributes (Fig. 9). Focus in this process is also on evaluating the sensory attributes with the highest relevance for the sensory panel members. The sorting process is relatively intuitive and is subject to the subjectivity of the sensory assessors. No absolute sample comparisons are carried out. In addition to the positioning data of individual products, statements regarding the clusters' product groups are obtained. The primary objective is to find similarities in the products that are presented and to understand how consumers group the products according to the characteristic sensory attributes of relevance to them. This method, too, can be used to select products prior to actual profiling or to support sample compilation for a multi-product consumer test (acceptance test).

With their holistic product analysis approach, the various sorting and Napping methods have already achieved a certain degree of popularity in sensory product characterisation in some areas, particularly since they can be used with both trained and untrained sensory panel members. One of their disadvantages is that all of the samples have to be presented at the same time. Subsequently including further samples is not possible in this case. The following methods were developed as an alternative to these, because the samples to be tested are compared with a previously determined and defined product set, called ‘poles’, therefore making the process independent of the scheduling and timing of sensory tasting sessions.

- **Polarized sensory positioning (PSP)**: In this method, each test product is compared with three previously selected products that serve as ‘poles’. The product’s similarity to each pole is rated on a 10-cm-long, unstructured scale (Fleming et al., 2015). As the choice of poles has a significant influence on the final result, this aspect is of particular importance. Data evaluation can be carried out in various ways (multidimensional scaling, main component analysis, multiple factor analysis). An example of a PSP test form is shown in Figure 10.

- **Polarized projective mapping**: This method is a combination of the polarised sensory positioning method with a mapping process and therefore combines the advantages of both methods with regard to a) the holistic approach of Napping or sorted Napping and b) the possibility of comparing products that were tasted in different sessions rather than at the same time. The sensory assessors are provided with a tasting form on which the position of the three pre-defined ‘poles’ is marked. They taste the three poles and the samples that are to be tested and position the latter on the sheet of paper (see Napping or sorted Napping) in relation to the poles. All of the samples are then briefly described in sensory terms. Data evaluation is carried out by means of multiple factor analysis (Ares et al., 2013).

![Fig. 10: Example of a test form for polarised sensory positioning tests for tomato juices](image-url)
Descriptive sensory analyses, i.e., the methods of descriptive sensory analysis, are regarded as the most demanding sensory methods due to the conventional sensory panel's high relevance to consumers. Traditionally, they are based on the sensory perception of accordingly trained sensory panel members. However, they do not result in a comprehensive accurate sensory profile of individual samples. The check all that apply method enables the collection of analytical information, description, and quantification of product characteristics that are objectively perceptible in sensory terms. The objective of these methods is to obtain a detailed product description that can be compared with other products or transposed into product recipes. This enables the product developer or the person responsible within the quality assurance department to focus on the essential dimensions of their product and to compare them with company standards or with competing products. Additional sample assessments with statistical result validation compared to QDA® or Spectrum™ are also enabled. The usage of QDA® and similar methodological approaches is possible for trained sensory panel members with little training, consumers, etc. A summary overview of the classic and new descriptive analysis methods is shown in Figure 11.

**Fig. 11: Overview of descriptive analysis methods**

**Conclusion:**

Descriptive sensory analyses are the most demanding sensory methods due to their diversity and complexity. Traditionally, they are based on the sensory perception of accordingly trained sensory panel members. However, they do not result in a comprehensive accurate sensory profile of individual samples. The check all that apply method enables the collection of analytical information, description, and quantification of product characteristics that are objectively perceptible in sensory terms. The objective of these methods is to obtain a detailed product description that can be compared with other products or transposed into product recipes. This enables the product developer or the person responsible within the quality assurance department to focus on the essential dimensions of their product and to compare them with company standards or with competing products. Additional sample assessments with statistical result validation compared to QDA® or Spectrum™ are also enabled. The usage of QDA® and similar methodological approaches is possible for trained sensory panel members with little training, consumers, etc. A summary overview of the classic and new descriptive analysis methods is shown in Figure 11.
Detailed information on the topic:

Authors:

Bianca Schneider-Häder, sensory analysis project Manager, DLG Competence Center Food, B.Schneider@DLG.org

Dr Eva Derndorfer, nutritional scientist and sensory analysis expert, textbook author, consultant and lecturer at several universities, Vienna/Austria eva@derndorfer.at, www.evaderndorfer.at

In cooperation with the DLG Sensory Analysis Committee.

Detailed information on the topic:
- Busch-Stockfisch M: Praxishandbuch Sensorik, Produktentwicklung/ Qualitätssicherung. Loose leaf collection
- DIN standards concerning the above methods
- DLG Sensory Analysis Committee (Ed.): Sensory Analysis Vocabulary. DLG-Verlag GmbH, Frankfurt/Main 2015.
- Jaeger SR, et al.: Check-all-that-apply (CATA) questions for sensory product characterization by consumers: IQHVWLJ|DWLRQVLRQWRQHHQXPEHURlWUXVHVGLQ6$5TXHVWLRLQJ|1RGGXVLRQDQG3UHHUHDFKJH
6WRQH6LGHUH46HVQRV|YDOXDWLRQ3UDWLFHV5FDGHFLF3UHVV,QF6DQ'LHJR}