Temporal Methods

An introduction, review, and suggested applications of temporal methods for sensory testing

Our interaction with any consumer product does not take place in a single moment, it's an experience that takes place over a period of time. From the moment you lay your eyes on a chocolate glazed donut, to its sweet lingering aftertaste, you are taking a sensory journey.

In sensory and consumer science, various temporal methods seek to evaluate an individual's experience over the course of this journey, and to help us capture and better understand sensory changes that occur over time. Every temporal method option has its strengths, as well as limitations, that depend on a variety of factors. These include the product, required analysis, time, budget, and access to a trained panel. In most cases, the use of a sophisticated data collection software is also required in order to capture the temporal data accurately and efficiently. However, the key to capturing the most accurate data is to begin by deciding if using temporal methods align with your project goals, and if so, which method is best suited for your unique testing and product circumstances.

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Time Intensity
(Single and Dual Attribute)

Time Intensity (TI) is a temporal method that is used to measure the rate, duration and intensity of one (or two) sensory attributes and how these factors change over time. TI is a great option for the evaluation of products that have most intensity changes in one or two specific attributes over a short period of time, such as sweetness and/or cinnamon flavor in chewing gum, or tenderness and/or juiciness in beef.

For TI questions, either one or two attributes are displayed to panelists at a time. The attributes evaluated depend on the type of product being evaluated. Attributes can be presented only one at a time with Single Attribute Time Intensity (SATI), or two at a time with Dual Attribute Time Intensity (DATI). TI provides rich, deep data, however the method is more involved in comparison to other methods. Compared to descriptive analysis, training for Time Intensity panelists is more challenging due to the complexity of the task.

Multi-Attribute Time Intensity

Multi-Attribute Time Intensity (MATI) is a temporal method that is used to measure the rate, duration, and intensity of several sensory attributes. This is a great option for products that change relatively slowly over time, such as toffee and chewy sweets.

For MATI questions, between 3 and 6 attributes are displayed to panelists at a time. The intensity of attributes can be scaled using either a categorical scale or a line scale. The software cues the assessor's attention to a particular attribute and they indicate the intensity of this attribute while it is cued. The cued attribute changes at regular intervals.

MATI has the benefit that it collects intensity information on 3 or more attributes, however the drawback is that the intensity data are not collected continuously.

> *Time Intensity is a great option for the evaluation of products that have more intensity changes in one or two specific attributes over a short period of time...*

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> *[TDS] might be best suited for product evaluations in which attributes are fleeting or tend to be noticed in sequence.*

Progressive Profiling

In Progressive Profiling, trained panelists are presented a series of attributes to rate on line scales at pre-determined time-intervals. After each time point, the panelist must wait a set period before scoring the attributes again. The same attributes are evaluated repeatedly, giving measurements that are sequential and repetitive. The regular intervals for scaling attributes ensures that panelists all stay on the same timeline within the test.

Progressive Profiling requires a well-trained and calibrated panel that can detect and scale the product attributes. However, many attributes can be measured in one evaluation, and the information collected produces a rich set of data. Progressive Profiling also has the ability to evaluate more complex products that include the combination of attribute types such as texture, particles, mouthfeel, etc., such as a multigrain bread, cheeses, or oral nutrition supplements.

Temporal Dominance of Sensations (TDS)

Temporal Dominance of Sensation (TDS) asks panelists what attribute they perceive as the most dominant out of a list of attributes at any given moment over the course of the sample evaluation. TDS is often used as a screening tool because of its ability to quickly measure multiple attributes in a product, with a general recommendation of a maximum of 10 attributes presented. However, TDS results are difficult to reproduce, and the interpretation of the data can sometimes be difficult because intensity is not measured.

On the other hand, TDS has been applied to a broad range of products including juice, yogurt, and wine, and might be best suited for product evaluations in which attributes are fleeting or tend to be noticed in sequence.

Another variant of TDS captures both the dominant attribute and its intensity. The benefit of this method is that it provides intensity data. The drawback is that the task is much more difficult for assessors. Furthermore, the intensity data are not continuous, and are often discarded prior to TDS data analysis.

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- Place Sample 591 in your mouth, press the START button below and begin to chew the product.

- Hold the sample in your mouth and manipulate/chew for 20 seconds, then swallow. Evaluate during the manipulation/chew and after the swallow.

- Indicate the dominant attribute as you perceive it by clicking on the attribute below. When a new attribute is perceived as dominant, click on the new attribute.

- After 45 seconds the timer will end. Press 'Next' when it appears.

■ ▶ 0:17

| Grain Flavor | Caramelized Flavor | Dried Fruit Flavor |
| Nutty Flavor | Sweet | |

If you have any comments, please identify them here:

TDS questions ask panelists to start a timer and then click the sensation choices that are most dominant during the sampling time. They can click as many choices as they perceive.

Temporal Order of Sensation (TOS)

Temporal Order of Sensation (TOS) asks panelists to identify the order in which the first few attributes are perceived. As with TDS, the attributes that are noticed might not be the most intense attributes.

TOS is also a great screening tool because of its ability to measure multiple attributes at once. It's also a relatively quick and simple task for panelists to perform. However, TOS emphasizes order of attribute appearance, which can be limiting depending on the testing objective. For this reason, TOS is a great option for quick product profiling. It's also a practical option if there is no access to a computerized sensory software, such as Compusense® Cloud, because evaluations can be accomplished using paper ballots.

However, these results are not as rich or revealing as some of the other methods. TOS is often used to capture the initial impression of products, such as saltiness perception in nacho chips, and umami in soup.

Temporal Check-All-That-Apply

Temporal Check-All-That-Apply, or TCATA questions, are similar to traditional check-all-that-apply questions, however, the panelist is asked to check and uncheck attributes as they are noticed, or are no longer noticed throughout the period of the evaluation. TCATA can be a good option for more complex products with multiple attributes. However, research continues around the limit of attributes per sample. Usually 4 to 12 attributes are presented to panelists at one time.
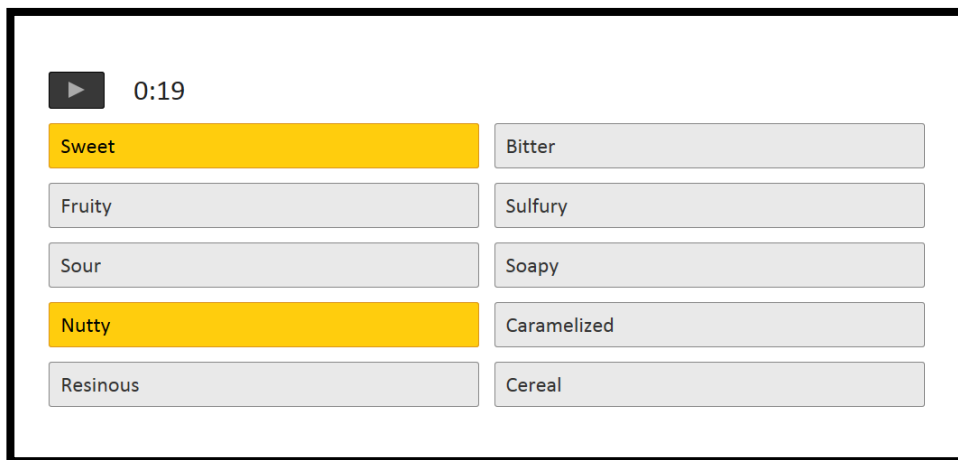
TCATA provides results that are similar to, but more nuanced than, results provided by TDS on the same products. The task of selecting and deselecting multiple attributes could overload panelists and compromise results. Recent research is investigating a refinement of TCATA that allows attributes to be unchecked automatically to determine whether it provides better results.

TCATA is the newest temporal method of those mentioned. Methodological refinement continues to be an exciting topic of research in the sensory science community.

Choosing the Right Temporal Method

Each temporal method has its strengths and limitations, and each one is suitable for varying testing purposes. It could be the case that a combination of temporal methods may lead to the best outcome. Since the first application of a temporal method for tracking the intensity of sweetness over time by Holway and Hurvich in 1937 (Lawless and Heymann, 2010), to today, where technological advancements allows for precise measures using sensory testing software, exciting research on the aforementioned methods continues to unveil the prospective applications of temporal testing.

Table 1 looks at the capabilities of each method, which should be thoroughly considered before undertaking a Temporal Methods project. Figure 1 goes through the important questions that a reseacher should consider when deciding on if Temporal Methods is appropriate for their project, and if so, which one.

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	SATI	DATI	MATI	TDS	TOS	TCATA	Progressive Profiling
Can it measures Intensity?	✓	✓	✓	ⓘ	✗	✗	✓
Can be used with multiple attributes?	✗	✓	✓	✓	✓	✓	✓
Is it a good screening tool?	✗	✗	✗	✓	✓	✓	✗
Can it be used with untrained panelists?	✗	✗	✓	✓	✓	✓	✗
Is it fast?	✗	✗	✗	✓	✓	✓	✗
Can it captures simultaneous sensations?	✗	✓	ⓘ	✗	✗	✓	ⓘ
Does it offer rich analysis?	✓	✓	✓	✓	✗	✓	✓
Requires computerized Sensory Software?	✓	✓	✓	✓	✗	✓	✓

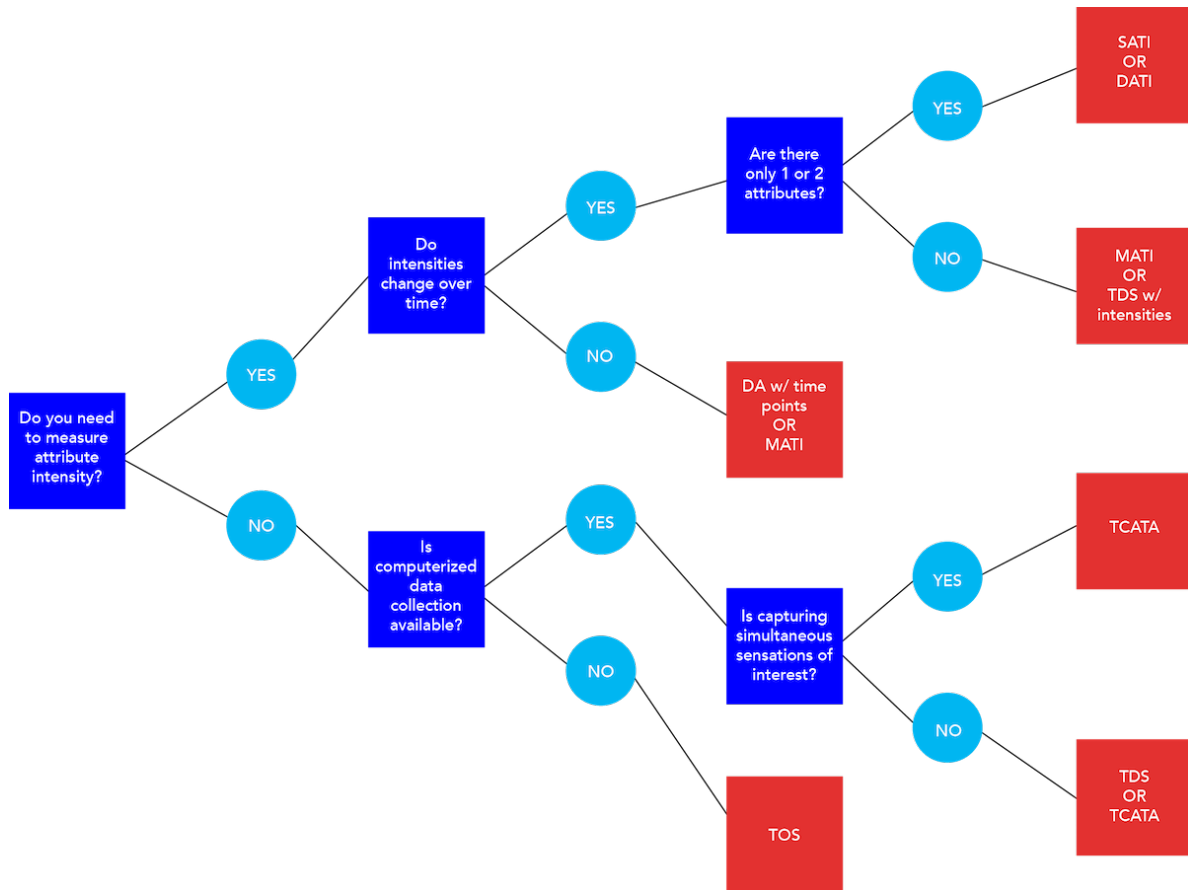Table 1 Temporal Methods Comparison

Figure 1 Temporal Methods Decision Tree

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