



# Identification of drivers of (dis)liking based on dynamic sensory profiles: Comparison of Temporal Dominance of Sensations and Temporal Check-all-that-apply



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## ABSTRACT

Temporal Dominance of Sensations (TDS) and Temporal Check-all-that-apply (TCATA) are two multi-attribute methods for dynamic sensory characterization. Previous research has shown that both methodologies provide complementary information. However, it remains an open question which of the two approaches better explains consumers' hedonic perception of products. In this context, the aim of the present work was to compare TDS and TCATA in terms of their ability to identify the influence of the dynamic sensory profile of food products on consumer overall liking scores. Two consumer studies were conducted using two different product categories (French bread and vanilla milk desserts). In each study, a between-subjects design was used to obtain dynamic sensory profiles using TDS and TCATA. After the dynamic sensory characterization tasks consumers rated their liking using a 9-point hedonic scale. Across the two studies, both methodologies provided similar information on the main drivers of liking and disliking, particularly when samples showed clear differences in liking. However, in one of the studies attribute applicability from TCATA provided additional insights on the influence of the dynamics of the sensory characteristics of products on consumers' liking. Results of the present work stress the complementarity between TCATA and TDS and highlight the potentiality of TCATA to provide a more detailed description of the dynamics of sensory perception during consumption.

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## 1. Introduction

The dynamics of sensory perception during consumption have been the focus of extensive research in sensory and consumer science for several decades (Cadena, Vidal, Ares, & Varela, 2014). The perceived sensory characteristics of foods markedly change during in-mouth transformation, which may influence consumer hedonic perception throughout consumption (Sudre, Pineau, Loret, & Martin, 2012). Therefore, static approaches to sensory characterization, such as Descriptive analysis, may miss valuable information for understanding consumer preferences (Lawless & Heymann, 2010).

Methods for dynamic sensory characterization based on the description of the sensory characteristics of products over time, such as Temporal Dominance of Sensations (TDS; Pineau, Cordelle, & Schlich, 2003) and Temporal Check-all-that-apply (TCATA; Castura, Antúnez, Giménez, & Ares, 2016), have gained popularity in the last decade. TDS is based on the concept of dominance, which makes it conceptually different from all other sensory methods (Meyners, 2010). In this method, assessors are presented with a list of sensory attributes and are

asked to select the dominant one at each moment of the evaluation, i.e. the attribute that catches their attention at a given time, which is not necessarily the most intense (Pineau et al., 2009). TDS has been used to study the temporal evolution of the sensory characteristics of a wide range of products (Di Monaco, Su, Masi, & Cavella, 2014). However, a potential drawback is that it only focuses on the dominant attribute, not taking into account the other sensory characteristics that are simultaneously perceived while consuming a product. When dealing with complex products that require simultaneous evaluation of multiple sensory modalities, individual differences in the conceptualization of dominance can hinder the ability of TDS to provide a detailed dynamic sensory characterization (Ares et al., 2015).

TCATA is an extension of check-all-that-apply (CATA) questions, which relies on the identification of all the sensory attributes that are perceived at each moment of the evaluation (Castura et al., 2016). In this methodology, assessors are presented with a list of sensory attributes and are asked to select all the attributes they consider applicable to describe the sensations they perceive at each moment of the evaluation. They are allowed to check several attributes, which enables them to describe sensory characteristics that are simultaneously perceived. Attributes that are no longer perceived should be unchecked. Despite its recent introduction to sensory and consumer science, TCATA has

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been already used with trained and untrained assessors for dynamic sensory characterization of food products of different complexity and cosmetic emulsions (Ares et al., 2015; Boinbaser, Parente, Castura, & Ares, 2015; Castura et al., 2016; Baker, Castura, & Ross, 2016; Oliveira et al., 2015).

TDS and TCATA have been reported to provide complementary information about the dynamic sensory profile of products (Ares et al., 2015). TDS focuses on the attributes that catch assessors' attention during consumption, whereas TCATA is related to the applicability of terms for describing the sensory characteristics of samples. According to Ares et al. (2015) TCATA provides a more comprehensive description of the temporal evolution of the sensory characteristics of samples, enabling greater discrimination among samples. However, it has not yet been explored which of the two approaches better explains consumer hedonic perception of food products.

Research on the influence of changes in the sensory characteristics of samples during consumption on consumer liking is still limited (Sudre et al., 2012). One of the first attempts to study the relationship between temporal aspects of sensory and hedonic perception was performed by Veldhuizen, Wuister, and Kroeze (2006). These authors studied the relationship between taste intensity and pleasantness of orange lemonades. They reported that both measurements were correlated, but did not occur simultaneously. Paulsen, Næs, Ueland, Rukke, and Hersleth (2013) reported that preference mapping based on TDS parameters provided additional insights on the drivers of consumer liking of salmon-sauce combinations compared to a descriptive analysis approach. More recently, Thomas, Visalli, Cordelle, and Schlich (2015) introduced the concept of temporal drivers of liking to provide a better understanding of the influence of temporal changes in the sensory characteristics of products on consumer liking.

In this context, the aim of the present work was to compare TDS and TCATA in terms of their ability to identify the influence of the dynamic sensory profile of food products on consumer overall liking scores.

## 2. Materials and methods

Two consumer studies with different product categories were conducted, involving a total of 200 consumers. In each study, the dynamic sensory profile of samples was obtained with consumers using either TDS or TCATA, according to a between-subjects experimental design. After the sensory characterization task, consumers were asked to indicate their overall liking using a 9-point hedonic score.

### 2.1. Samples

In Study 1, five samples of French bread, obtained from an industrial food producer, were evaluated. For commercial confidentiality reasons, details about the French bread samples cannot be provided. In Study 2, five commercial samples of milk chocolate, available in Montevideo (Uruguay), were used. Samples were purchased in local supermarkets and stored at room temperature until their evaluation.

In both studies samples were presented labelled with random 3-digit codes and presented following a Williams Latin square experimental design which balanced for sample order and carry-over effects. Samples were presented at room temperature.

### 2.2. Participants

A total of 100 consumers participated in each study. They were recruited from the consumer database of the Sensometrics & Consumer Science research group of Universidad de la República (Uruguay), based on their consumption of the focal products and willingness to participate in the study. Participants were 60–75% female and ranged in age between 18 and 62 years. Participants gave written informed consent and were given a gift equivalent to \$5 (USD) for their participation.

### 2.3. Experimental procedure

Consumers were randomly divided into two groups, each of which used a different procedure for sample evaluation: Temporal Dominance of Sensations (TDS) or Temporal check-all-that apply (TCATA). No significant differences in the distribution of age, gender, and frequency of consumption of the focal products between the two groups were found ( $p > 0.18$ ).

Studies took place in standard sensory booths that were designed in accordance with ISO 8589 (ISO, 2007), under artificial daylight and temperature control (22 °C). Still mineral water was used for rinsing between samples. Data collection was carried out using *Compusense Cloud* (Compusense Inc., Guelph, Canada).

Attribute lists included terms related to both flavour and texture, and was identical for TCATA and TDS. In Study 1 8 terms were used (*crunchy, tasty, smooth, soft, toasted, salty, hard, light*), whereas 10 terms were considered in Study 2 (*bitter, sweet, chocolate flavour, vanilla flavour, off-flavour, hard, soft, brittle, sticks to teeth, melting*). Terms were selected considering results of previous consumer studies and pilot work with consumers to assure that the sensory attributes responsible for differences among samples were included in the lists. Following standard practice in consumer studies involving TDS, CATA, or TCATA, no definition of the terms was provided to consumers prior to the evaluation. Presentation order of the terms was balanced among consumers following a Williams' Latin square design.

#### 2.3.1. Temporal Dominance of Sensations (TDS)

Consumers were instructed to read the list of terms carefully prior to the evaluation to facilitate selection of the dominant attribute during the evaluation. They were asked to select the term that caught their attention at each moment of the evaluation. Assessors had to click on the Start button concurrently with taking a bite of sample, and to start sample evaluation immediately. No precise instructions were given about the specific moment at which they should swallow the samples. Task duration was different for each product and was determined following pilot testing: 25 s for French bread and 60 s for chocolate. After the dynamic characterization of each sample, consumers were asked to re-taste the samples and to rate their overall liking using a 9-point hedonic score (1 = dislike very much, 9 = like very much).

#### 2.3.2. Temporal Check-all-that-apply (TCATA)

Consumers were asked to read the list of terms carefully prior to the evaluation to facilitate selection of attributes that applied to describe each sample. They were asked to select all the terms that applied to describe the sensory characteristics of the sample at each moment of the evaluation. They were instructed that terms that were no longer applicable should be unchecked. Assessors had to click on the Start button concurrently with taking a bite of sample, and to start the evaluation immediately. During the evaluation, they were free to check any unselected attribute, or to uncheck any selected attribute. No precise instructions were given about the specific moment at which they should swallow the samples. Task duration was identical for TDS and TCATA within each study (25 s in Study 1 and 60 s in Study 2). After the dynamic characterization of each sample, consumers were asked to re-taste the samples and to rate their overall liking using a 9-point hedonic score (1 = dislike very much, 9 = like very much).

### 2.4. Data analysis

All data analyses were carried out using R version 3.2.0 (R Core Team, 2015).

#### 2.4.1. Overall liking scores

A mixed linear model was used to analyze overall liking scores using the *lmerTest* package (Kuznetsova, Brockhoff, & Christensen, 2015). Methodology, sample and their interaction were specified as fixed

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