

# A New Annotation Scheme for the Semantics of Taste

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## Abstract

FrameNet serves as a comprehensive lexical database intended to represent contemporary language usage. However, it faces challenges in accurately representing specialized domains. Among these domains, FrameNet presents difficulties in capturing the specific semantics of human senses. Senses such as smell and taste are in fact included in more general frames or inadequately represented. Building on a previous resource proposing a new framework for olfactory events, we propose a similar annotation scheme for gustatory references in English, enlightening the potential of frames to effectively capture sensory semantics. Having a comprehensive framework to deal with the annotation of this kind of references in textual data is especially important to develop systems for the automatic extraction of sensory information. Moreover, our approach incorporates words from specific historical periods, thereby enriching the framework's utility for studying language in a diachronic perspective. In this paper, we introduce the annotation guidelines for taste and a preliminary annotation of culinary documents done using this approach.

**Keywords:** Sensory Language, Corpus Annotation, Frame Semantics, FrameNet

## 1. Introduction

The study of human senses is a fascinating topic that has always attracted scholars from different fields, such as philosophy, linguistics, cognitive science and neuroscience. Despite their importance, few works have dealt with the topic in the field of Natural Language Processing (NLP) or Digital Humanities (DH). Indeed, the development of automatic systems for the extraction of sensory-related information lacks a comprehensive linguistic framework to capture the semantics of specific senses. In this paper, we propose annotation guidelines for the semantics of taste in English, inspired by the annotation guidelines proposed for smell in [Tonelli and Menini \(2021\)](#). Our aim is to propose a comprehensive framework to capture the semantics of taste with a twofold purpose. On the one hand, we want to test whether a FrameNet-like approach, already proposed for smell, can be applied also to other senses, leading to the creation of comparable sensory benchmarks that can be used for different sensory studies. On the other hand, differently from FrameNet, we include in the lexical units for taste also obsolete terms in order to create resources that can be used for diachronic studies. Furthermore, the annotation guidelines proposed in this paper are specifically intended as a first step towards the development of an automatic system for the extraction of gustatory information for linguistic and historical studies.

Taste, together with smell, is especially interesting for its tendency to appear in emotionally charged contexts and to present a more evaluative content in its vocabulary. This tendency has shown that the most suitable way to study this sense is

by focusing not only on single words but also on their context ([Sneffjella and Kuperman, 2016](#); [Winter, 2019](#)), making frame semantics an appropriate framework for dealing with its study. In paragraph 3, we present the annotation guidelines for taste based on FrameNet, which entail a detailed examination of each label. Subsequently, we provide an overview of the annotation process with a preliminary annotation conducted on household and cooking recipe manuals, encompassing a temporal span of five centuries.

## 2. Related Work

Among the few works that have dealt with the topic of sensory language in NLP, [Tekiroğlu et al. \(2014\)](#) introduced Sensicon, a sensorial lexicon aiming to automatically associate English words with senses. This resource contained lemma-POS pairs with associated modality degrees for all five senses. Additionally, researchers have analyzed specialized lexicons used by reviewers to describe whisky and wine, focusing on taste and smell. [Hamilton and Lahne \(2020\)](#) developed a flavor wheel for whisky using a descriptive lexicon, while [Lefever et al. \(2018\)](#) aimed to predict wine characteristics from wine review corpora. The goal of these works is to identify words descriptive of perceptual experiences. Concerning taste specifically, there has been a growing interest in food representation, particularly for health-related studies. Some studies have focused on automatically extracting food entities, developing named-entity recognition (NER) models to support biomedical research and food science ([Cenikj et al., 2020](#); [Stojanov et al., 2021](#)). The authors constructed specialized corpora, pri-

marily emphasizing nutrient descriptions, quantities and food composition, by annotating recipes sourced from culinary social networks and websites (Popovski et al., 2019; Wróblewska et al., 2022). From a linguistic point of view, it has been recognized that understanding the semantics of human senses requires considering context, as already noted in Tonelli and Menini (2021), where the authors proposed an olfactory annotation framework based on FrameNet. Framing an entire event with its semantic roles enables a more holistic understanding of sensory information beyond isolated words. Their methodology was then used to create a multilingual benchmark (Menini et al., 2022), intended as a training for a supervised system for the automatic extraction of olfactory information which was used to analyse shifts in the perception of specific smell-related objects over time (Menini et al., 2023; Paccosi et al., 2023). The use of Frame Semantics to analyze taste-related language was successfully proposed in Diederich (2015). The author analyzed the use of two specific gustatory adjectives, *crispy* and *crunchy*, and the frames they trigger in both food experts' and everyday language. Through careful collocational analysis, the author elucidates the methodological strength of the frame-semantic approach in dealing with context analysis. By examining the evoked frames, the author demonstrates that even two adjectives considered synonyms can have different contexts of use upon thorough analysis. From a diachronic perspective, Bagli (2021) proposed an investigation into the vocabulary used to discuss gustatory experiences in English and the evolution of their semantic elaboration through the conceptual mechanisms of metaphor and metonymy. He argues that despite the disparagement that taste has undergone over time, it is a sense that has played an important role in shaping our conceptualization of emotions, with several metaphors based on its lexicon.

### 3. Annotation Guidelines for Gustatory Events

The present annotation guidelines for taste references in texts are inspired by the ones proposed for smell in Tonelli and Menini (2021). Their work puts its bases on the linguistic framework of frame semantics (Fillmore, 1976; Fillmore and Baker, 2001), implemented through the FrameNet annotation project (Ruppenhofer et al., 2006). The goal of FrameNet is to capture events and situations mentioned in texts. Frames represent constructs (i.e. events or situations) that function as the basis of our knowledge to understand the meaning of the words. For example, a word like the verb “talk” evokes an entire scenario implying at least two people in-

involved in a conversation. The events in FrameNet are modeled as a set of semantic roles or *frame elements* (FEs), which are typically the participants in the event, all connected to a *lexical unit* (LU) (i.e., the textual anchor that triggers the event or situation). In their work, Tonelli and Menini (2021) propose an adaptation of FrameNet to the olfactory domain, where only situations related to smell are annotated and specific semantic roles connected to olfactory events are identified. While FrameNet is a general-purpose framework including several frames to describe the perceptual experience of smell, the authors consider only one smell-related event that they call the *Olfactory Frame* (or *Olfactory Event*). They borrowed some general FEs from FrameNet and added some domain-specific ones that are self-explanatory and not ambiguous (e.g., *Evoked Odorant*, *Smell Source*) to facilitate a good agreement among annotators. As was done for smell, we define a single frame for taste: the *Gustatory Frame*. By searching for the lexical unit “taste” (both as a noun and as a verb) in FrameNet, we found 4 frames containing it: *Perception active*, *Sensation*, *Perception Experience* and a more specific one, presenting only two LUs (“taste” and “try”), *Tasting*. A part from them, we consider as taste-related frames also the *Ingestion* and the *Food* frames, from which we borrow some similar frame elements in our annotation guidelines. In the next sections, we present in more detail the two main components of the *Gustatory Frame*: LUs and FEs.

#### 3.1. Lexical Units

In the choice of LUs for the *Gustatory Frame*, we select taste words incorporating lexical terms from different resources. The selected words have different part-of-speech including nouns, verbs, adverbs and adjectives, in line with FrameNet practice. The selection was conducted starting from the mental lexicon of De Deyne et al. (2019) and from WordNet (Miller, 1995). For the diachronic insights, we select lexical terms from the Historical Thesaurus of English (Kay, 2009)<sup>1</sup> from the “Taste/Flavour” category considering only those terms that are included in our temporal span (1500-2000). This combination of cognitive, contemporary, and historical lenses ensures that our selected LUs are both representative of current usage but also of the linguistic evolution of English, providing a robust foundation for our frame-based approach also in a diachronic perspective. A list of the LUs for taste is provided in Table 1.

<sup>1</sup><https://ht.ac.uk/>

<b>Lexical Units for Taste</b>
<b>Nouns:</b> acidity, aftertaste, aroma, bitterness, dainty, delicacy, disgust, distaste, flavor, flavour, flavorful, flavourful, flavoring, flavouring, flavorsome, flavoursome, flavorful, flavourous, gustation, insipidity, mistaste, over-eating, palatableness, piquancy, pungency, rancidity, relish, rellish (obsolete), saltiness, sapidity, sapor, savor, savoriness, savour, season, seasoning, sharpness, smack, smatch (obsolete), sourness, sowreness (obsolete), sweetness, tang, tarage, tartness, tast (obsolete), taste, tastelessness, tasting, unsavoriness, unsavouriness
<b>Verbs:</b> drink, drink up, eat, eat up, distaste, mistaste, partake, relish, season, smack, smatch (obsolete), sweeten, taste
<b>Adjectives:</b> acid, acidic, appetizing, appetizing, bitter, bitter-sweet, bland, dainty, delectable, delicious, delightsom(e), disgusting, flavorless, flavorful, flavourful, flavourless, flavoursome, gamy, indigestible, insipid, juicy, mellow, palatable, piquant, pungent, racy, rancid, rank, salt/salty, sapid, savory, savoury, savourily, seasoned, sharp, sour, soured, sower (archaic form of sour), spicy, stale, sweet, tangy, tart, tasteless, tasty, toothsome, unpalatable, unavor, unsavour, unsavoury, unsavory, unseasoned, unsweet, unsweetened, wearish, wersh (obsolete), yummy
<b>Adverbs:</b> sweetly, sourly, tastefully

Table 1: List of Lexical Units for Taste

## 3.2. Frame Elements

The selected FEs encompass all potential participants contributing to frame activation along with lexical units. We first outline their differences or similarities with FrameNet’s FEs. Subsequently, we present more in detail each FE, providing some instances extracted from the annotated dataset. The FE *Taste Source* is a concept similar to the frame element *Food* for *Tasting* and *Ingestible* for *Ingestion* frames in FrameNet. In the same vein, *Quality* is a concept similar to the *Descriptor* FE in the context of food, and the semantic role of *Taster* aligns with *Agent* in *Tasting* and *Ingestor* in *Ingestion*. The *Location* FE of taste events finds a counterpart in the *Place* FE for both *Tasting* and *Ingestion* frames. There are no direct correspondence in FrameNet for several of the FEs contained in our framework, such as *Taste Modifier*, *Taste Carrier*, *Evoked Flavor*, *Circumstances*, and *Effect*, which we specifically created as domain-specific for the *Gustatory Frame*. Current FrameNet schema does not fully encapsulate aspects of the gustatory event that can be relevant for the study of sensory language. These domain-specific FEs could be viewed as extensions or specializations of existing ones, tailored to capture the unique semantic and experiential dimensions of taste. Our proposal aims at showing the relevance of FrameNet in capturing semantic content but also at underscoring the necessity for its continuous augmentation to accommodate the richness and specificity of human experience as captured through language. In the next sections, we present each FE in detail. In the example sentences, FEs will be represented between brackets, while the LUs are underlined. Taste frame elements have been defined with the goal to align with those for smell, facilitating comparison while emphasizing unique semantic structures. While certain elements such as *Effect* and *Location* remain identical, others such as *Evoked Taste* and *Taste Carrier* are complementary counterparts, with *Taste modifier* as the only label exclusive to gustation.

### 3.2.1. Taste Source

This FE corresponds to the person, animal or object that possesses a specific taste. It can refer to (non)human/object having a taste/flavor (e.g., plant, animal, perfume, human). This FE (between brackets) is the entity or object that the taster experiences through his or her senses. It is important to notice that if the taste source presents an adjective that describes it - see “slimy” in example 1 - this has to be annotated as part of the taste source. If the adjective refers instead to the perception of that specific source - see “unpleasant” in example 1 - then it has to be annotated as Quality of the LU:

1. [Slimy milk] has an unpleasant taste
2. When [the lettuce] is too young, the flavor is bitter

### 3.2.2. Taste Modifier

The object or animal that with its own taste/flavor can modify, alter or adding something different to the perception of the taste of a specific taste source. It is usually represented by ingredients that are added to a main course/food and often introduced by the verb “to season” and the preposition “with” followed by a noun. If there is more than one element, they have to be annotated as separate spans (see example 1):

1. Place two thick chops (of mutton) in a wooden dish and season lightly [with salt] and [pepper]
2. Factitious Port Wine is flavored [with a tincture drawn from the seeds of raisins]

### 3.2.3. Taste Carrier

This FE corresponds to the carrier of a taste, which can be a liquid such as water, spirits or liquors, or the container of the taste source (glass, plate, etc.). Note that the taste carrier has a different role both from Taste Source and Taste Modifier. The taste carrier is an object/person/animal which carries the taste of something else which is usually described

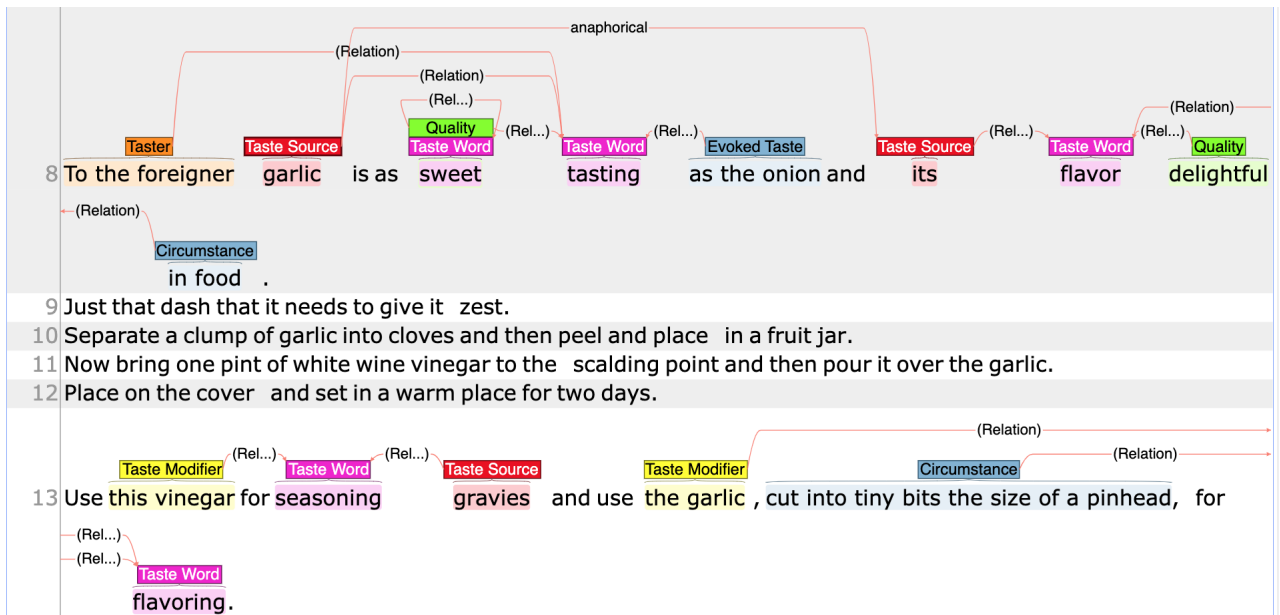


Figure 1: Screenshot of the INCEPTION tool used for taste annotation

as the object of perception by using the carrier. The distinction with taste modifier is important because there are few cases in which liquids/ointments are not modified by the taste of something but are the carriers of that taste. In example (1), “a considerable portion of essential oil” is the Taste Carrier, while the Taste Source is represented by “of the seeds”. Since sometimes this distinction is not clear, Taste Carrier should be annotated only when there is a clear distinction with the Taste Source and the Taste Modifier. This means that when a taste is described as coming generically from an object and it is not specified or clear from the context whether the object is the source or the container of the taste, the annotation as Taste Source should be preferred:

1. Only [a considerable portion of essential oil] has the flavour and taste of the seeds
2. Mr. Bland went into the hotel and drank [a glass or two] of wine and water

### 3.2.4. Quality

This is a quality associated with a taste and used to describe it. For example, sweet, disgusting, etc. This is typically expressed by qualitative adjectives. It is often preceded by an intensifier such as “very”, “really”. The intensifier has to be annotated with the related adjective in the same span, a part when the *Quality* is also a LU. In that case, the intensifier becomes a Quality of the Taste Word, with a double annotation which relates to itself (see Fig. 2). Qualities include intensity (weak, strong), duration (lingering, aftertaste), state (old, deteriorated),

character (quick, fruity), or hedonic characteristics (disgusting, pleasant, delicious). There are cases in which the Quality can also be a Taste Word, and has to be annotated with both the labels with the Quality FE linked to the Taste Word:

1. Cassia has a [slimy] [mucilaginous] taste
2. A taste which imparts a greater relish to the food is called [saline]



Figure 2: Double annotation of Taste Word and Quality

### 3.2.5. Taster

This FE refers to the human being/animal who perceives a taste with his/her mouth, has a perceptual experience of the taste. It is usually a personal pronoun, a possessive pronoun or a noun. The taster can also be expressed by mentioning the perceptive organ (e.g., palate, mouth) used in the gustatory experience (see example 2):

1. [To the foreigners] garlic is as sweet tasting as the onion
2. [Your palate] will reject them on account of their bitterness

Century	1500	1600	1700	1800	1900
Document	3	4	4	4	6
Taste_Word	212	381	169	376	278
Taste_Source	205	323	143	272	216
Taste_Modifier	130	102	60	89	68
Quality	83	204	60	171	128
Taste_Carrier	0	2	0	3	4
Evoked_Taste	1	2	3	12	2
Location	4	4	0	8	2
Taster	0	36	25	30	11
Circumstance	4	40	9	62	43
Effect	0	2	0	4	3

Table 2: Statistics of the Annotated Documents

### 3.2.6. Location

This FE describes the location/place where the taste event takes place, or the taste of a taste source is perceived. Locations can include both named places (for example names of cities), and common nouns describing physical locations such as garden, kitchen, room, etc.:

1. And [a neatly laid table] will stand before you with the most delicious food on it
2. He ordered the cat to be taken down [into the kitchen] and given something to eat and drink

### 3.2.7. Evoked Taste

This FE describes the person, animal, object's taste that is evoked/reminded by tasting a specific taste source, even if it is not visible/present in the scene. In English, this is often part of a comparison or similarity using the verb or noun "taste" and introduced by "like", "as" or the verb "to resemble". It is used to describe a taste that is perceived, referring to another:

1. (Jombo) in taste it [is like to an apple]
2. Burgundy pitch has a [terebinthinate] odour and taste

### 3.2.8. Circumstances

This FE characterizes the condition or circumstance in which the taste event occurs. This includes also temporal expressions, which describe a duration or a specific moment in which the taste event takes place. This FE can describe causal implications that lead to or influence the tasting experience. Circumstances are used to describe all that conditions in which the taste of a specific taste source can be altered or limited to a specific moment/event. It has to be distinguished by *Taste Modifier* that only considers the object/person/animal which modifies the taste of the Taste Source with its own:

1. If eaten [in excess, especially in an unripe or overripe state], fruits may occasion a disturbance of the stomach and bowels, often of a severe form
2. Tea and coffee also contain an astringent called tannin, which gives the peculiar bitter taste to the infusions [when steeped too long]

### 3.2.9. Effect

This FE describes an effect or reaction caused by the taste of a specific Taste Source. This can include entire sentences or clauses describing another event, that is not necessarily a taste event. This can include also the description of emotions triggered in the Taster by the taste event or anything that can effect him/her in some way:

1. If eaten in excess, especially in an unripe or overripe state, fruits [may occasion a disturbance of the stomach and bowels, often of a severe form]
2. By the process of cooking, agreeable flavors are developed [which stimulate the appetite and the flow of digestive fluids]

## 4. Annotation Process

### 4.1. Annotation Workflow

For taste annotation, we use INCEpTION (Klie et al., 2018), a web-based annotation tool, easily customizable both for labels and relations. We provide a screenshot of the tool in Figure 1. In annotating taste events we follow FrameNet established annotation methodology: we start by annotating a lexical unit in a sentence, and then we identify and connect the possible FEs participating in the gustatory event. In the provided example sentences for each label, frame elements can encompass single words or entire phrases. The annotated spans include articles for all frame elements, while for the LUs (Taste Words), only single terms are annotated,

without considering determiners. In FrameNet only the relation between lexical units and frame elements is considered. In our case, we annotate also the so-called “anaphorical relations”, similar to the smell annotation process described in [Tonelli and Menini \(2021\)](#). This integration captures FEs that link back to previously mentioned concepts or entities within the text. This is a relation especially useful at document level, since it allows us to identify also frame elements expressed with a pronoun having its antecedent lexically expressed in a different text passage.

## 4.2. Dataset

We manually annotated 21 manuals for household and culinary recipes published between 1575 and 1927 to test the suitability of the annotation framework with texts having a greater density of taste-related terms. These documents are taken from different publicly available historical and literary repositories:

- *Early English Books Online (EEBO)*,<sup>2</sup> a repository of documents published between 1470 and 1790 in different domains (literature, philosophy, politics, religion, geography, history, politics);
- *Project Gutenberg*,<sup>3</sup> a digital archive compiled on a volunteer basis, containing different repositories, mainly in the literary domain;
- *medievalcookery.com*,<sup>4</sup> a list of texts freely available online relating to medieval food and ancient cooking recipes;
- *foodsofengland.co.uk*,<sup>5</sup> an online library which holds the complete texts of several cook books from 1390 to 1974;
- *Wikisource*,<sup>6</sup> an online digital library of free-content textual sources managed by the Wikimedia Foundation.

In Table 2, we show the statistics of the annotated corpus divided per century. Two expert linguists, who were trained on the taste guidelines, annotated a total of three documents from different time periods (1670, 1720, and 1920) to assess Inter Annotator Agreement (IAA). The computation of Krippendorff’s alpha at a span-level ([Krippendorff,](#)

<sup>2</sup><https://textcreationpartnership.org/tcp-texts/eebo-tcp-early-english-books-online/>

<sup>3</sup><https://www.gutenberg.org/>

<sup>4</sup><https://www.medievalcookery.com/etexts.html?England>

<sup>5</sup><http://www.foodsofengland.co.uk/references.htm>

<sup>6</sup>[https://en.wikisource.org/wiki/Main\\_Page](https://en.wikisource.org/wiki/Main_Page)

2011) resulted in an IAA score of 0.70, indicating a moderate level of agreement. While this suggests a reasonable level of consensus, there remains potential for improvement. Upon closer examination of the discrepancies, it was observed that there is a general agreement regarding the choice of labels. However, the disagreement arises from inconsistencies in the selection of spans, particularly in the exact number of tokens encompassed within those spans, as seen in the following instance, where the label *Taste\_Source* is correct but the tokens were selected in a different way:

1. Boil **[your biggest skirrets]***Taste\_Source* and season them with cinnamon and nutmeg
2. Boil your biggest **[skirrets]***Taste\_Source* and season them with cinnamon and nutmeg

This observation has prompted us to refine our guidelines, placing more emphasis on defining the span selection process accurately. We released the annotated corpus at <https://github.com/dhfbk/Taste-Annotation>.

## 5. Conclusion and Future Directions

In this paper, we introduced a comprehensive annotation scheme for taste semantics. Our goal was to propose a framework for capturing taste-related information in textual data, serving as a benchmark for developing automated systems to extract gustatory-related information, especially intended for historical and linguistic studies. We tested the suitability of a previous approach for smell analysis, expanding the annotation guidelines to a different sense, and conducted preliminary annotations on a small set of taste-related documents. In the future, we plan to extend the annotation to additional documents to create a corpus containing sufficient information for building an automatic classifier for gustatory information extraction. This annotation scheme is also capable of capturing obsolete terms, making it suitable for annotating historical taste-related documents in English. Such a system can be used to analyze changes in sensory vocabularies over time, enabling diachronic analysis of the evolution of sensory semantic fields, a topic that has been hardly explored thus far.

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