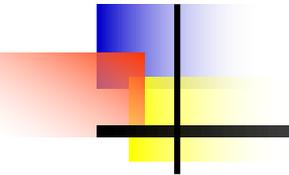


# ***Role of Flavorings in Determining Food Quality***

**Keith Cadwallader**

***Department of Food Science and Human Nutrition  
University of Illinois at Urbana-Champaign***

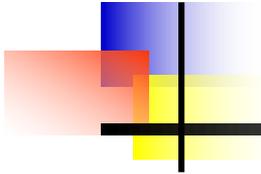
***6<sup>th</sup> Annual Food Sure Summit 2018  
Chicago, IL, March 26-27, 2018***



# Overview

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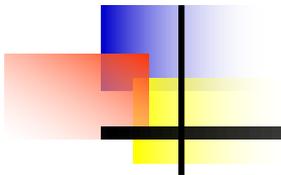
- **Flavor, Flavor Precepts and Flavor Quality**
- **Commercial Flavorings**
- **Importance of Product Form and Function**
- **Working with “Human Factors”**
  - **Considering Flavor (Human) Associations**
- **Other Important Flavoring Considerations**



# Significance of Flavor to the Food Industry

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- **Flavor is THE main determinant or driver of:**
  - consumer acceptance of a food product
  - repeat purchase intent for a food product



# Flavor

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- **Flavor is the integrated and nearly simultaneous response to the perception of taste, aroma and somatosensory (nerve) stimuli present in the oral and nasal cavities, generally as a consequence of the consumption of a food or beverage (Reineccius, 2006).**

**But many other factors influence our “flavor experience”**

Review

## The multisensory perception of flavor

Malika Auway \*, Charles Spence

*Department of Experimental Psychology, Oxford University, South Parks Road, Oxford OX1 3UD, UK*

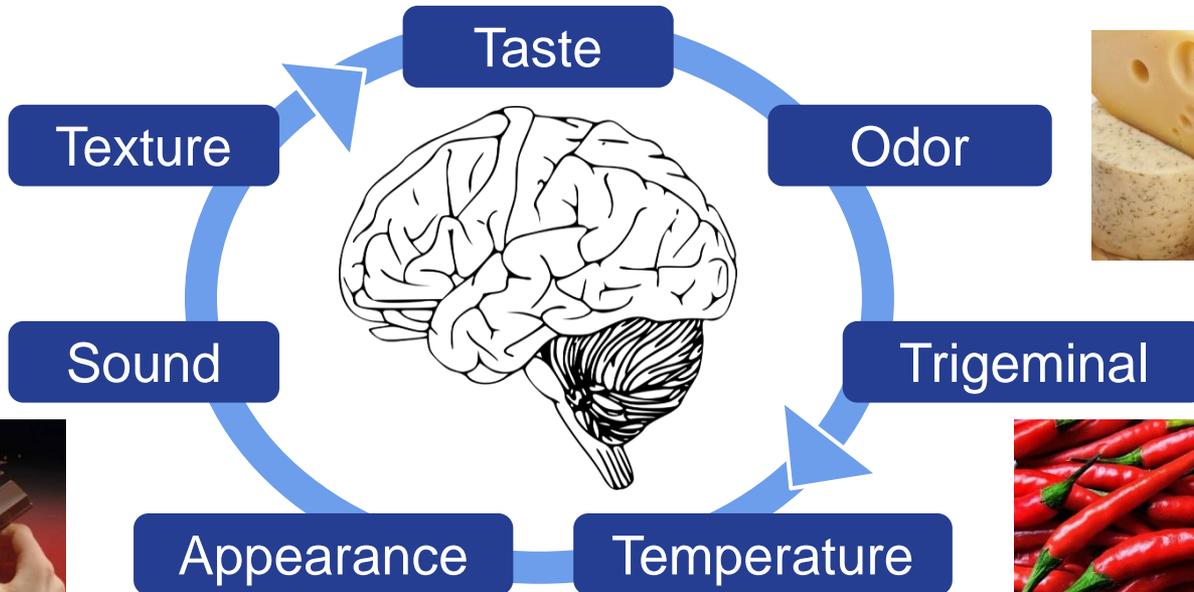


## The impact of perceptual interactions on perceived flavor

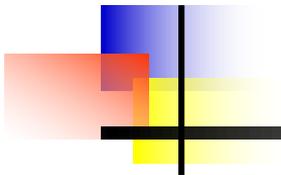
Jeannine Delwiche

*Department of Food Science and Technology, The Ohio State University, 2015 Fyffe Road, Columbus, OH 43210, USA*

Received 20 December 2001; received in revised form 29 January 2003; accepted 15 March 2003



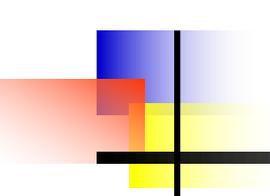
**Flavor is a multi-sensory experience**



# Flavor

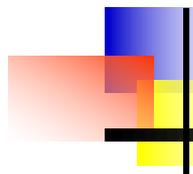
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- **Olfaction (aroma or odor) plays the predominant and characterizing role in food flavor quality, including recognition and overall food acceptance (Spence, 2015).**
- **This explains why most commercial flavorings contain aroma compounds (that is, they deliver the aroma components of the target flavor).**



# Aroma (Odor) Perception and Quality

- **People have enormous discriminating power**
  - Odor perception linked to memory/emotion/experience
  - Individual odorants easily detected and discriminated
  - But, describing/naming them is difficult
- **Perceived smells of odor mixtures is complex**
  - People can identify only ~ 3 individual odorants in mixtures containing > 8 odorants
  - People process food aroma (mixtures) as precepts called **“odor objects”** (coded and stored in the brain)

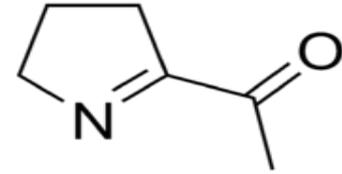


# Odor Objects (Precepts)

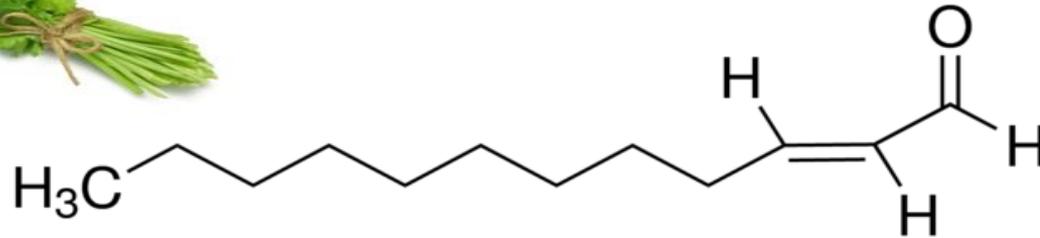
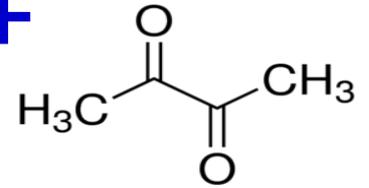
- **Odor Quality is Concentration Invariant**
  - **Mainly a function of defined ratios of the perceived odorants in the mixture**
  - **Individual odorants in a mixture are rarely perceived at the same odor intensity, otherwise an “odor white” condition might occur (e.g., > 30 odorants at equal intensity in the mix).**
  - **Occasionally, a single odorant (or just a few) may profoundly impact the aroma of a food – these are called “character-impact odorants”**

# Odor Objects (Precepts)

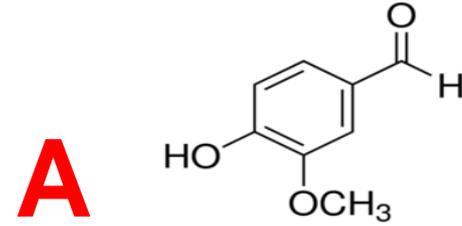
- Character-impact odorants



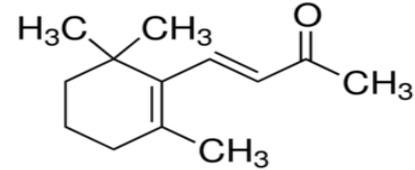
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# Odor Objects (Precepts)



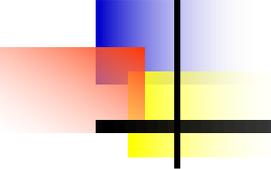
vanillin



$\beta$ -ionone

**A+B+C**



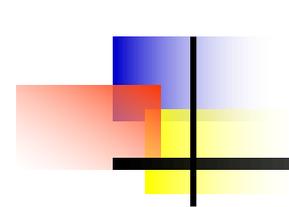


# What defines flavor quality ?

## *Desirable Sensory Attributes*

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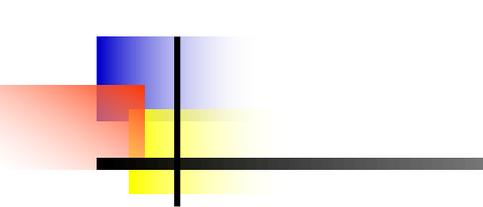
- Immediate impact of identifying (expected) flavor (e.g. vanilla / chocolate / lemon)
- Rapid development of a balanced, full-bodied flavor
- Compatible mouthfeel and texture
- Lack of foreign or off-flavors
- Minimal (brief) aftertaste, i.e. “clean taste”



# Why add flavor?

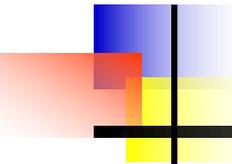
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- Impart target flavor attributes (aromatics) to formulated products that lack flavor
- Compensate for flavor deficits or defects  
e.g. frozen concentrated orange juice (FCOJ)
- Mask off-flavors  
e.g. functional foods
- Compensate for flavor losses caused by processing or storage  
e.g. thermal degradation, flavor fade due to flavor interactions & binding



# Commercial flavorings

- **May contain either natural or artificial (chemically synthesized) aroma compounds or a combination of both (+ essential oils/extracts).**
- **Most contain mainly aroma substances**
  - **taste components & enhancers are generally added separately by manufacturers**
- **Savory flavors (e.g., spice extracts, process flavors) may contain both aroma and taste-active compounds**
- **Available as concentrates, diluted flavors (in carrier), or bound to/in carriers (encapsulated)**



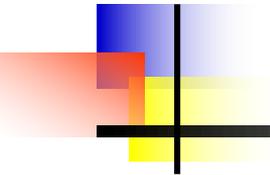
# Product Form and Function Matter

## Bars/Cereals

- Low moisture/low water activity
  - moisture migration concerns
  - texture concerns
  - possible phase changes
- No or mild thermal process
- Immobile flavor system
- Ambient storage/long shelf-life
- Possibility of using encapsulated flavors
  - will reduce flavor interaction and flavor loss

## Beverages

- High moisture
  - spoilage concerns
  - viscosity/consistency concerns
- pH restrictions/limitations
- Severe thermal process (UHT)
- Integrated/mobile flavor system
- Ambient or refrigerated storage
  - variable shelf-life
- Difficult to use encapsulated flavors

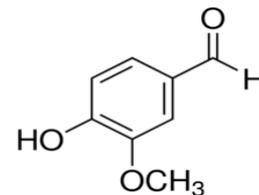


# Work with (not against) the “Human Factor”

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- Consider odor precepts
  - Food aroma (mixtures) are coded and stored (memory) as odor precepts = “odor objects” = “**flavor objects**”
- Consider the multimodal nature of the flavor experience
  - Work with learned/coded associations:  
**Aroma – Taste – Texture – Appearance (Color) – Sound**

# Flavor (Cross Modal) Associations



- **Sweet Perception**

- Add sweet aromatic compounds to enhance or boost “sweetness perception” without the need to increase sugar or sweeteners

- **Reinforce positive concepts, e.g. “Freshness”**

- Top noting of processed orange juice, coffee, etc.

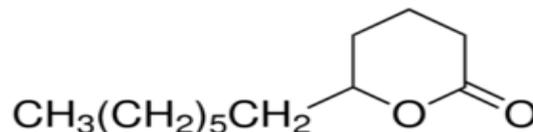
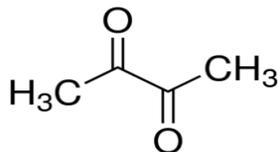
- **Saltiness Perception**

- Add savory extracts or spices to enhance flavor without the need for more salt

# Flavor Associations

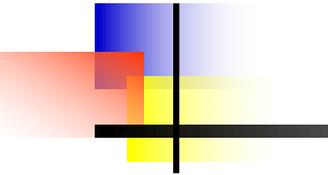
- **Creaminess**

- **Add aroma compounds associated with cream/butter to enhance “perceived creamy flavor and mouthfeel”**



- **Be careful with “edgy” flavors**

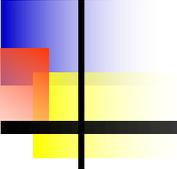
- **Green aromatics may evoke either positive or negative associations: raw, unripe, astringent mouthfeel, bitterness**



# More Flavoring Considerations

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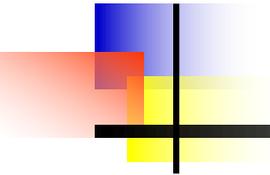
- **Use a flavoring that complements residual or lingering aromatics and tastes**
  - a.k.a. assimilation masking
    - e.g. coffee/chocolate flavors – *expect bitterness*
  - look for synergies (aromatic vs. taste compound)
- **Shelf-life issues: consider flavor changes that may occur over time**
  - flavor fade caused by binding of flavors to proteins
  - reformulate flavor to account for selective flavor binding (flavor rebalancing)



# Flavor - Food Matrix Interactions

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- **Flavor partitioning, diffusion and mass transfer**
  - e.g., low fat versus full fat products
  - fat modulates flavor release
- **Flavor stability, retention/release**
  - storage, packaging interactions
  - encapsulated flavors
- **Flavor binding**
  - e.g., flavor - protein interactions
  - leads to flavor loss (fade) and imbalanced flavor



# Summary and Conclusions

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- **Flavor is a multi-sensory experience**
- **Flavor is a learned and remembered human experience**
- **In the consumer's mind, flavor is a coded object**
  - **key to a creative flavoring strategies is to break the code and work with flavor-human associations**
- **Consider and work with the product's chemical/physical nature and the technology used in its production**

**Thank you**

