Origins of food flavour preferences

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Principles of food acceptability

We eat what we like

\[ \downarrow \]

Sensory factors are important
Innate taste preferences:
- Neonates show stereotyped facial responses to basic tastes in solution

Sensory preferences: Crucial determinants of food intake

Tastes:
- primary reinforcers for development of flavour likes & dislikes

sucrose
quinine
Across-species responses to tastes

Sucrose

Quinine
Hedonic responses to basic tastes across cultures: independent of diet

(1 = Dislike extremely; 9 = Like extremely)

Prescott et al. (1992; 1998)
Palatability & toxicity highly correlated

**Taste:** adaptive mechanism mediated by palatability

◊ promotes nutrient intake & toxin avoidance

Scott & Mark (1987): dimension representing relative similarities among tastants in activity profiles of NST taste cells correlates 0.85 with stimulus toxicity ($LD_{50}$)

- Sweet: Sucrose, Fructose, Glucose
- Sour: Citric acid, Lactic acid, Acetic acid, HCl
- Salty: NaCl, Quinine, Nicotine, Caffeine, Brucine, CaCl2, MgCl2, Strychnine, KCl
- Bitter: Nicotine, Caffeine, Brucine, CaCl2, MgCl2, Strychnine, KCl

Low toxicity | High toxicity
CD36 involvement in orosensory detection of dietary lipids, spontaneous fat preference, and digestive secretions

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Rats and mice exhibit a spontaneous attraction for lipids. Such a behavior raises the possibility that an orosensory system is responsible for the detection of dietary lipids. The fatty acid transporter CD36 appears to be a plausible candidate for this function since it has a high affinity for long-chain fatty acids (LCFAs) and is found in lingual papillae in the rat. To explore this hypothesis further, experiments were conducted in rats and in wild-type and CD36-null mice. In mice, RT-PCR experiments with primers specific for candidate lipid-binding proteins revealed that only CD36 expression was restricted to lingual papillae although absent from the palatal papillae. Immunostaining studies showed a distribution of CD36 along the apical side of circumvallate taste buds cells. CD36 gene inactivation fully abolished the preference for LCFAs-enriched solutions and solid diet.
Effects of information on acceptability
Sensory qualities exert greatest influence

70% of subjects agreed with the statement:

“It is better to choose foods without MSG”

Prescott & Young (2002)
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We tend to like what is within an optimal sensation range

↓

What is optimal?

What do individual differences tell us?
Genetic variations in responses to
- 6-n-propylthiouracil (PROP)
- phenylthiocarbamide (PTC)

Assoc with polymorphisms in the bitter
taste receptor gene TAS2R38

Other genes: TAS2R3, 4, 5 (coffee
bitterness); TAS2R48, 60 (grapefruit
bitterness)

Spatial summation

Distribution of intensity ratings
of 0.0032 M PROP
Taste perceptions & preferences: Sources of variation

Thermal tasting Green et al. (2005)

Green & George (2004)
Thermal tasting & liking for alcoholic drinks

p<0.05 *, p<0.1χ
Taste perceptions & preferences: Sources of variation

Variations in hedonic value of sweetness (Pangborn, 1970)

– aetiology unknown
PROP intensity as an index of sensitivity to other tastes

Overall intensity of QHCl/NaCl mixtures

PROP NTs do not show "typical" suppression of sweetness by bitterness

(Prescott et al., 2001)
PROP tasting & capsaicin oral burn

1 ppm capsaicin
\[ r = 0.20, p = 0.07 \]

10 ppm capsaicin
\[ r = 0.48, p < 0.0001 \]

100 ppm capsaicin
\[ r = 0.41, p = 0.0001 \]

Relationship between burn intensity & PROP status holds only at sites possessing taste papillae
PROP tasting & tactile sensations

Perceived Viscosity of Guar Gum

Perceived Bitterness of 0.0032M PROP
Sourness ratings of beverage as a function of citric acid & CO$_2$

PROP group differences increase with increasing CO$_2$ conc

Prescott et al. (2004)
Weber Ratios for PROP groups: Tastes in foods/beverages

<table>
<thead>
<tr>
<th></th>
<th>SWEET</th>
<th></th>
<th>BITTER</th>
<th></th>
<th>SOUR</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Orange juice</td>
<td>Yogurt</td>
<td>Orange juice</td>
<td>Cream cheese</td>
<td>Yogurt</td>
<td>Cream cheese</td>
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<tr>
<td>STs</td>
<td>0.64</td>
<td>0.28</td>
<td>0.57</td>
<td>0.44</td>
<td>0.36</td>
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<tr>
<td>MTs</td>
<td>0.64</td>
<td>0.32</td>
<td>0.68</td>
<td>0.61</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>NTs</td>
<td>0.91</td>
<td>0.27</td>
<td>0.86</td>
<td>0.91</td>
<td>0.76</td>
<td>2.17</td>
</tr>
</tbody>
</table>

Average % change required for a JND

(Prescott et al., 2004)
PROP tasting & food preferences

PROP tasting predicts dislikes better than likes

Relative to NTs, for tasters:
- sharp tasting foods less liked
- greater number of disliked foods
- Brussels sprouts, broccoli, spinach are more bitter & liked less
- Dairy products with > 10% fat are too creamy

Responses to specific food ingredients
- esp. bitter compounds?
PROP tasting & food consumption

Very little data, but ...

♦ sensitivity to bitterness in beer and coffee, & oral tactile/irritant sensations inversely related to consumption

♦ PROP tasters like strong alcohol less & have lower intake

Genetic Variation in Taste

Food/Beverage Sensations

Food/Beverage Preference

Food/Beverage Intake
Principles of food acceptability

We like what we eat

Exposure - esp in a liked context - increases liking
Mere Exposure

Necessary - *and sometimes sufficient* - to increase liking

Not merely a change in familiarity

→ small increase in both groups
Mere Exposure
Initial exposures are pre-natal

Mennella, Jagnow, & Beauchamp (2001): Infants exposed to the flavor of carrots in either amniotic fluid or breast milk -

- fewer negative facial expressions while feeding the carrot-flavored cereal compared with the plain cereal
- perceived by their mothers as enjoying the carrot-flavored cereal more compared with the plain cereal.
- control infants whose mothers drank water during pregnancy and lactation exhibited no such difference.
Odours paired with liked tastes become liked
Flavour-flavour learning

Yeomans et al. (2006)

Change in odour pleasantness

Sweet-likers
Sweet-dislikers

Sucrose  Water
US during training
Learned changes in odour pleasantness
Effects of individual differences in response to taste

Sweet liking:
- Increased for sweet likers; decreased for dislikers

PROP:
- Decrease for ST, but not NT or MT

(Yeomans et al., 2009)
Conditioned liking using observational cues

Change in children’s liking for drink flavours following observation of a model sampling drinks of the same colour (‘Present’) (Baeyens et al, 1996)
Overcoming neophobia: Does mere exposure operate through learned safety?

Novel foods are judged as ‘more dangerous’

Culture-specific flavour principles

How do we overcome neophobia & incorporate new foods into a cuisine?

Japan   soy/sake/sugar
Korea   soy/garlic/sesame/chilli
Vietnam  fish sauce/lemon grass/coconut
China   soy/rice wine/ginger
        + chilli/sweet & sour (Szechuan)
        + black bean/garlic (Canton)
Food-specific flavour principles
Lamb + characteristic flavour principles

(Prescott et al., 2004)
Principles of food acceptability

We like what we eat

↓

Not a passive process
Exposure effects on liking are cognitively mediated
Mere exposure effects modulated by attention
Ignored vs. Attended odours during exposure

Comparison of changes from pre- to post-exposure liking ratings odours treated as “target” and “non-target”

Ignoring devalues the stimulus

( Prescott, Kim & Kim, 2008)
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We like food flavours .... not discrete sensory properties

Do trained panellists enjoy their food?
Synthetic vs. Analytic Perception
Different attentional strategies

Apple flavour

Elements of apple flavour
Effects of rating multiple attributes

What you rate influences how you attend

♦ No enhancement when attending to several attributes, even if only sweetness rated
  \textit{van der Klaauw and Frank (1996)}

♦ Enhancement not shown by a trained panel
  \textit{Bingham et al. (1990)}

Proposed process:

♦ Providing salient response alternatives
  \textit{---} separation of the elements of a flavour

♦ Evaluating a quality shared by the odour & taste
  (sweetness) \textit{---} synthesis of common elements
Changes in odour liking following pairing with sucrose: Effects of analysis

Exposure of novel odours + sucrose in multiple triangle tests

Synthesis: respond to overall flavour
Analysis: respond to taste + odour separately

(Prescott & Murphy, QJEP, in press)
Analysis inhibits the expression of preferences
Attentional strategies and panellist responses

*Do analytical questions influence overall hedonic responses?*

♦ Evaluation of lemon-flavoured tea by 2 groups:
  – Hedonic rating only
  vs.
  – Hedonic + analytical ratings
Analysis inhibits the expression of preferences
Impact of adding attributes to an hedonic rating

Synthetic  (N=54):  Overall Liking ONLY
Analytic  (N=59):  OL - then sweetness, sourness, bitterness, lemon flavour & astringency

p = 0.033
Analysis inhibits the expression of preferences
Impact of adding attributes to an hedonic rating

Synthetic  (N=54):  Overall Liking ONLY
Analytic  (N=59):  OL - then sweetness, sourness, BITTERNESS, lemon flavour & ASTRINGENCY

p = 0.033
Analysis inhibits the expression of preferences
Impact of adding attributes to an hedonic rating

Synthetic  (N=54):  Overall Liking ONLY
Analytic A  (N=59):  OL - then sweetness, sourness, bitterness, lemon flavour & astringency
Analytic B  (N=52):  OL - then sweetness, sourness, tea, lemon & honey flavours

$p = 0.055$
Principles of food acceptability

We like what our body tells us to like

\[\downarrow\]

Liking reflects the metabolic effects of nutrients
Metabolism modulates preference development

Effects of motivational state (hunger)

Yeomans & Mobini (2006)
Learned preferences for foods & flavours

- Flavours paired with energy or other required nutrients become highly liked
  - → fat
  - → sugar
  - → salt (following depletion)
  - → glutamate

Kern et al. (1993): flavours paired with fat in yoghurt drinks were more liked than non-fat versions .... but only when ingested
Example: Effects of ingested glutamate on flavour preferences

- **Dietary** glutamate is essential in a variety of metabolic processes
  - amino acid synthesis: glutamine, proline, arginine
  - precursor of glutathione (antioxidant)
  - a source of energy?

- *How to demonstrate its metabolic value?*
Conditioning flavour preferences using MSG

(Prescott, 2004)

69 Ss allocated to 3 groups:

1. Consume MSG+
   Consume 250 ml of soup with added MSG
2. Consume MSG-
   Consume 250 ml of soup - no added MSG
3. Taste MSG+
   Taste 10 ml of soup with added MSG

Pre-test

Exposed soup
Non-exposed control

Rate liking for flavour of a novel soup (without MSG)

- Chickpea soup - Chinese dried flower soup base
- Spinach soup - Chinese dried fungus soup base
Procedure: all groups

Daily exposures

<table>
<thead>
<tr>
<th>Day</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Consume MSG+</td>
</tr>
<tr>
<td>2</td>
<td>Consume MSG-</td>
</tr>
<tr>
<td>3-9</td>
<td>Taste MSG+</td>
</tr>
</tbody>
</table>

Exposed

Control

Pre-test
Procedure: all groups

Daily exposures

Exposed  1  2  3  4  5  6  7  8  9  Control

Pre-test  Post-test

Rate liking for soup flavour (without MSG)
Changes in liking for soup flavour

Greater increase in liking for Consume MSG+ than Consume MSG- or Taste MSG+

Influence of added MSG on hunger

Yeomans et al., 2008
Influence of added MSG on intake

Yeomans et al., 2008
Principles of food acceptability

We like what our body tells us to like

\[ \Downarrow \]

Exposure to sensory properties changes their short-term hedonic value
Hedonic changes *during* eating

♦ Eating is accompanied by:
  
  – initial increase in desire to eat - *appetiser effect*
  
  – a decrease in the rate of eating
  
  – *Satiation*: post-ingestive meal cessation signals
  
  – *Satiety*: inhibition of post-meal consumption
  
  – *Alliesthesia*: physiological homeostasis following intake of calories (Cabanac, 1971)

♦ Cessation of eating:
  
  – “*I just got sick of eating that food*”
    
  – just as common as “*feeling full*”
Sensory-specific satiety
Changes in liking ratings of lemon drinks

Which value is the real measure of liking?
Hedonic changes during eating

Sensory Specific Satiety:

- Decrease in food’s hedonic value, or those of sensory properties, due to exposure
- Does not reflect
  - intra-gastric signals
  - post-absorptive effects - begins within mins
  - energy density or nutrient content
  - generalisation between foods reflects similar sensory properties not nutrients
- Does not require ingestion
- Occurs with specific sensory properties
  - Texture, tastes, flavours, colours
Significance of SSS

One implication of SSS is that dissimilar foods are subsequently more likely to be eaten

- Presumed to be a consequence of relative palatability of eaten and non-eaten foods

Concepts of SSS: what is being regulated?

- adaptive strategy to ensure adequate nutrition through food variety?
  - Approx same increase in intake with variety as with decline in liking (~ 15%)

- A sensory novelty seeking & boredom avoidance mechanism?
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