

CHANGES IN SENSORY PERCEPTION WITH OLDERAGE AND THEIR INFLUENCE ON FOOD BEHAVIOUR



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How does taste change with age & health ?



Taste Detection Thresholds: Why They May Increase with Age

Morphological changes
- decrease in receptor numbers

Stimulus persistence hypothesis – the signal from the taste cells continues to be sent to the brain even when stimulus falls below threshold.

Neural noise hypothesis – the signal to noise ratio in the brain is lowered by decrease in signal intensity and increase in spontaneous firing from the taste receptor cells.

Disinhibition hypothesis – cognitive inaccuracies make an individual unable to retrieve information from memory and connect with current signals from taste cells

Perceptual noise hypothesis - Repetitive neural firing from the taste cells makes brain unable to ignore irrelevant signals.

Functional changes of gustatory cells

What's this literature evidence?

- Meta-analysis of **23 studies**
- Consensus was that taste detection **thresholds increased** with age ($p < 0.001$) across all taste modalities.

& Now Italian Taste Project

Identification thresholds higher for older adults in 17 out of 18 studies.

16 out of 25 studies reported **perception of taste intensity at supra-threshold levels to be significantly lower** for older adults,

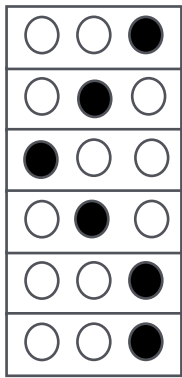
Chemосensory loss is connected with Frailty not just Age



Orosensory decline correlates with dependency (poor health, medication, cognitive dysfunction):

- N=559 France (65-99 yr)
- Independent living & Nursing Home
- Measured:
 - Salt taste detection
 - Olfaction: detection, characterisation & discrimination
- Results:
 - Well preserved abilities : 43%
 - Moderate Impairment : 21 %
 - Clear trend between impairment & level of dependence

Sulmont-Rossé et al. (2015) *Chem Senses*, 40, 153-164.



Our Evidence: Taste Detection Thresholds

In the region of salt level of typical meals

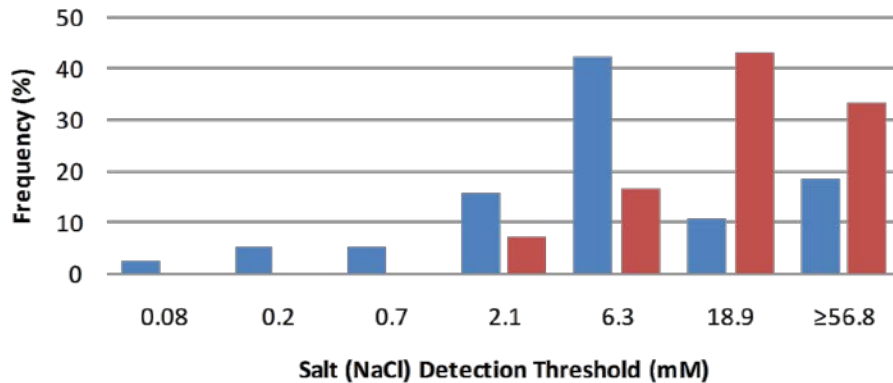


Group	n	Mean Age(range)	Sweet (sucrose)	Salt (NaCl)	Glutamate (MSG)	Bitter (quinine)
Hospital patients	(50) (42) (51) (28)	84 (65-98)	16mM (0.5%)	19.4 mM (0.12%)	3.7 mM (0.06%)	0.03 mM (0.002%)
Healthy older volunteers	38 (35)	71 (62 – 87)		5.9 mM (0.03%)	1.8 mM (0.03%)	0.006mM (0.0005%)
Healthy younger volunteers	35	(25-35)		2.5mM (0.01%)	0.5mM (0.01%)	

Significant increase in taste thresholds between YV & OV and between OV & OP (p<0.001 to p<0.05)

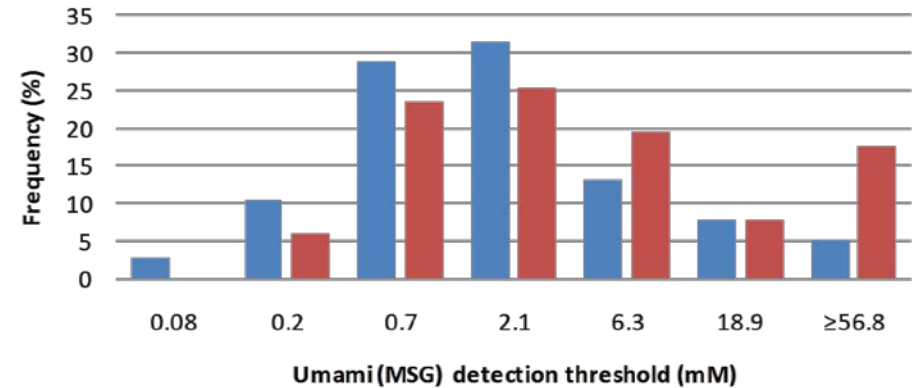
Taste Thresholds : Age & Health

Salt Taste Detection Thresholds



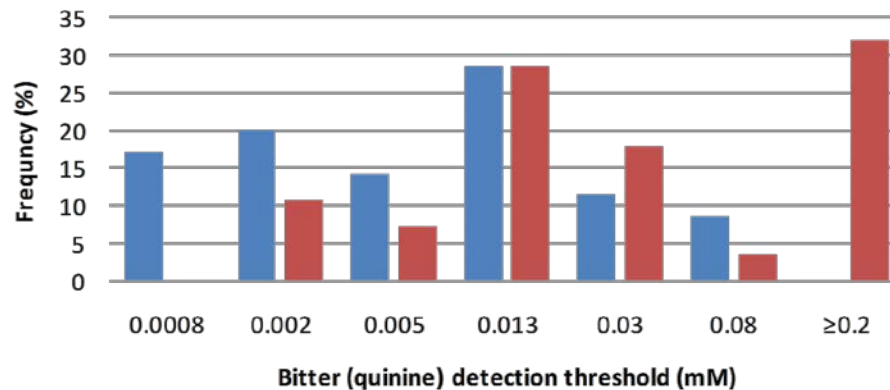
Older Volunteers (%) Older Patients (%)

Umami (glutamate) Detection Thresholds



Older Volunteers (%) Older Patients (%)

Bitter (quinine) Detection Thresholds



Older Volunteers (%) Older Patients (%)

WHAT ABOUT AROMA : Ortho & Retronasal?



What are the impacts of ageing on odour perception?

- Diminished olfaction with age more common than taste decline
- Effects > 50% of adults 65- 80 yrs; ca. 75% of adults > 80

Doty & Kamath (2014) *Frontiers in psychology*, 5(20)1- 20 (Review)

Olfactory Detection Thresholds with SNIFFIN' Sticks

- SNIFFIN' Sticks of butanol; 3 AFC



Younger group (20 – 40 yrs)

Average = 0.03 mg/ L

Older group range (65+ yrs)

Average = 0.35 mg/ L

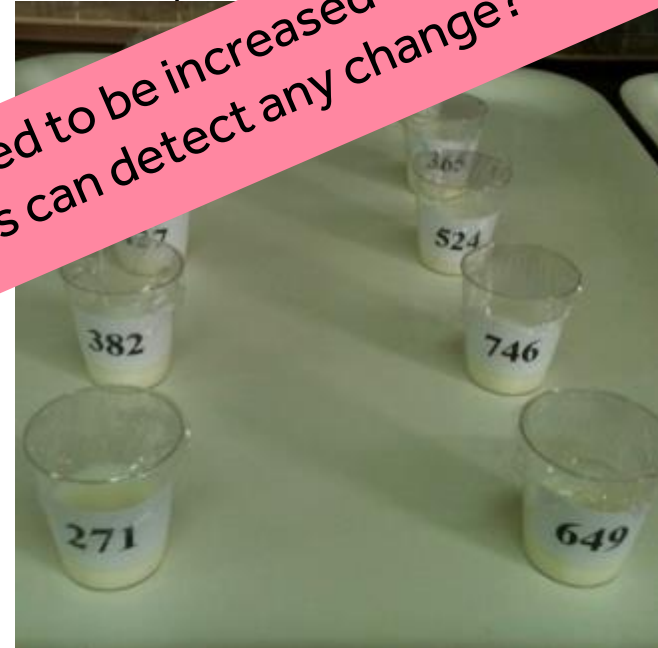
14 x higher

Supra-threshold Aroma Perception

- Caramel flavours in sweetened milk at supra-threshold levels
- Both ortho-nasal (smell) and retro-nasal (flavour) perception were assessed to determine...

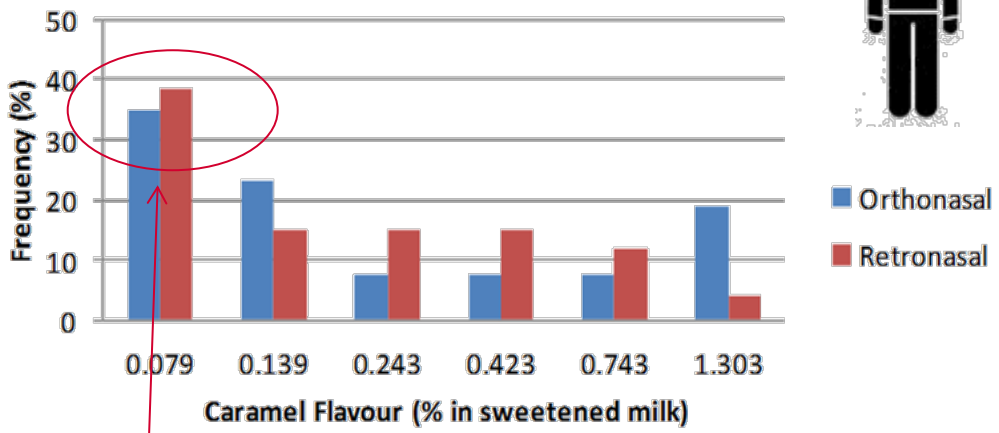


JND : How much does flavour need to be increased before a younger and older consumers can detect any change?



Discrimination Thresholds : Caramel

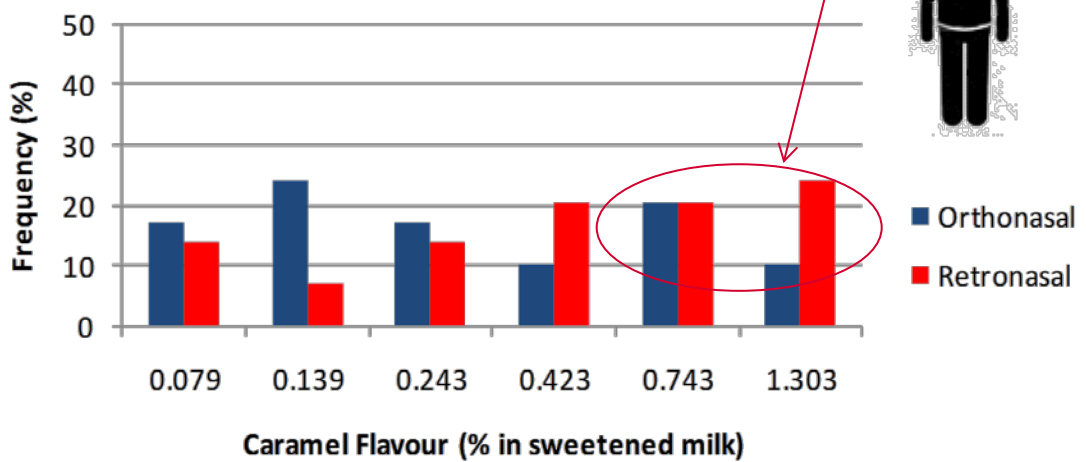
Frequency Plot of Discrimination Threshold of Younger Volunteers: Caramel Flavour



Lots of Older people need more to notice a difference

Lots of Younger people noticed small increases

Frequency Plot of Discrimination Thresholds of Older Volunteers : Caramel Flavour



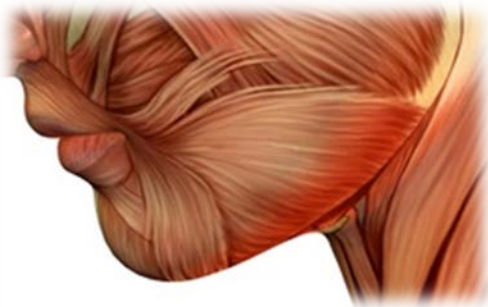
WHAT ABOUT TEXTURE?



Generally accepted increase in preference for foods that are easier to breakdown & swallow with age

Texture Perception with Age

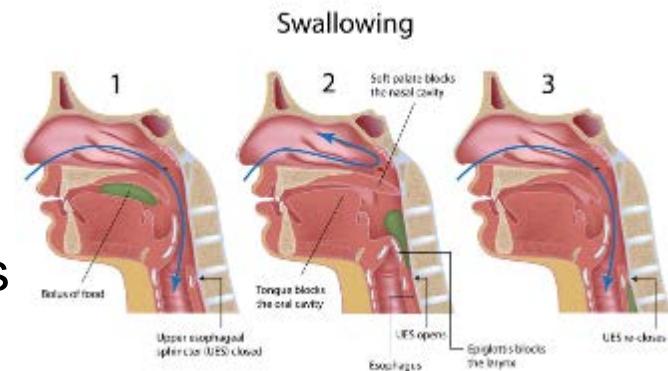
Dentition influences mouthfeel perception



Muscular strength could also impact on the ability to chew and move food around the mouth

25% OAs have swallowing difficulties (dysphagia)

50% of institutionalised / hospitalised OAs



Previous Studies

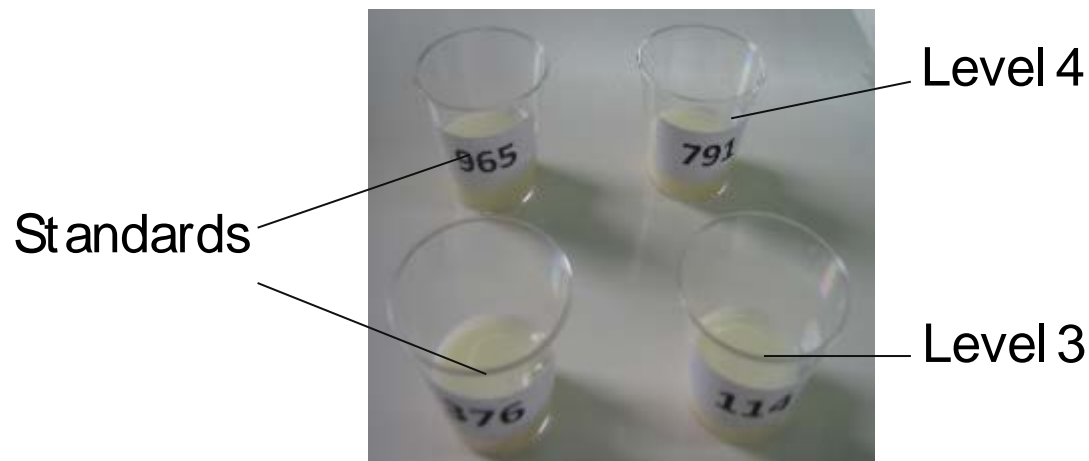


- Mioche 2004; younger v older (healthy, dentate) chewing meat:
 - neuro-muscular activity declined with age & less saliva incorporated
 - BUT partly compensated by changes in chewing behaviour (eg length of chew).
 - So, texture perception well preserved
- Kremer studies report decline of texture sensation with age:
 - Kremer 2005: soup less creamy
 - Kremer 2007 : waffles less elastic

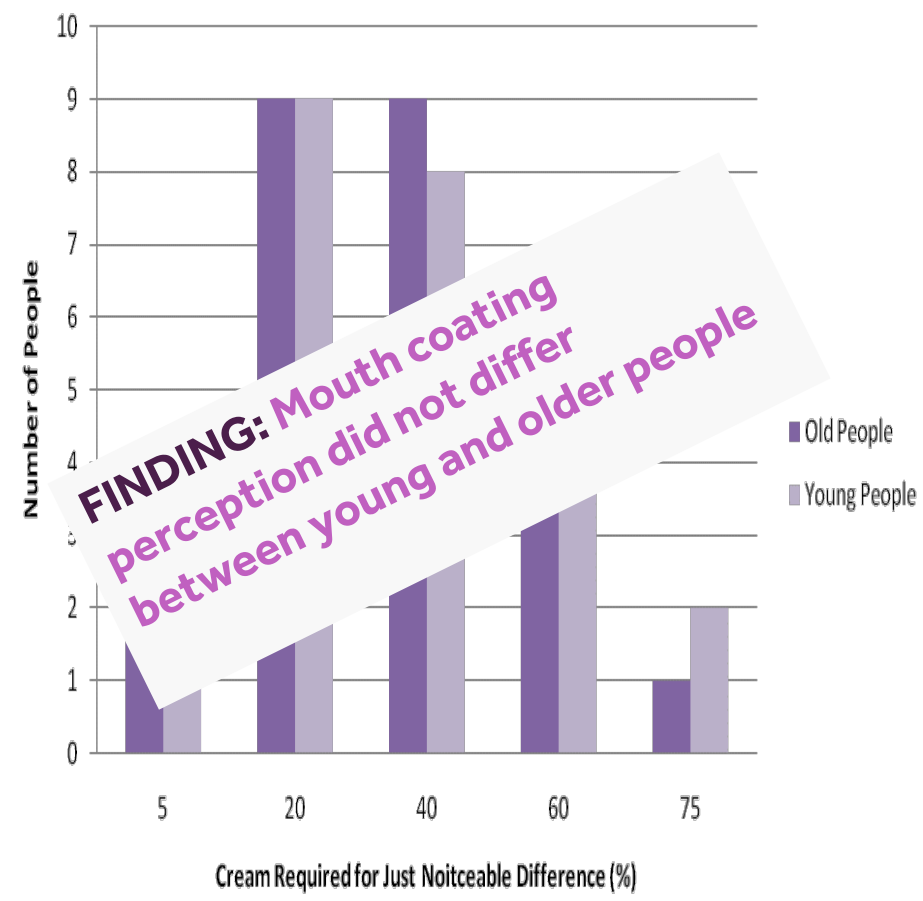
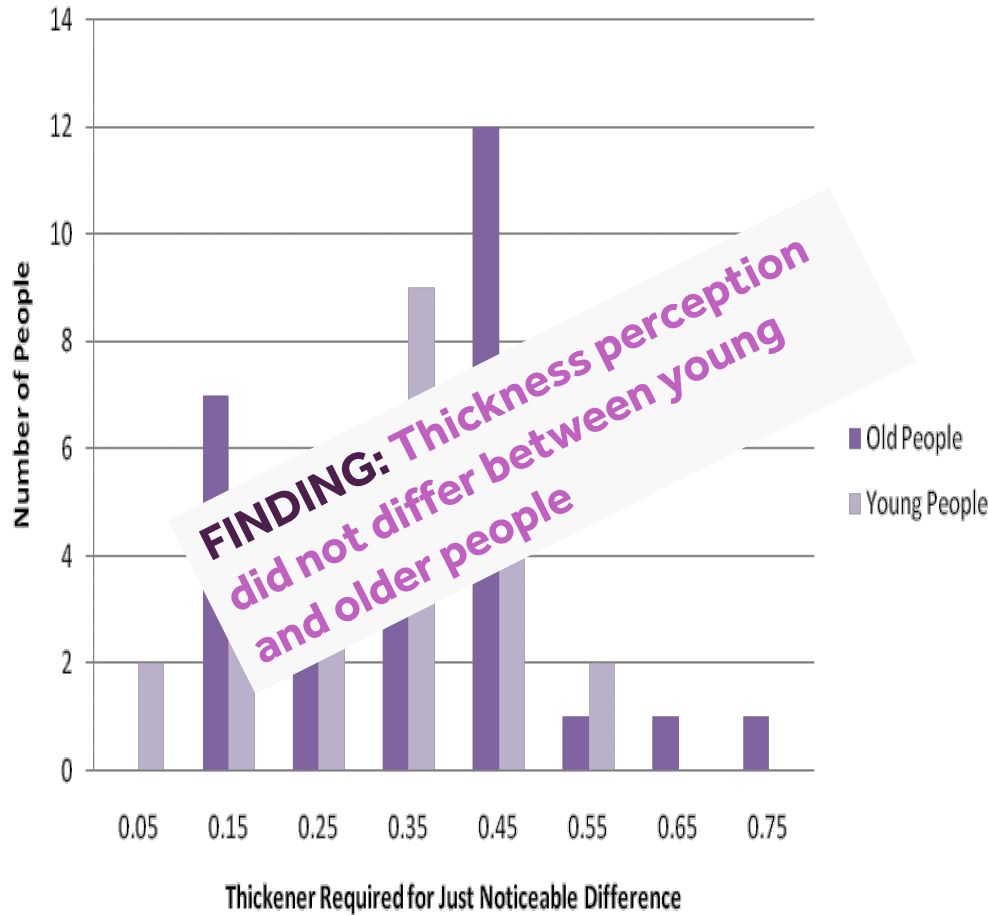


Thickness & Mouth-coating Perception

- Skimmed milk + starch thickener or Weightwatchers thick cream : 5 thickness & 4 mouth-coating levels
- Staircase 2-AFC tests



JNDs Thickness & Mouthfeel



Perceived Mouth drying



- Milk-based Mouth drying
 - Heat treated rennet whey compared to skimmed milk
- Older volunteers found whey significantly more mouth drying than skimmed milk (p=0.03)
- Young volunteers found no significant difference
- Suggest that whey is more important and easier to detect to older groups

FINDING: Older Group detected milk based mouth drying more easily than younger group

Sensory Perception with Ageing : Key Findings

Taste perception declines with ageing, with sweetness most preserved

Odour and flavour thresholds are generally affected by ageing, although the extent is stimulus specific

Thickness and mouth coating perception not / or less influenced by ageing

Older people can detect mouth drying to a greater extent than younger people

Food Neophobia & Food Pickiness (Fussiness)

Both can influence food rejection at all ages

Food Neophobia (rejection of an unfamiliar food)

- Peaks in childhood at 2-6 yr, decreases to adulthood
- BUT, also INCREASES with older age (Italian Taste Project)

Food Pickiness (rejection of a familiar food)

- Pickiness effects some infants & declines by 6 yrs (Lafraire et al, 2016)
- But, “pickiness” in older adults increases with dependency (Maitre et al, 2014)

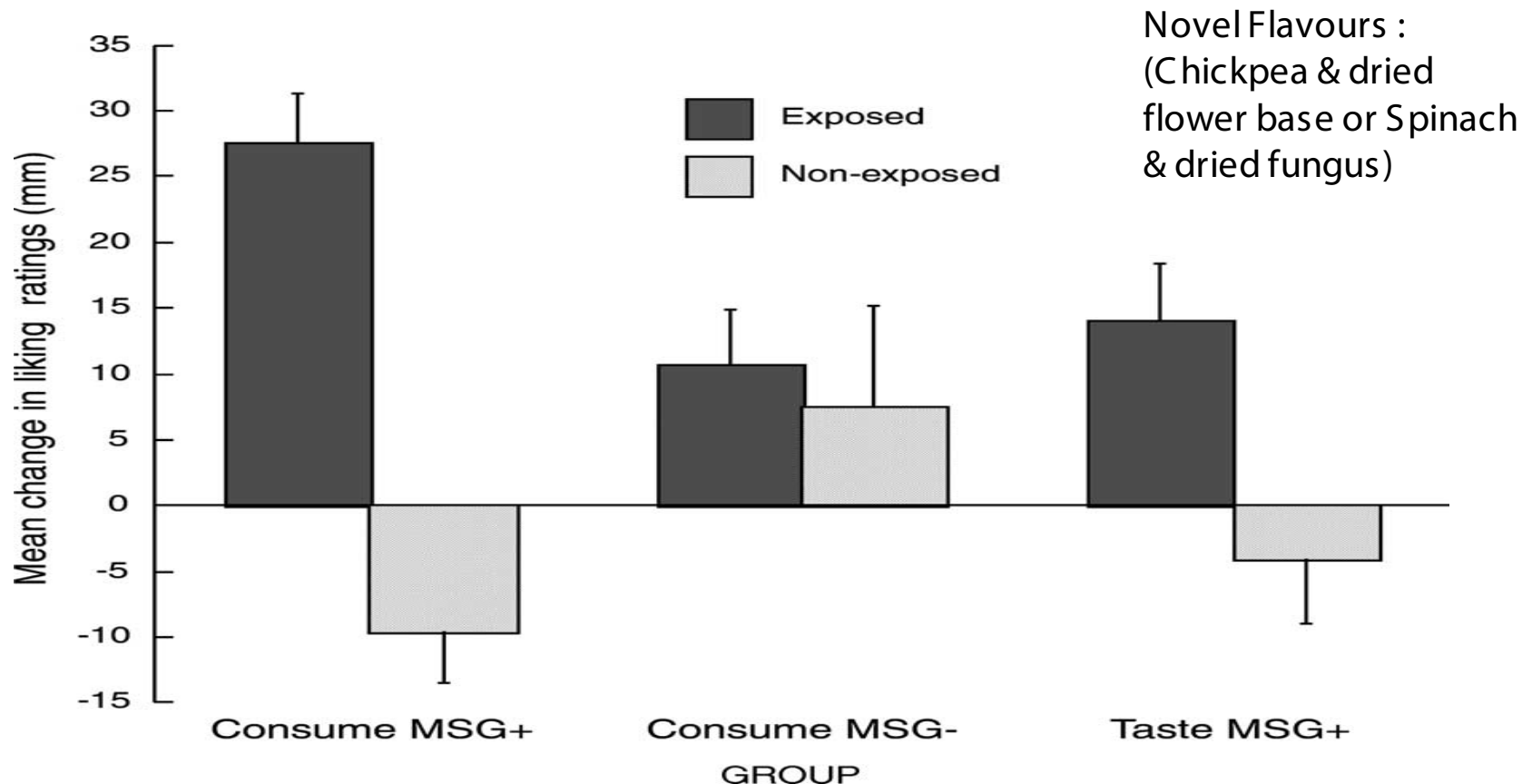
Repeated Exposure to Increase Familiarity & Liking

- Mere exposure, Flavour-Flavour & Flavour Nutrient Learning
 - All Shown to Increase Liking
- It works in children & adults generally
- Does it work with Older Adults....



Umami Taste can Condition Liking

- Subjects (n=69) rated liking of novel soups
- 9 exposures to one novel soup; either consuming with MSG, without MSG, or just tasting with MSG



Prescott, 2004. *Appetite*, 42, 143-150

Can Umami condition liking in older adults?

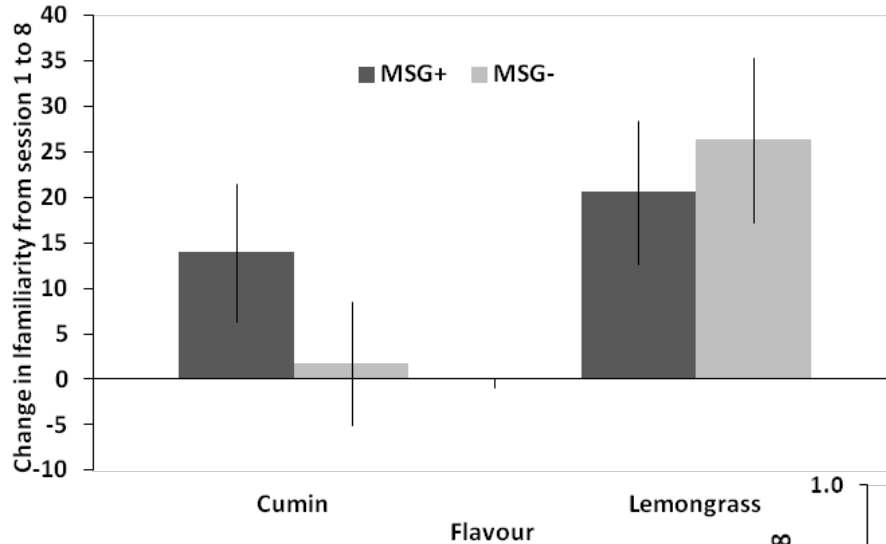
- We studied older adults (n=40; age 65-88)
- Used “novel” flavoured potato soups
 - Lemongrass
 - Cumin



- Ran a repeat exposure liking & consumption study

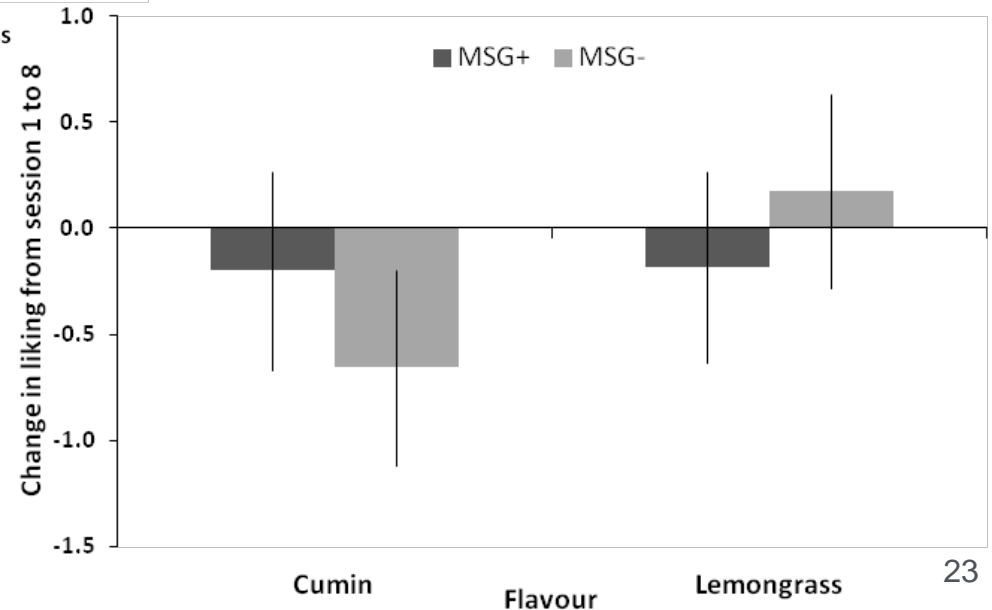
Dermiki, M., Prescott, J., Sargent, L. J., Willway, J., Gosney, M. A. and Methven, L. (2015). *Appetite*, 90. pp. 108-113.

With Older Adults & excessive Umami:

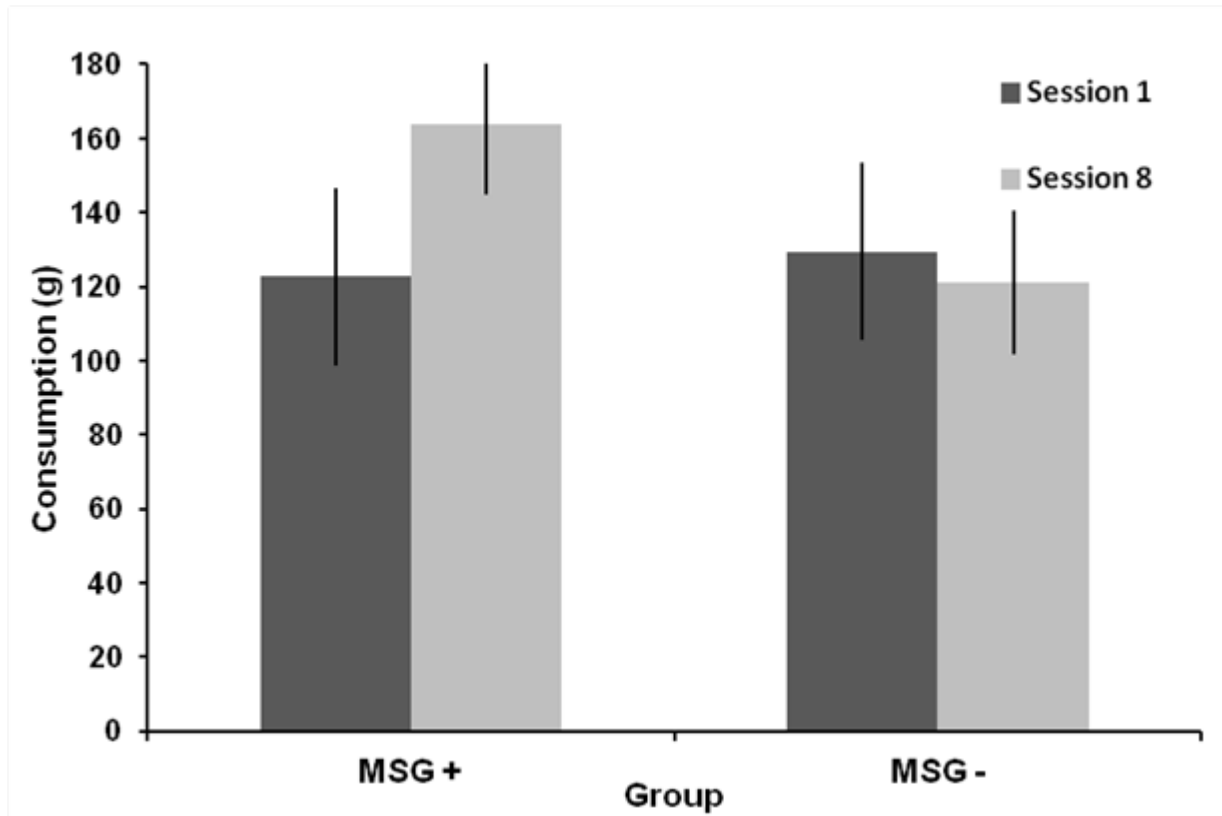


Familiarity increased...

...but liking did not!



However consumption of soups that had been paired with MSG increased!



So, Does Umami Condition Wanting ?

Caveat: we're not suggesting you add in spoons of MSG to food !!

DEVELOPING FOODS FOR OLDER PEOPLE: Taste Enhancement of Food for Older Hospital Patients using natural ingredients



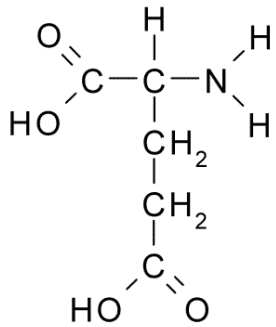
OUR APPROACH...

Use **natural ingredients** rich in **umami** taste compounds

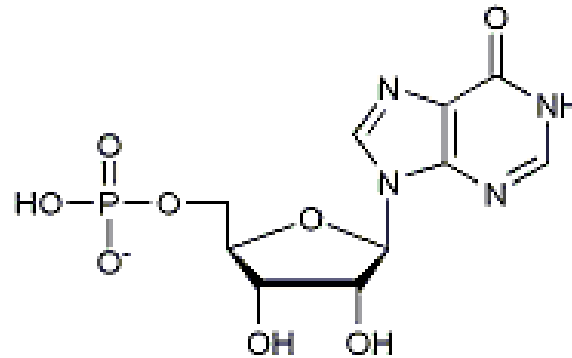


- ✓ Maximum levels of “UMAMI” ingredients in a meat dish
- ✓ Keep Sodium levels constant

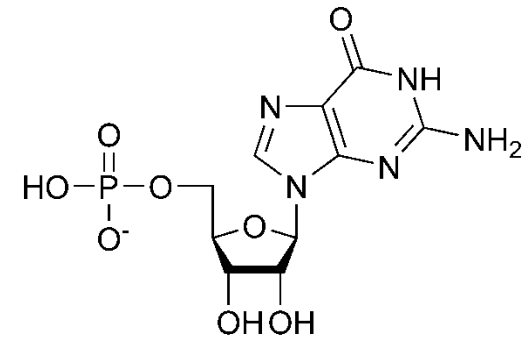
Umami Amino Acids & Ribonucleotides



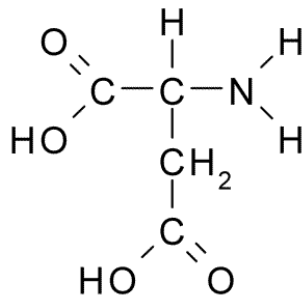
Glutamic acid



Inosine
monophosphate

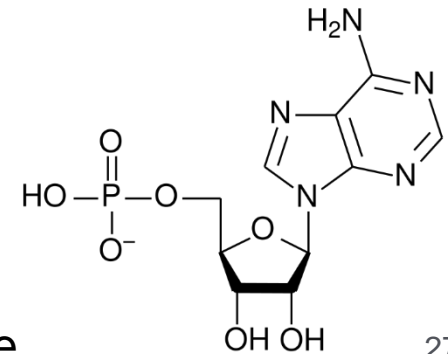


Guanosine
monophosphate



Aspartic acid

Adenosine
monophosphate



Umami : other possible benefits to Older People

- Dry mouth due to diminished salivation
 - Umami stimulation increases salivary flow (Hodson and Linden, 2006; Schiffman et al.)
- Gastric dysfunction
 - Stimulating gastric function through gastric L- glutamate receptors (Toyoma et al, 2008)
 - Chronic atrophic gastritis
 - MSG supplementation of meals was reported to increase basal and maximal acid output to normal amounts and improved appetite (Kochet et al)
 - Increased gastric emptying
 - MSG in combination with protein rich foods increased gastric emptying rate (Zai et al, 2009)

Optimisation of Recipe

NHS Basic minced meat recipe

Minced meat (42%)

+

Sunflower oil (1%)

+

Onion puree (8.6%)

+

Garlic puree (0.7%)

+

Cornflour (1.7%)

+

Water (beef stock) (43%)

+

Tomato puree (30% TS)
(2.8%)

+

Salt (0.2)

Instructions

1. Heat oil
2. Brown beef
3. Cook onion
4. Add garlic tomato puree
5. Add salt
6. Add beef stock and simmer
7. Add cornflour

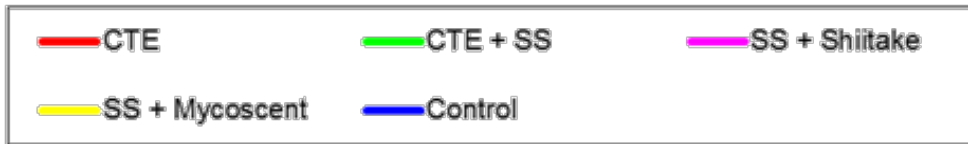
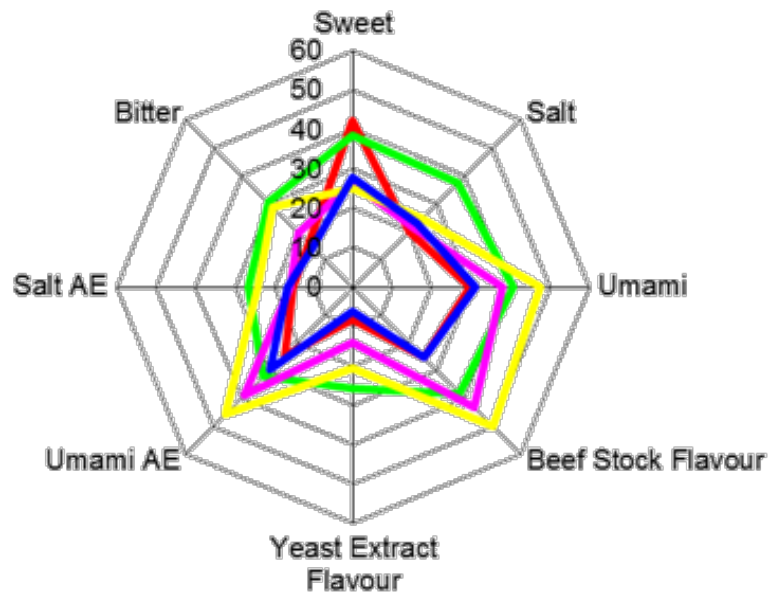
- ✓ Maximum possible levels of ingredients
- ✓ Sodium levels kept constant for all recipes (0.2%)

Additional Ingredients :

- ✓ MSG
- ✓ Yeast extracts (maxarome, gist ex)
- ✓ Mycoscent (mycoprotein)
- ✓ Soy sauce (Kikkoman Low Salt) (SS)
- ✓ Tomato puree
- ✓ Honzokuri miso paste (Low Salt)
- ✓ Shiitake (70°C extract)
- ✓ Concentrated Tomato Extract

Sensory and Consumer results :

Sensory analysis



Consumer Liking by OV

Sample	OV		
	Min	Max	Mean
SS & mycoscent	4	9	6.9 ^a
SS & Shiitake	3	9	6.9 ^a
SS & CTE	4	9	7.0 ^a
CTE	3	9	6.8 ^a
Control	3	9	6.8 ^a

No discrimination : tendency to give high scores to please researcher !!

SS+CTE most positive comments

Dermiki et al (2013) *JSFA*, 93(13): 3312-3321

Hospital Study: Methods

Samples:

Control vs Enhanced cottage pies

Enhanced pie: Soy Sauce and Concentrated Tomato

Extract Enhanced gravy : Soy Sauce



Location:

Elderly Care Wards in RBH NHS
Trust



Volunteers:

31 Older Patients (aged 65+)

11 male, 20 female



Protocol:

Consent , Screening

Liking and preference test on
minced meat

Measurement of consumption
of the two cottage pies

Hospital study: Results

	Control	Enhanced	significance
Preference minced meat (number of people)	6	24	p=0.001
Consumption (g)	119	137	n.s.

- ✓ Enhanced significantly preferred
- ✓ A trend but no sig. difference in consumption

Dermiki et al. (2013) *Nutrition and Aging*, 2,69-75

So, Is Enhancement effective?

- Difficult to demonstrate ↑ intake, but we found ↑ preference**so Yes**
- 2 Recent Reviews :

Song & Bredie (2016):

- “Flavor and texture modifications usually enhance food liking of most dependent elderly.”

Doets & Kremer (2016):

- “Most flavour enhancement/enrichment strategies do not increase liking in independent living seniors”
- Need holistic interventions
- Combined visual / textural modifications with flavour enhancement / enrichment did increase liking (Kremer, 2014)

Song, Giacalone, Johansen, Frøst, Bredie (2016). Trends in Food Sci & Tech, 53, 49-59

Doets & Kremer (2016) *FQP*, 48, 316-332

Kremeretal. (2014) *FQP*, 38, 30-39

Table 1
Age-related orosensory perception changes and effects of compensatory strategies on elderly's food preferences. Please refer to footnotes for details.

Elderly's dependence level & food systems	Elderly population			Decline/impairment of orosensory perception ¹			Compensatory strategies and their preference effects ²			
	Sample size	Age	Specific group characteristics	Taste	Odor	Oral touch	Flavor enhancement	Flavor enrichment	Irritant addition	Texture change
Dependent living condition										
Liquid										
Functional red fruit drink ^a	N = 76	64–97	Residents from Clinical Rehabilitation Institute	Yes	Yes	–	Higher sweetness, lower sourness	○	–	–
Orange lemonade ^c	N = 29	79 ± 6	Senior homes	Yes	–	–	Sweetness	↑ & ↓ ³	–	–
Peach juice ^a	N = 36	82.8 (F) 78.8 (M) ⁴	Nursing home	Yes	Yes	–	Sweetness	↑	–	–
Tomato soup ^b	N = 20	60–90	From the geriatric unit of Academic Hospital	–	–	–	Peach aroma Soup flavor	↑ ↑	–	–
Semi-solid										
Grain porridge ^c	N = 29	79 ± 6	Senior homes	Yes	–	–	Sweetness	↑ & ○ ³	–	–
Strawberry jam ^c	N = 29	79 ± 6	Senior homes	No	–	–	Sweetness	↑ & ↓ ³	–	–
Strawberry yogurt ^c	N = 29	79 ± 6	Senior homes	Yes	–	–	Sweetness	↑ & ○ ³	–	–
Chocolate spread ^c	N = 29	79 ± 6	Senior homes	Yes	–	–	Sweetness	↑ & ↓ ³	–	–
Yoghurt ^b	N = 20	60–90	From the geriatric unit of Academic Hospital	–	–	–	Cherry flavor	↑	–	–
Solid										
Mashed potatoes ^f	N = 33	65+	Nursing home	Yes	Yes ⁵	–	–	MSG	↑ & ○ ⁵	–
Spinach ^f	N = 33	65+	Nursing home	Yes	Yes ⁵	–	–	MSG	○	–
Ground beef ^f	N = 33	65+	Nursing home	Yes	Yes ⁵	–	–	MSG	↑	–
Quorn ^g (meat substitute) ^h	N = 20	60–90	From the geriatric unit of Academic Hospital	–	–	–	Chicken spices, marjoram and chicken flavor	↑	–	–
Broth with pasta ^a	N = 36	82.8 (F) 78.8 (M) ⁴	Nursing home	Yes	Yes	–	Vegetable extra	↑	–	–
Pasta with tomato sauce ^a	N = 36	82.8 (F) 78.8 (M) ⁴	Nursing home	Yes	Yes	–	–	Capers and oregano	↑	–
Vegetable puree ^a	N = 36	82.8 (F) 78.8 (M) ⁴	Nursing home	Yes	Yes	–	–	Pesto sauce	↑	–
Rice with butter ^a	N = 36	82.8 (F) 78.8 (M) ⁴	Nursing home	Yes	Yes	–	–	Sage and rosemary	↑	–
Bread with aubergine spread ^f	N = 104	79–101	Nursing home, 32 subjects had dementia	–	–	–	Lemon, garlic, salt and pepper	↑	–	–

Most studies show an increase in Liking / Pref / Acceptance. BUT only for dependent elderly

Song, Giacalone, Johansen, Frøst, Bredie (2016). Trends in Food Sci & Tech, 53, 49-59

Why does flavour enrichment / enhancement not often work in independent older adults ?

- The **MISFIT** Theory (Koster et al., 2014):
 - We do not notice familiar odour / flavour
 - BUT, we react immediately to unexpected ones
- Enhancement may cause the **misfit** – or at least not be noticed (Doets & Kremer, 2016)
- **Neural pathways** of perception & liking are independent (Rolls, 2015)
- The **extent of impairment** may not be sufficient to warrant flavour modification



Older Adults & Sensory : Summary & New Challenges

- Taste & Flavour Enhancement
 - Do it for more dependent older adults
 - Use a “real food” approach
 - Avoid Misfits!!
- Nutrient Fortification (Protein)
 - Need to overcome sensory negatives
 - Need to ensure familiarity & congruency
- Need Better Understanding of Appetite control
- More focus on Texture for Older adults
- Need Better understanding of sensory/ nutrient feedback mechanisms
- Understand & Modify older adults emotional food experiences

Thank you



- Our Volunteers
- Dr Maria Dermiki
- Dr Orla Kennedy
- Prof Margot Gosney

- Project Students
- RBH NHS Trust Catering
- RBH NHS Clinical
- MMR Sensory panel

