

Beyond Ultra-Processed;

Future perspectives on Processed food and health

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Chair; Sensory Science and Eating Behaviour,
Wageningen University & Research,
The Netherlands

Tuesday 21st of March 2023



Overview; Beyond Ultra-Processed...

- **The Evidence:** A quick summary of the evidence on processed food and health.
- **The Mechanism:** Speculation on mechanisms that promote higher energy intakes from processed foods.
- **Beyond Ultra-processed:** Future considerations on processed food and health.

NOVA: Moving from Nutrients to Classifying Foods by Degree of Processing

Traditional Dietary Advice

Evidence based Nutrient Guidelines

Dietary Lipids / LDL/HDL and CVD

Na²⁺ and Hypertension

Folate and Neural Tube Defects

Ca²⁺, Vit D and Bone health

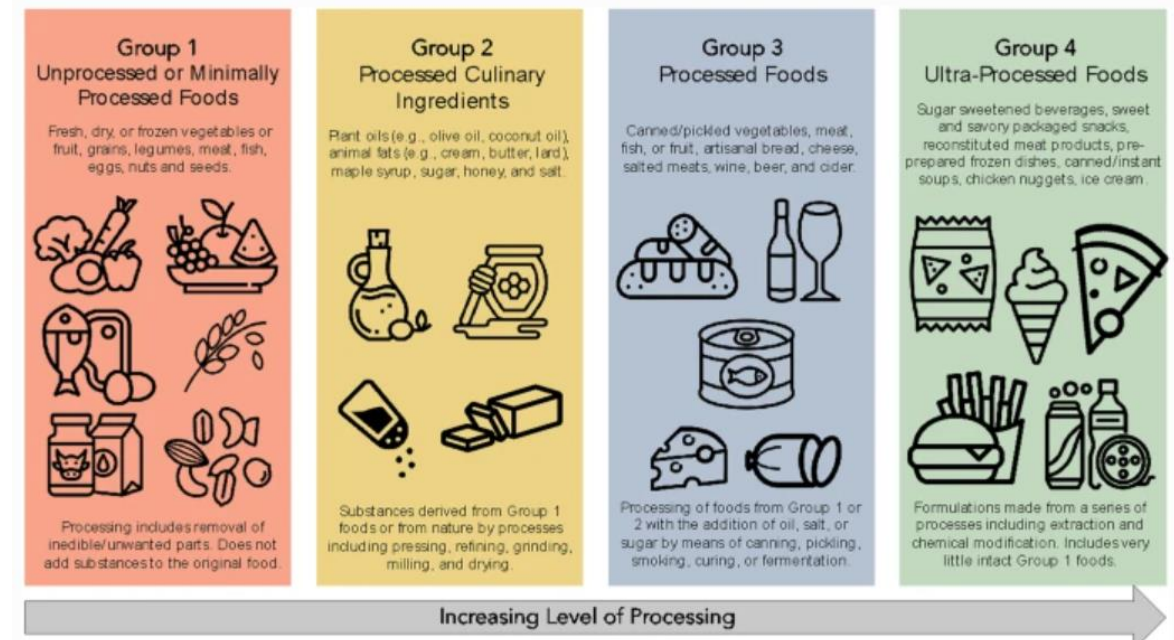
Nitrosamines and Colon Cancer

Iodine and Child IQ

Sugar and Dental Caries

NOVA Scheme to Classify Food by Degree of Processing

The most important factor today when considering food nutrition and public health is not nutrients, and not foods, so as what is done to foodstuffs..... the issue is food processing ... And what happens to food as a results of processing (Monteiro et al 2019 PHN)



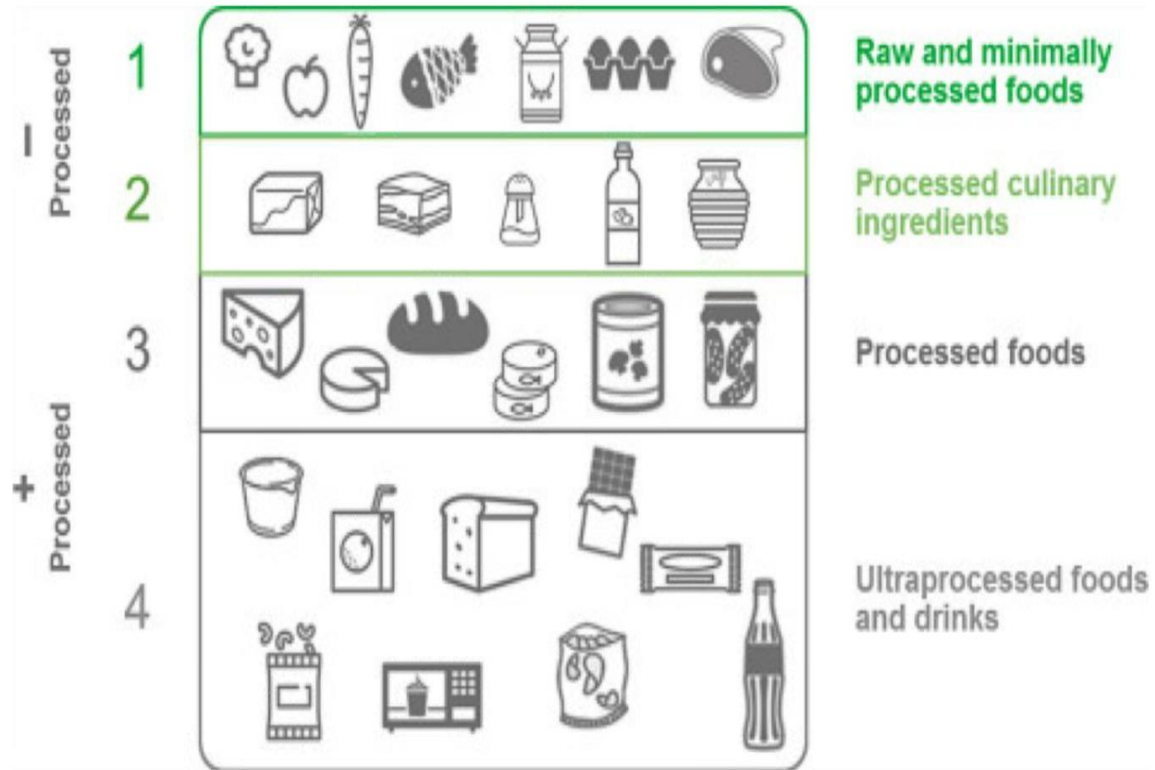
Crimarco, Landry & Gardner (2021) adapted from Monteiro, et al. (2018)



World Health Organization



NOVA; Definitions, Debates and Research Gaps...



Monteiro *et al* (2009) *Pubic Health Nutrition*

Ultra-processed foods in human health: a critical appraisal

Michael J Gibney,¹ Ciarán G Forde,^{2,3} Deirdre Mullally,¹ and Eileen R Gibney¹

The American Journal of
CLINICAL NUTRITION

nature
food

PERSPECTIVE

<https://doi.org/10.1038/s43016-021-00457-9>

Check for updates

Nutrition research challenges for processed food and health

Michael J. Gibney¹ and Ciarán G. Forde²

ANNUAL
REVIEWS

Annual Review of Nutrition

The Importance of Food Processing and Eating Behavior in Promoting Healthy and Sustainable Diets

Ciarán G. Forde¹ and Eric A. Decker²

Gibney, Forde, Mullaly and Gibney (2017) *AJCN*

Gibney and Forde (2022) *Nature Food*

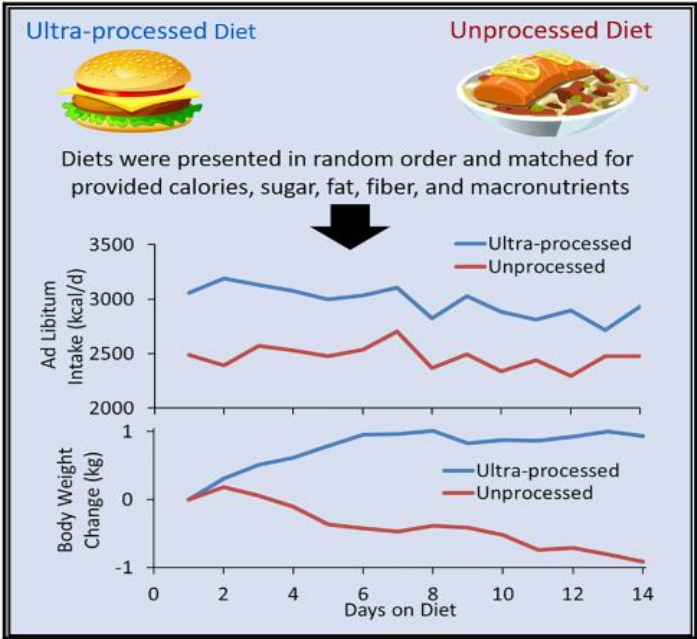
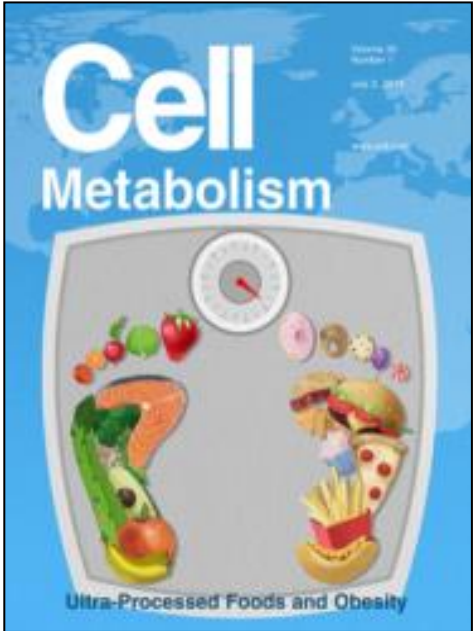
Forde and Decker (2022) *Annual Reviews in Nutrition*

One RCT: Energy Intake Un-Processed vs. Ultra-Processed Diets

Cell Metabolism

Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of *Ad Libitum* Food Intake

Sustained consumption of UPF Diet led to >500kcal/day increase in EI
Weight gain 0.9kg (mostly fat mass)



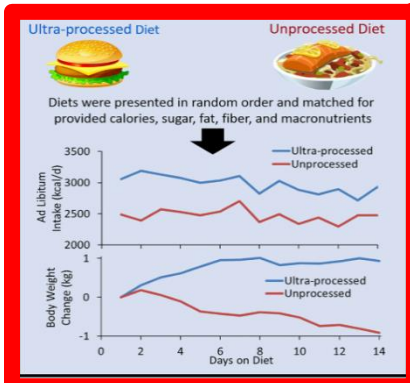
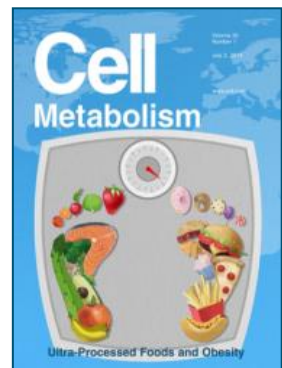
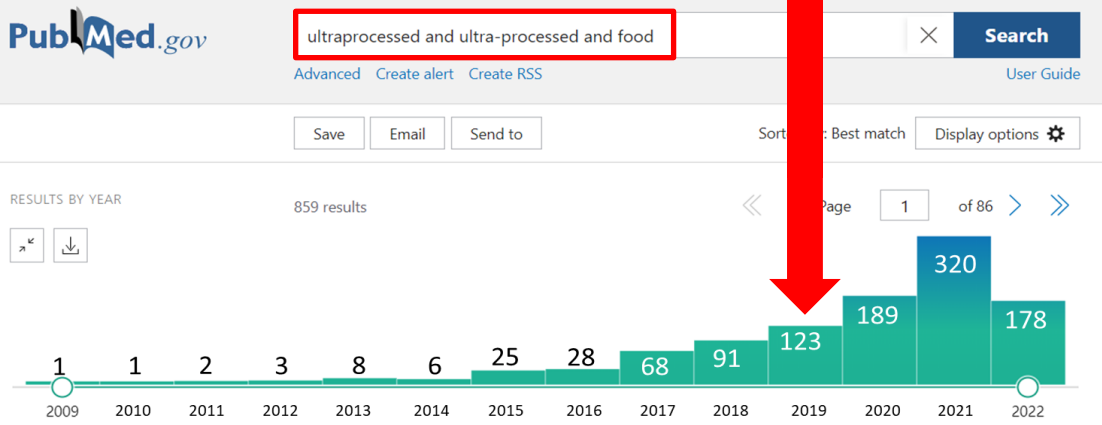
Dr. Kevin Hall
NIH/NIDDK

Energy intake from Ultra-Processed Diets; Searching for a Mechanism

836 / 1,069 Papers on UPF published since 2019

Cell Metabolism

Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of *Ad Libitum* Food Intake



Emulsifiers / Additives

'Hyper-palatability'

Taste-Nutrient Disruptions

Food Matrix / Microbiome

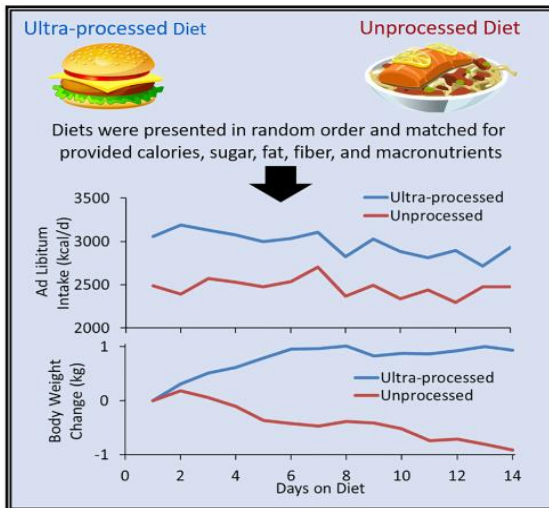
Reward Value / Food reinforcement

BUT; ICC's, Covariates, different classification schemes, food groups etc....

What drives energy intake from UPF diets?

The Hall Study was not designed to identify mechanisms, but we can speculate on the putative mechanisms previously suggested

Why?



- Food Additives / Synthetic-cosmetic ingredients`?
- Hyper-palatable / Low Satiety?
- Disrupts normal 'taste-nutrient' relationships?


Evidence: Is additive intake from Processed foods driving poor health?


scientific reports


OPEN Exposure to food additive mixtures in 106,000 French adults from the NutriNet-Santé cohort


Check for updates


Consumption of 90 main food additives


- 

Cluster 1: Consumers of additives found in cookies and sweet cakes
e322 lecithins, e471 mono- and diglycerides of fatty acids, e500 sodium carbonates, e450 diphosphates, e503 ammonium carbonates, e422 glycerol and e420 sorbitol
- 

Cluster 2: Consumers of additives found in broths, meal substitutes, butter, and bread
e14xx modified starches, e621 monosodium glutamate, e304 fatty acid esters of ascorbic acid and e320 butylated hydroxyanisole (BHA)
- 

Cluster 3: Consumers of additives found in dairy desserts, breakfast cereals and pastries
e407 carrageenan, e270 lactic acid, e282 calcium propionate, e452 polyphosphates, e160b annatto and e1442 hydroxy propyl distarch phosphate
- 

Cluster 4: Consumers of additives found in industrial sauces and processed meat
e250 sodium nitrite, e316 sodium erythorbate, e451 triphosphates, e120 cochineal, e330 citric acid, e415 xanthan gum, e202 potassium sorbate, e412 guar gum and e224 potassium metabisulphite
- 

Cluster 5: Consumers of additives found in sugary and artificially sweetened sodas
e950 acesulfame K, e951 aspartame, e955 sucralose, e960 steviol glycosides, e440 pectins, e160a carotenes, e331 sodium citrates, e301 sodium ascorbate, e160c paprika extract, e150d sulphite ammonia caramel, e100 curcumin, e252 potassium nitrate, e338 phosphoric acid, e161b lutein, e211 sodium benzoate, e472 esters of mono- and diglycerides and e212 potassium benzoate.
- 

Cluster 6: Consumers of various staple foods with low additive content
Lowest exposure.

Chazeles et al (2021) *Scientific Reports*



PERSPECTIVE

<https://doi.org/10.1038/s43016-021-00457-9>

Check for updates

Nutrition research challenges for processed food and health

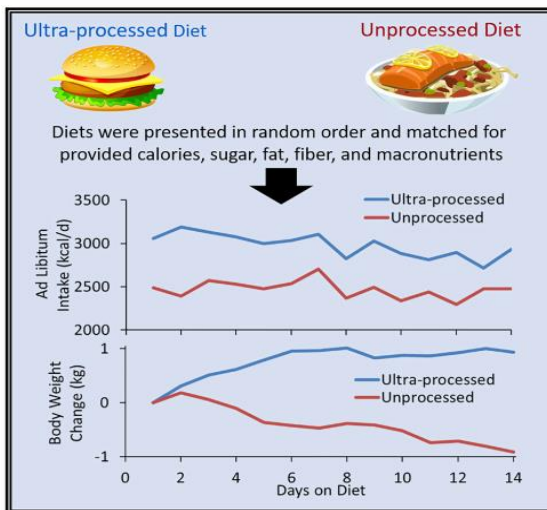
Michael J. Gibney¹ and Ciarán G. Forde²

Table 2 | Additives from processed foods and natural sources: a comparison of the estimated intake of selected additives

Food additive	Estimated exposure (mean daily intake) from processed foods in French adults	Possible exposure from naturally occurring sources	Intake from naturally occurring sources (mg)	
Lecithin	54 mg	One large egg	147	x 3
Citric acid	2 g	100 ml of orange juice	16	x 8
Ascorbic acid	16 mg	One orange	70	x 4.5
Sodium nitrite	<1 mg	Mean daily intake of vegetables (conversion from nitrates)	10	x 10
Pectin	200 mg	One Golden Delicious apple	811	x 4
Carotene	2 mg	One serving of cooked spinach	14	x 7

Gibney and Forde (2022) *Nature Food*

Why?



- Food Additives / Non-nutrient components / synthetic-cosmetic ingredients

- **UPF are Hyper-palatable and ↓Satiety**

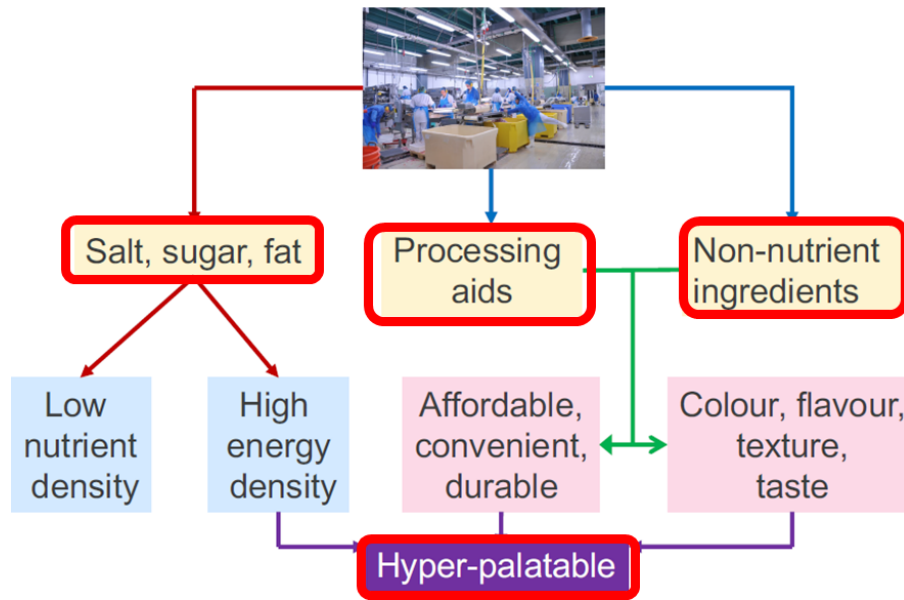
- Disrupts normal 'taste-nutrient' relationships?

Energy Intake from Processed vs. Ultra-Processed Foods; is it (hyper)Palatability?

Obesity Symposium
EPIDEMIOLOGY/GENETICS

Hyper-Palatable Foods: Development of a Quantitative Definition and Application to the US Food System Database

Tera L. Fazzino^{1,2}, Kaitlyn Rohde^{1,2}, and Debra K. Sullivan³



Fazzino, et al (2019) *Obesity*

nature food

Brief Communication

<https://doi.org/10.1038/s43016-022-00688-4>

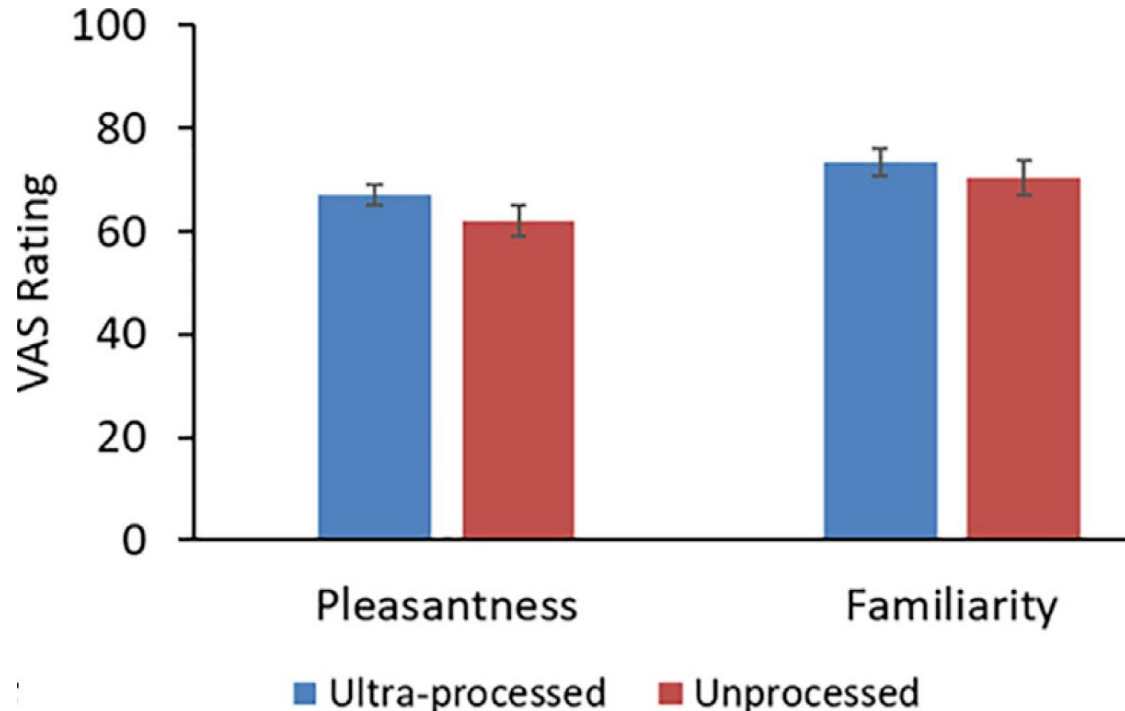
Ad libitum meal energy intake is positively influenced by energy density, eating rate and hyper-palatable food across four dietary patterns

Fazzino, Courville, Guo and Hall (2023) *Nature Food*

Could it be that modern processed foods are just too tasty / rewarding that they override our physiological responses to promote excessive intakes?

Ultra-Processed Foods; is it (hyper)Palatability?

Pleasantness / familiarity were on average Equal across diets



*Individual differences in liking drive increased energy intake
Equivalent effect for both Unprocessed and UPF diets

Some Problems with Hyper-palatability.....

1. **We cannot predict 'palatability' composition** (9/10 fail)
2. **Tautology**; A food is hyper-palatable because it's eaten and to explain why, it's because it's hyper-palatable
3. **No association between 'Liking' and Obesity**; if liking does play a role in obesity, then there should be clear differences in human hedonic responses across different weight classes (there is not!)
4. **SSS**: We have built in Biological systems to reduce the palatability of food as it is consumed
5. **Palatability and intake**; Actually, Liking/palatability are not even a strong predictor of intake! (and adding more energy to a food does not make it more palatable)
6. **Energy Density is conflated with Hyper-palatability**

Energy Intake from Processed vs. Ultra-Processed Foods; Energy Density



Energy density (kcal/g) of...	Non-processed diet	Ultra processed diet
Foods offered to subjects	1.02	1.03
Foods selected by subjects	1.09	1.36



Average = ↑ 508 kcal/day

Large Differences in Non-beverage Energy Density (Hall et al 2019, *Cell Metabolism*)

Solid foods offered were on average **1.1 kcal/g** higher than foods on the less processed diet.

A difference of 0.1 kcal/g can be associated with a 100-kcal change in daily energy intake.

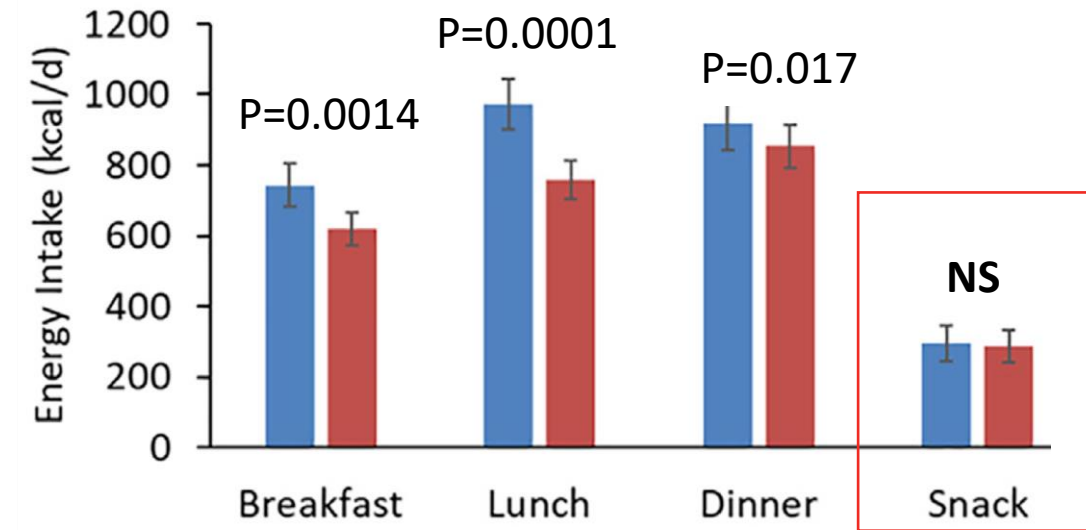
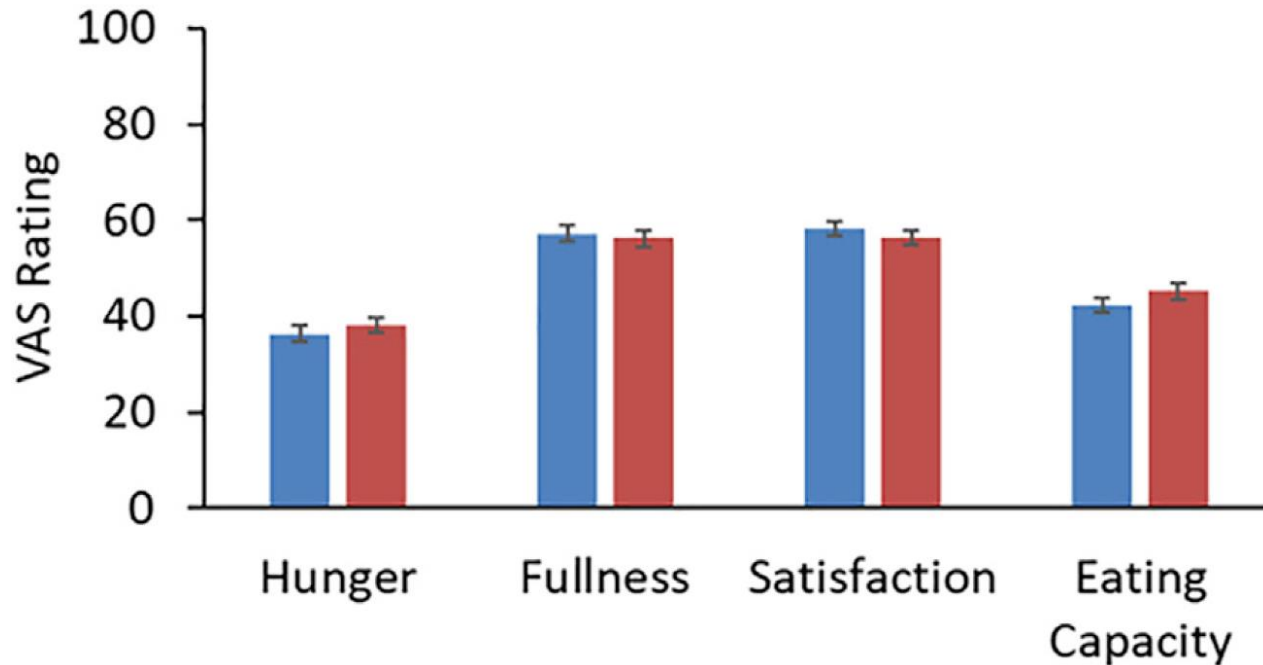
Rolls (2009) *Physiology and Behaviour*

Rolls, Cunningham and Diktas (2020) *Nutrition Today*

Energy Intake from Processed vs. Ultra-Processed Foods; is it Satiety / Appetite?

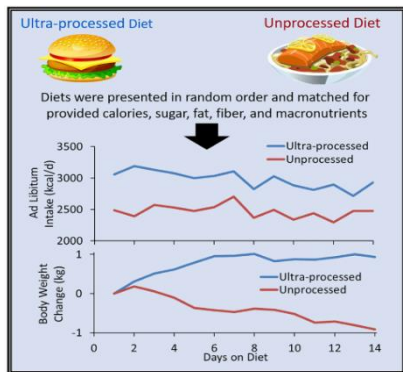
Subjective Satiety was rated equivalent (on average) across both diets
No difference in snack energy intake on UP of UPF diets

Breakfast ($\Delta 144 \pm 39$ kcal/day; $p = 0.0014$), lunch ($\Delta 248 \pm 39$ kcal/day; $p < 0.0001$), and dinner ($\Delta 108 \pm 41$ kcal/day; $p = 0.017$)



■ Ultra-processed ■ Unprocessed

Why?



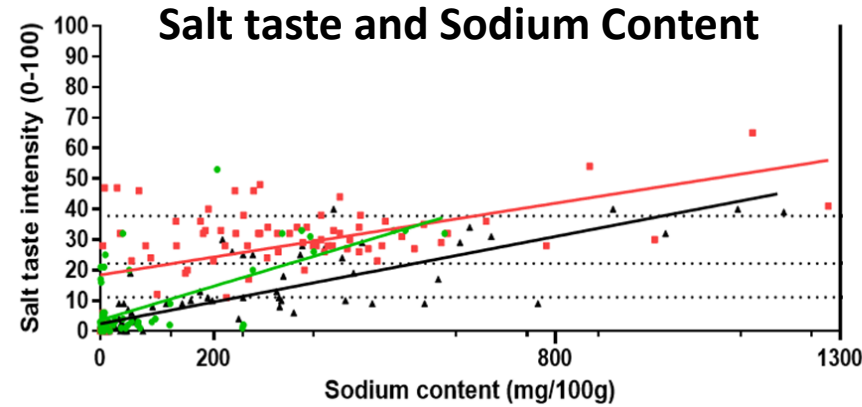
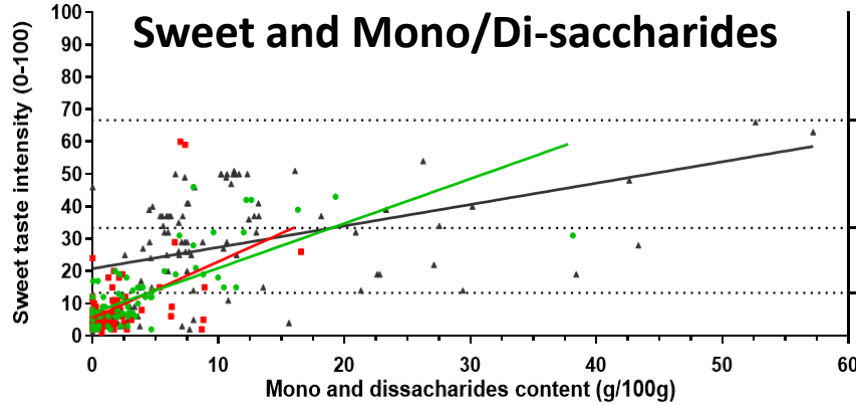
~~Food Additives / Non-nutrient components / synthetic-cosmetic ingredients~~

~~UPF are Hyper-palatable / Low Satiety~~

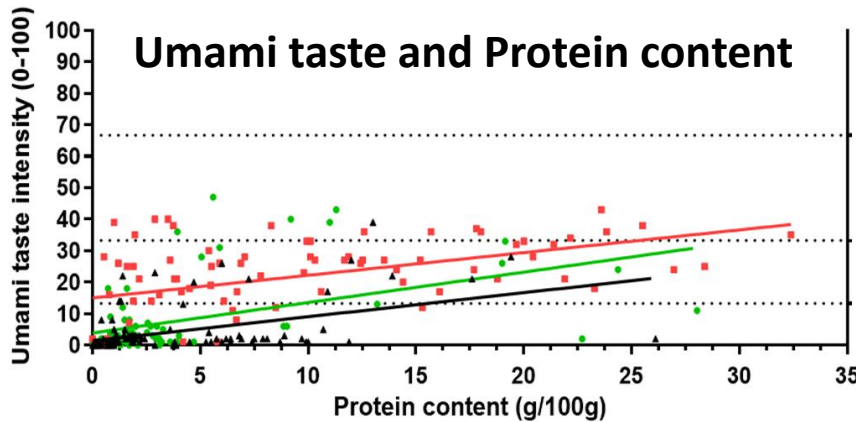
- Processing disrupts normal 'taste-nutrient' relationships?

Taste as a Nutrient Signal; Does Food Processing disrupt this relationship?

Trained panel Taste intensity of individual foods ((n = 263) plotted against taste substrate content of the food



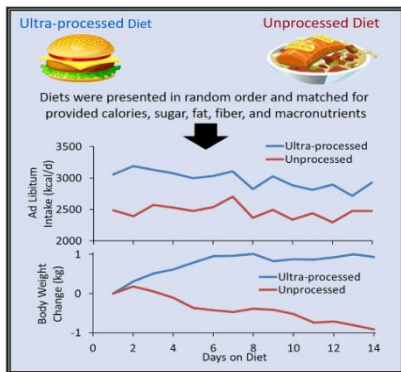
Singapore Multi-Ethnic Cohort II
N = 263 Singaporean Foods



- Unprocessed foods (n=72)
- Processed foods (n=82)
- Ultra-processed foods (n=109)

Associations between perceived taste intensity and quality are preserved across different degrees of Food Processing

Why?



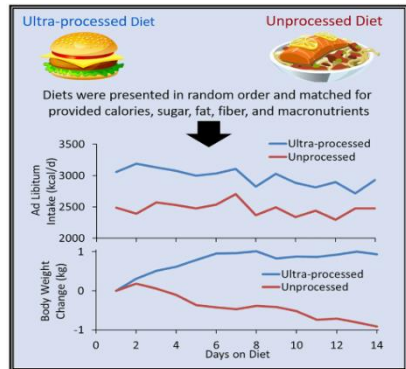
~~Food Additives / Non-nutrient components / synthetic-cosmetic ingredients~~

~~UPF are Hyper-palatable / Low Satiety~~

~~Processing disrupts normal 'taste-nutrient' relationships?~~

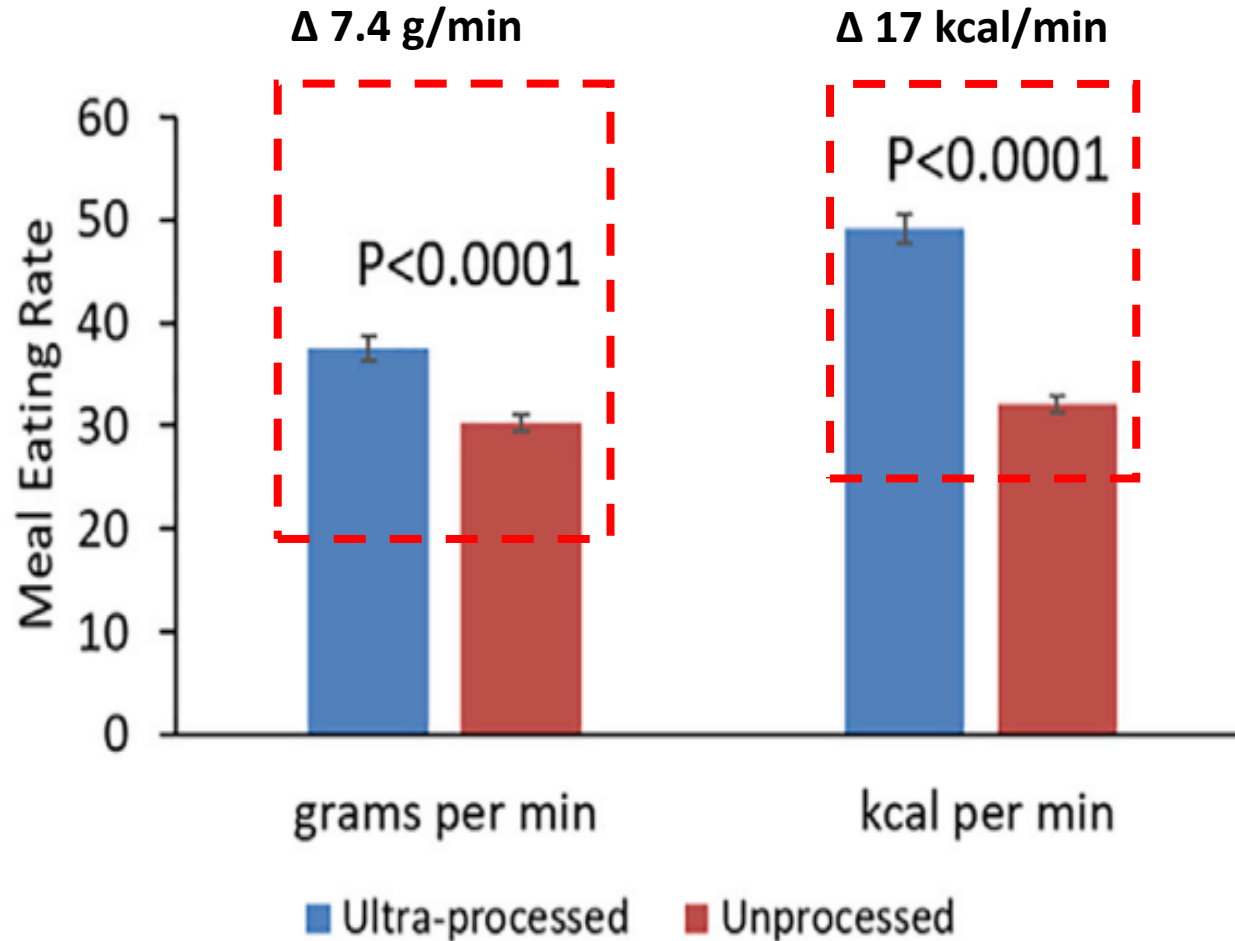
- So What is it?

Why?



- ~~Food Additives / Non-nutrient components / synthetic-cosmetic ingredients~~
- ~~UPF are Hyper-palatable / Low Satiety~~
- ~~Processing disrupts normal 'taste-nutrient' relationships?~~
- ~~—~~
- What about the eating rate / energy intake rate of the diet?

Energy Intake Rate: Un-Processed vs. Ultra-Processed Foods Diets



Energy Intake Rate (kcal/min)

Eating Rate x Energy Density

50 % increase in Energy Intake Rate (kcal/min) on the UPF arm

48 kcal/min vs 31 kcal/min

Ultra-Processed

Unprocessed

'Ultra-Processing or Oral Processing': Energy Intake Rate by Processing

Average Energy Intake Rate increases from 35.5 to 53.7 to 69.4 kcal/min

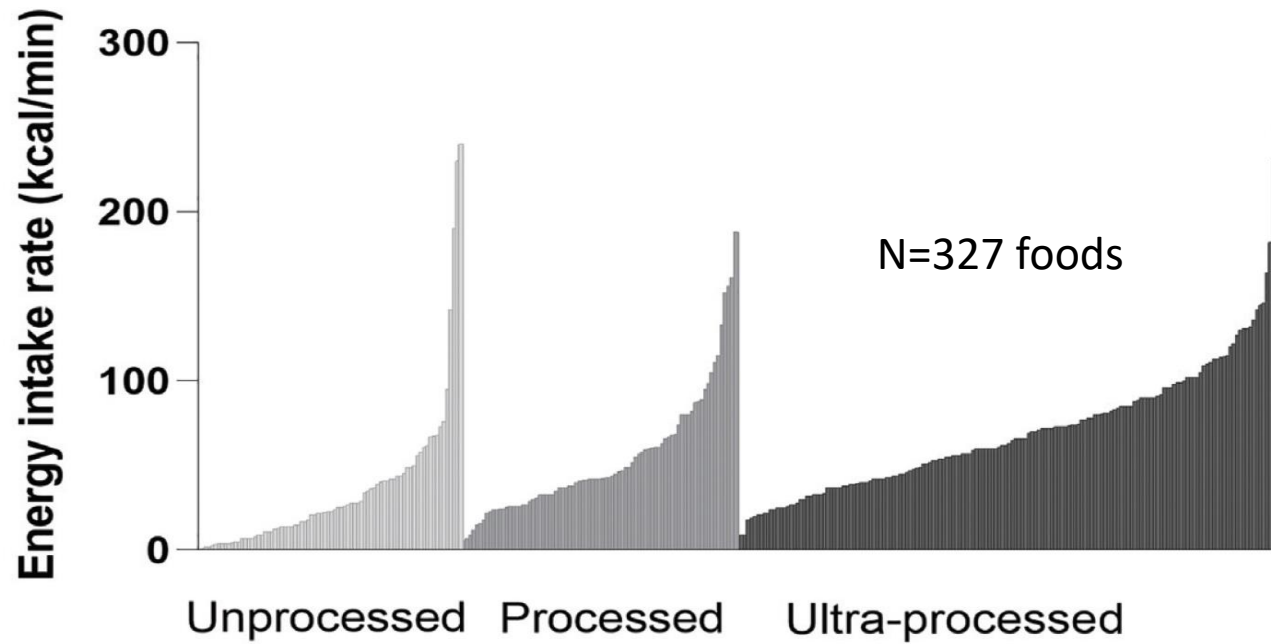
ORIGINAL RESEARCH

CURRENT DEVELOPMENTS IN NUTRITION



Ultra-Processing or Oral Processing? A Role for Energy Density and Eating Rate in Moderating Energy Intake from Processed Foods

Ciarán G Forde,^{1,2} Monica Mars,³ and Kees de Graaf³



Forde, Mars, DeGraaf (2020) *Current Developments in Nutrition*

Consumption of Foods With Higher Energy Intake Rates is Associated With Greater Energy Intake, Adiposity, and Cardiovascular Risk Factors in Adults

Pey Sze Teo,¹ Rob M. van Dam,^{2,3} Clare Whitton,² Linda Wei Lin Tan,² and Ciarán G Forde^{1,4}

Consuming diets high in dietary EIR;
Increased risk of abdominal Obesity / CVD risk



Singapore Multi-Ethnic Cohort II

Teo et al (2020) *Journal of Nutrition*

Ad-libitum Intake of meals Varied by Processing and Texture



Texture-based differences in eating rate influence energy intake for minimally processed and ultra-processed meals

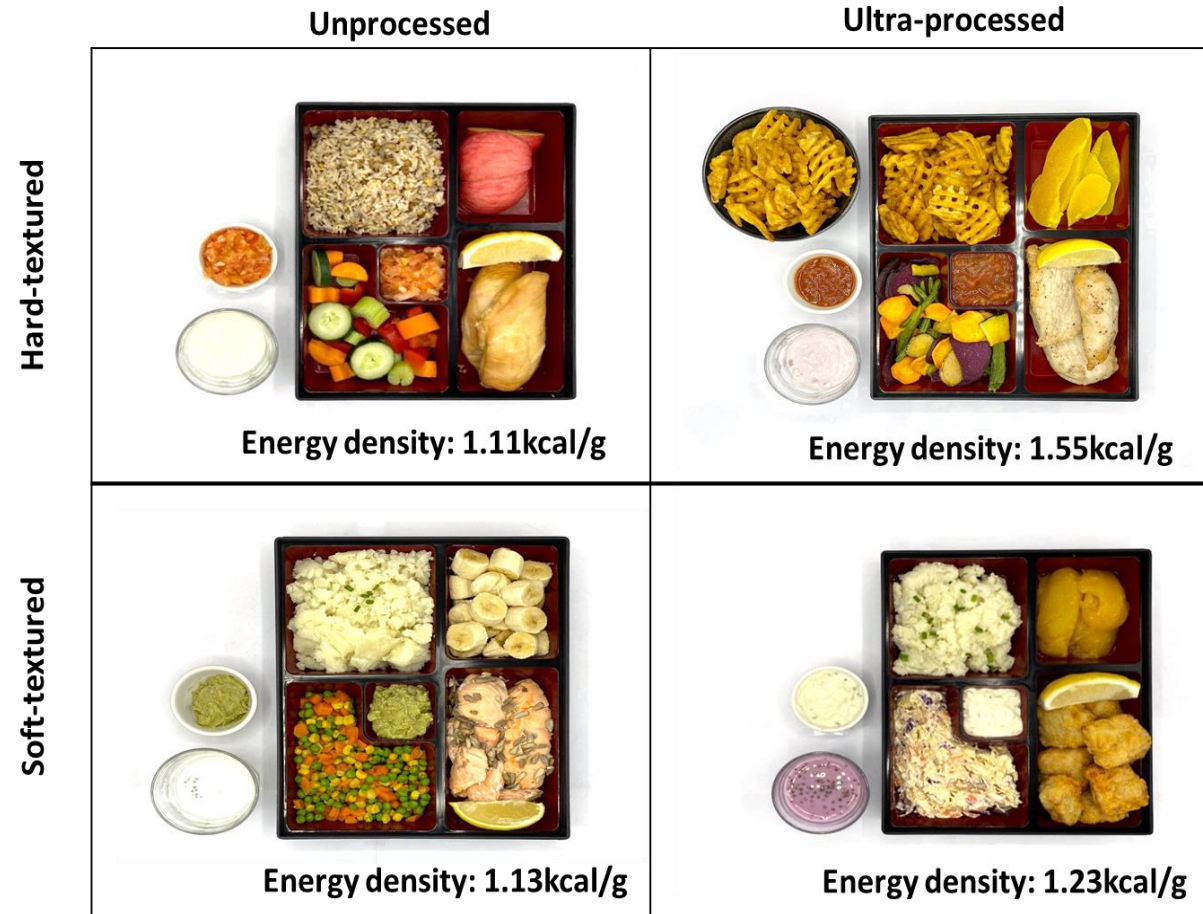
Pey S Teo,¹ Amanda J Lim,¹ Ai T Goh,¹ Janani R,¹ Jie YM Choy,¹ Keri McCrickerd,² and Ciarán G Forde^{1,3}

N=50 (male/female)

4 ad lib meals – matched for energy from macronutrients, average kcal/g of components, and overall energy served.

Full cross-over design (200 meals).

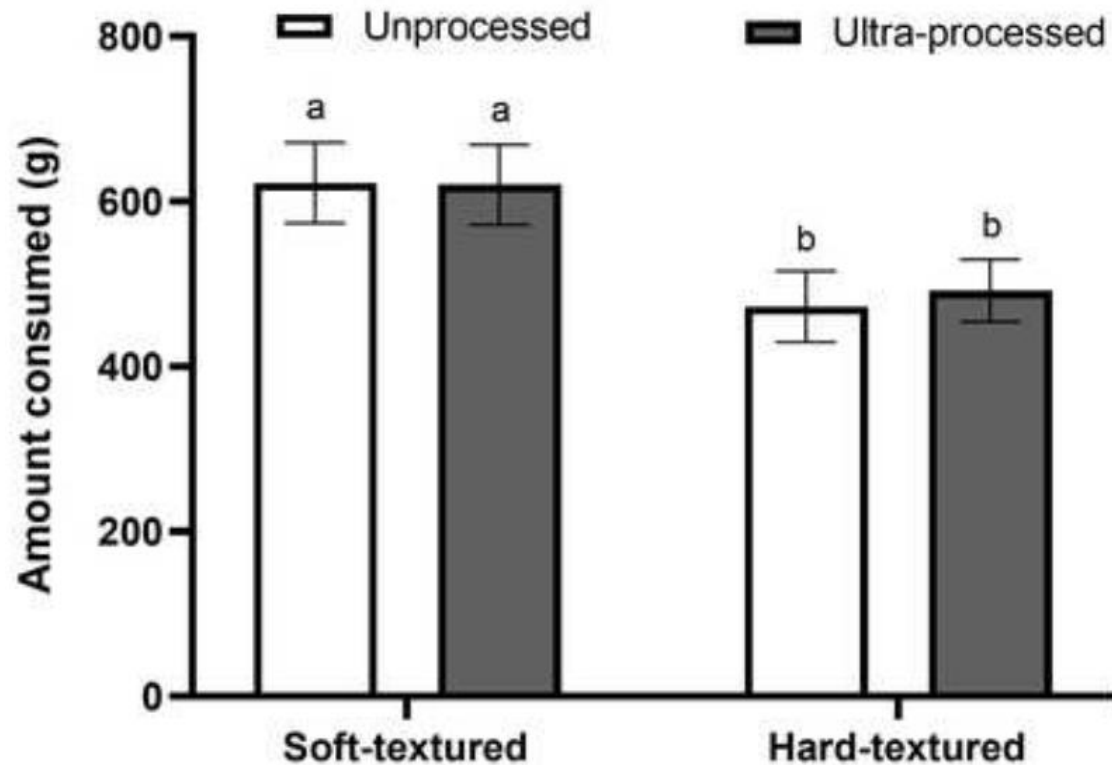
Standardised pre-meal appetite need state.



(1) *Ad-libitum* Meal Intake is driven by Texture not Processing

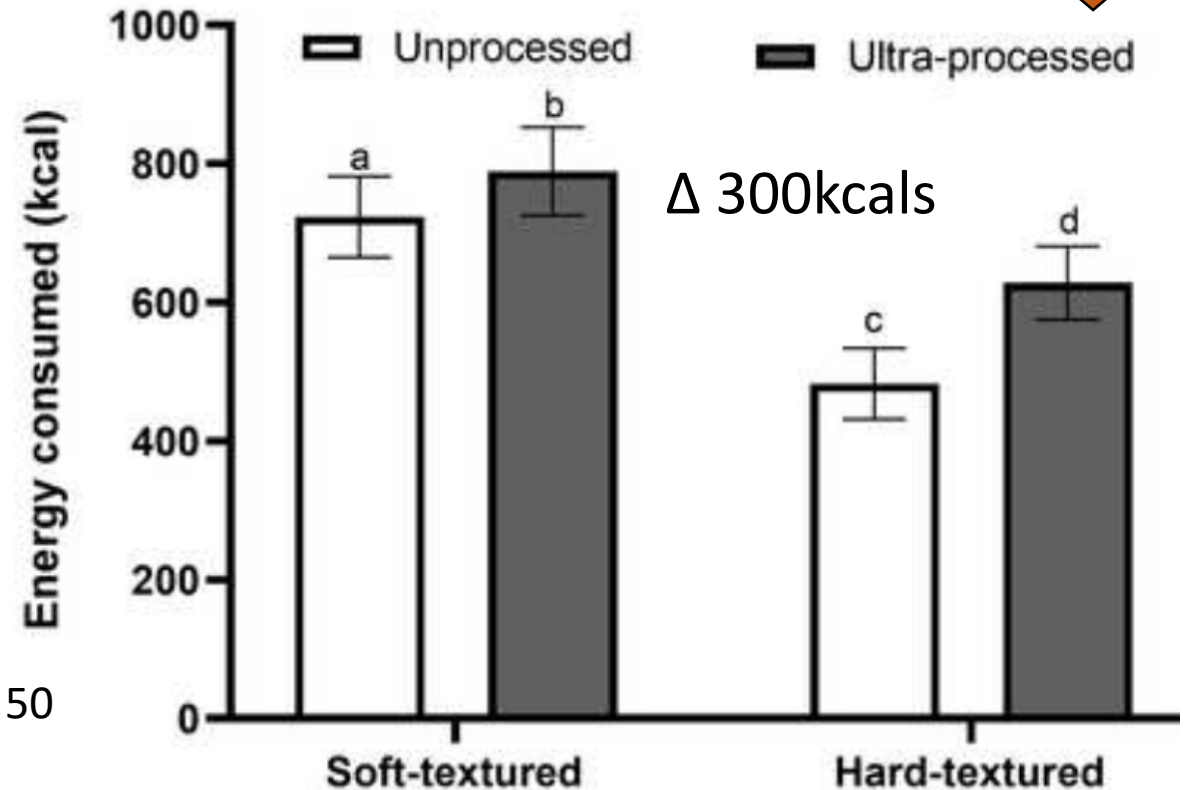
Significant effect of texture on amount consumed. No effect of processing on amount (g) consumed

Amount consumed (g) **21%**
↓



N = 50

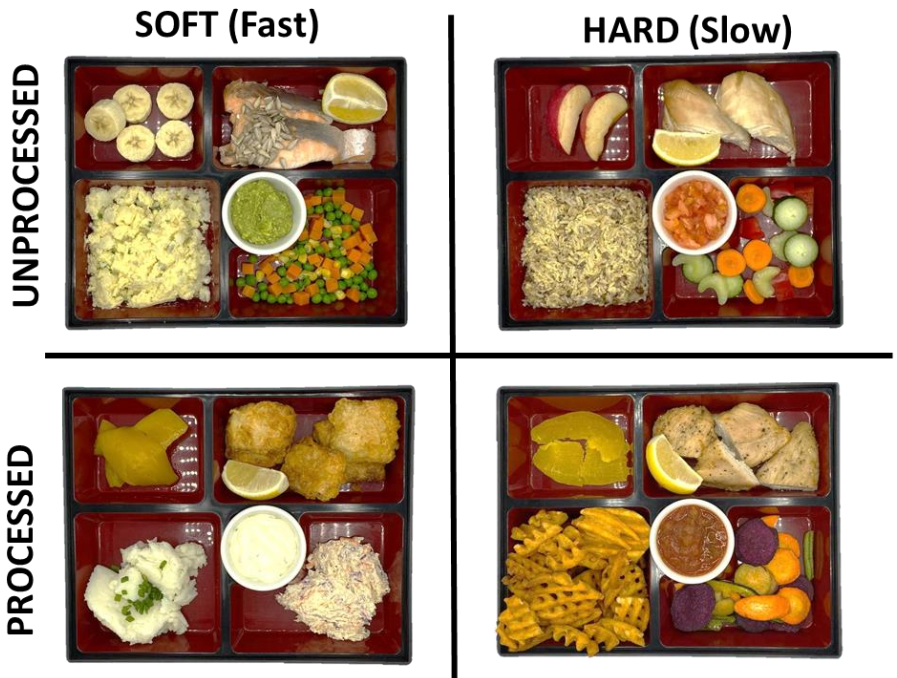
Energy consumed (kcal) **26%**
↓



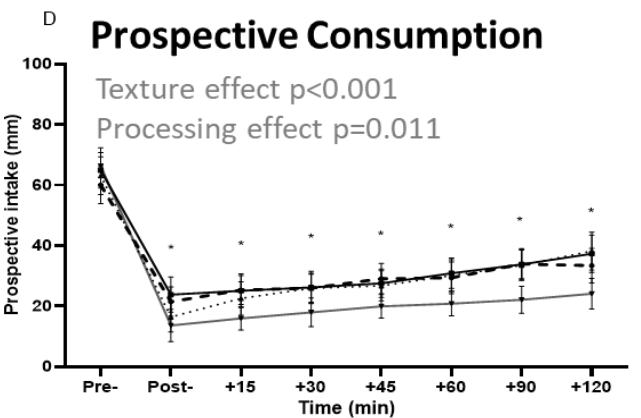
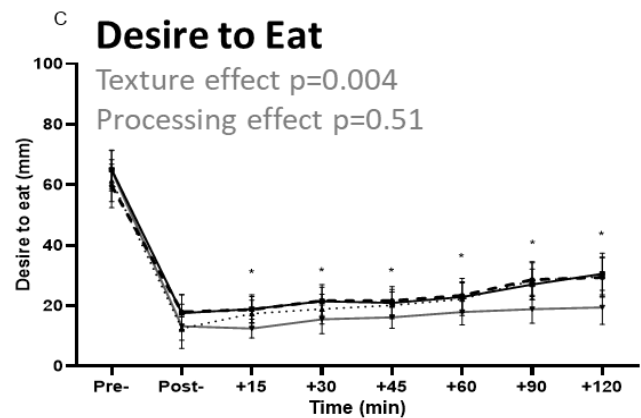
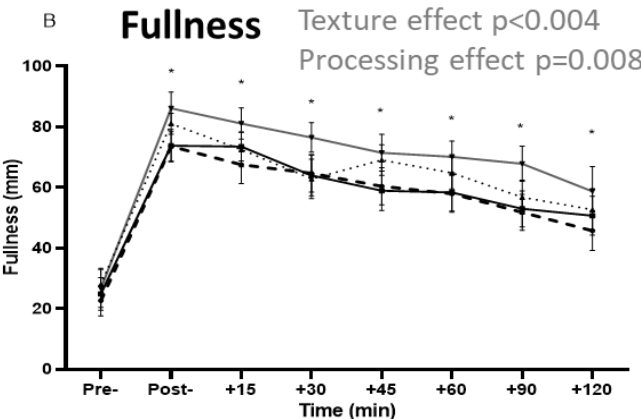
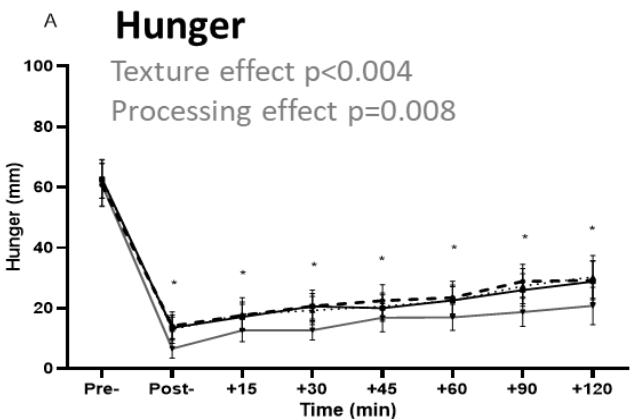
mean (95%CI) adjusting for pleasantness

Teo, Lim, Goh, Choy, Janani, McCrickerd and Forde (2022), *AJCN*

(2) Satiety per kcal was Higher for UPF vs. Un-processed meals



Fixed Portion Satiety test
 ~445g / 630 kcals
 Macronutrient / Energy density matched



--- Soft-Minimally-processed —●— Soft-Ultra-processed -.-.- Hard-Minimally-processed —▲— Hard-Ultra-processed

Meal Texture had a stronger effect on post-meal satiety than degree of food processing (effects are small)

Teo, et al (2023) (in preparation)

Beyond Ultra-Processed; Interim Conclusions

- Many of the putative mechanisms have either not been tested, or are not supported by available evidence (i.e. additives, hyper-palatability, ↓satiety).
- Differences in energy density and eating rate are more likely driving differences in *ad lib* energy intake than degree of food processing (Hall RCT).
- Our findings show that food texture had a stronger effect on both energy intake and post-meal satiety than degree of food processing in controlled trials.



Food Processing; The Good guy or the Bad guy?



Can we divide the modern food supply into healthy and unhealthy based on a simple processing classification?

Can Processing be used as a Proxy for Health? **It's complicated...**

**Similar processes,
but different
nutritional value**



High fiber low sugar



Low fiber high sugar

**Different processes, and
similar nutritional value**



Canning



Freezing

Forde and Decker (2022), *Annual Reviews in Nutrition*

Beyond 'Ultra'-Processed

5 considerations for the future of processed food and health

- 1. Need for more mechanistic studies**
too many hypotheses, not enough data
- 2. Processing, Sustainability, Affordability**
- 3. Future (Mild)-processing**
- 4. Reformulating our food environment**
- 5. 'Communicating' processing**



Texture; A non-nutritive food component that moderates Energy Intake

 The American Journal of
CLINICAL NUTRITION

Editorial



Food texture trumps food processing in the regulation of energy intake

Michael J Gibney

Institute of Food and Health, University College Dublin, Dublin, Ireland

With increasing evidence that eating rate is a major driver of energy intake, strategies to manipulate the texture of processed foods will arise.....

.....if science is to drive policy, then this issue of texture, in food reformulation or public health nutrition advice, is simply a challenge that has to be embraced.

The Restructure Project





WP 1: Creating models that predict intake from textural and nutritional food properties



WP 2: Validation of design rules on daily energy intake in a human trial with ultra processed foods

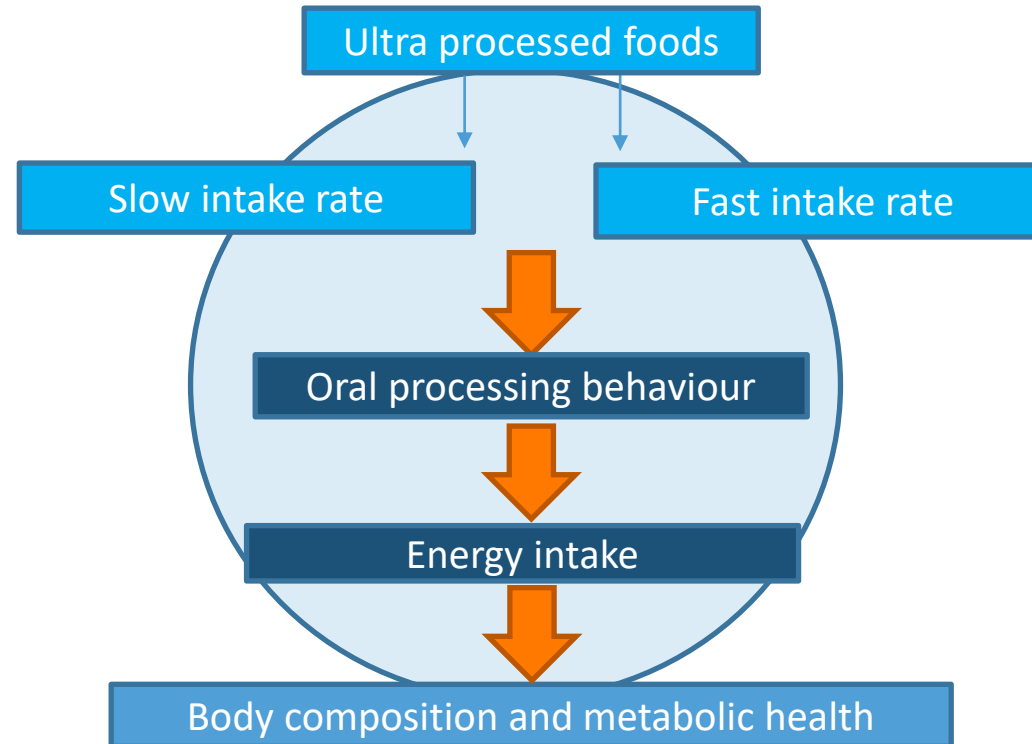


WP 3: Impact of ultra processed diets on body composition and metabolic health



WP 4: Dissemination and implementation of results in food industry and policy makers

<https://restructureproject.org/>



Public-private partnership (Govt. co-funding)

11 Consortium partners (Advisory role)

Scientific Steering Committee (guidance and approval)

Independent Project Governance & Communication

RESTRUCTURE Project Work-packages and Teams



RESTRUCTURE PROJECT TEAM



Project management, overview & assistance



WP 1: Creating models that predict intake from textural and nutritional food properties



WP 2 and WP 4: To determine the role of texture of ultra-processed foods (UPF) in moderating energy intake, body composition and metabolic health



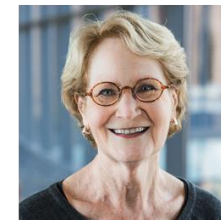
WP 3: Dissemination and implementation of results in food industry and policy makers



Advisory Partners (N = 11)



Scientific Steering Committee



Prof. Barbara Rolls,
Penn State University



Dr. Dave Mela
Independent consultant



Prof. Remko Havermans
Maastricht University

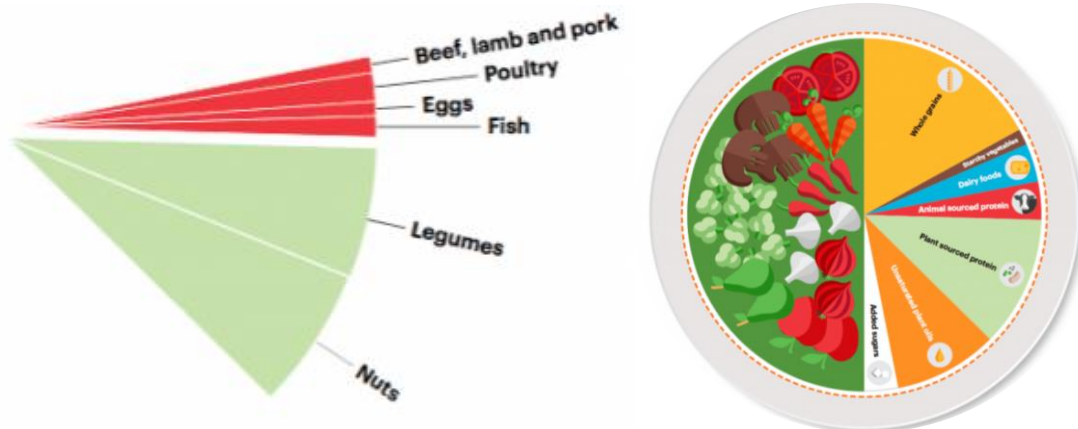
<https://restructureproject.org/>

(2) Sustainability: Processing is needed to feed the world sustainably

‘the food system alone could push us over 1.5° C’ (Sir Charles Godfray)

Processing will be needed for;

- Shifting to a more plant-based diet
- More sustainable food production
- Less food loss during production (currently approx. 30%)
- Less food waste (in the home / food service / retail)
- Economies of scale / consistency – food availability
- Access to nutrition – affordable access to nutrition



AR ANNUAL REVIEWS

Annual Review of Nutrition

The Importance of Food Processing and Eating Behavior in Promoting Healthy and Sustainable Diets

Ciarán G. Forde¹ and Eric A. Decker²

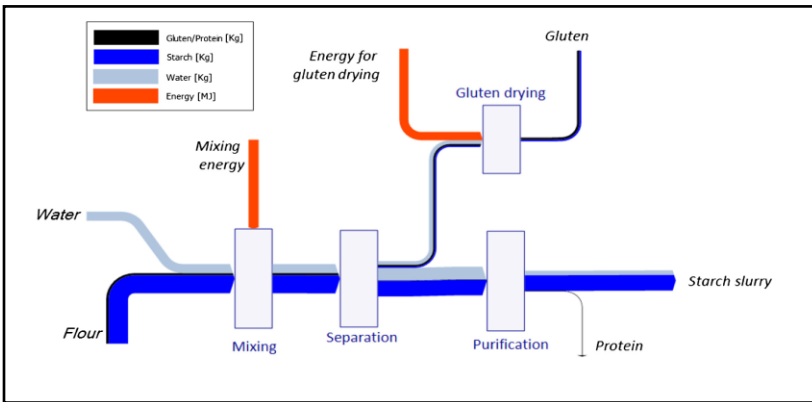
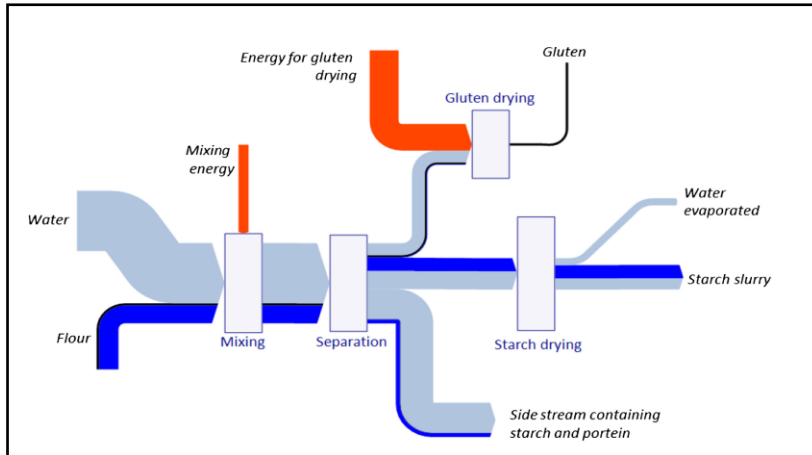
¹Sensory Science and Eating Behavior Group, Division of Human Nutrition, Wageningen University and Research, Wageningen, The Netherlands; email: ciaran.forde@wur.nl

²Department of Food Science, University of Massachusetts, Amherst, Massachusetts, USA

Forde and Decker (2022) *Annual Reviews in Nutrition*

(3) Milder Food Processing: Sustainable and Affordable Processes

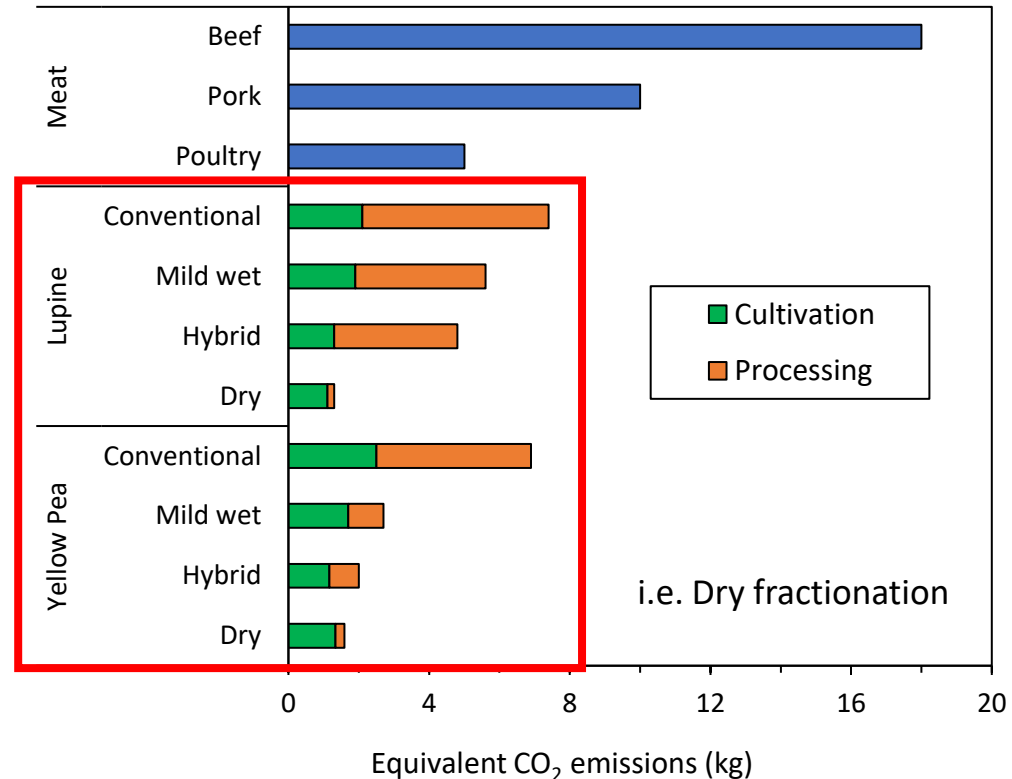
Industry focus is now on shifting to 'milder-processing' techniques driven primarily by Cost and Sustainability



Lie-Pang *et al* *Journal of Cleaner Production*
 Van der Groot *et al* *Journal of Food Engineering*



TKI LWV22098 *Metabolic Impact of Food Processing* (PI: C. Forde, 2023-27)



(4) Reformulation: NOVA Calls for 'Revolution' but Reformulation is a Fact of Life



“50% of the products on our shelves today will be gone within 5 years, as food producers continue to innovate in formulation and production of their products”

Food Drink Europe

Public Health Nutrition: 21(1), 247-252 doi:10.1017/S1368980017001392

Commentary

Ultra-processed foods and the limits of product reformulation

Gyorgy Scrinis^{1,*} and Carlos Augusto Monteiro²

- Sugar, fat and salt reduction
- Lower Energy density / sugar reduction
- Adding Nutrients (i.e. Vit A, D, Milk)
- Fortification for LMIC countries
- Protein isolates for sport nutrition
- Low GI ingredients
- Probiotics/prebiotics....



Fortified Stock Cubes
(Fe²⁺, Vit A, Iodine, Zn)

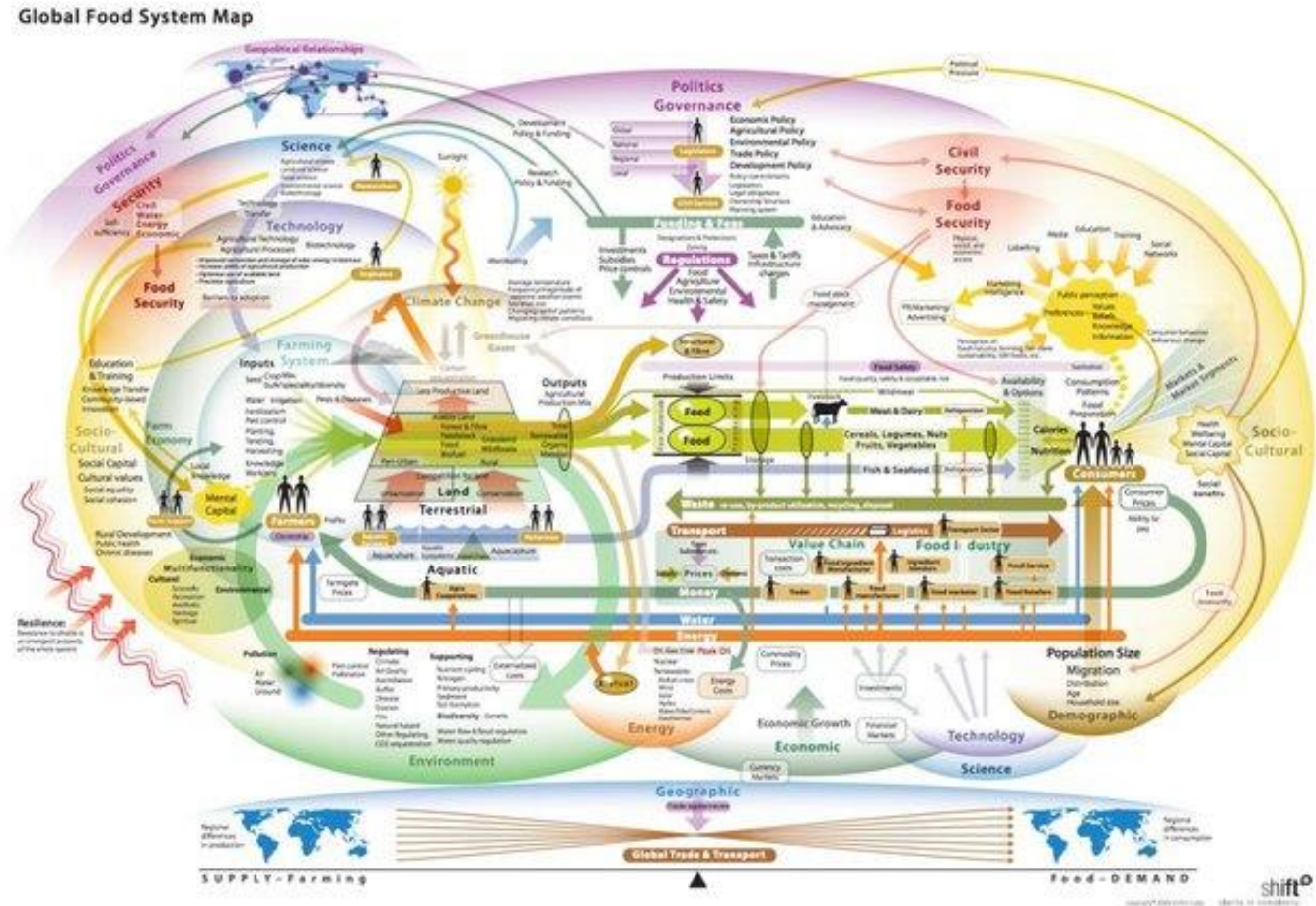
(5) Food Processing has an image problem: **Communication is Key!**



The average apple; 12-15 months old – Food Innovation may be impactful but is often **emotional** for consumers

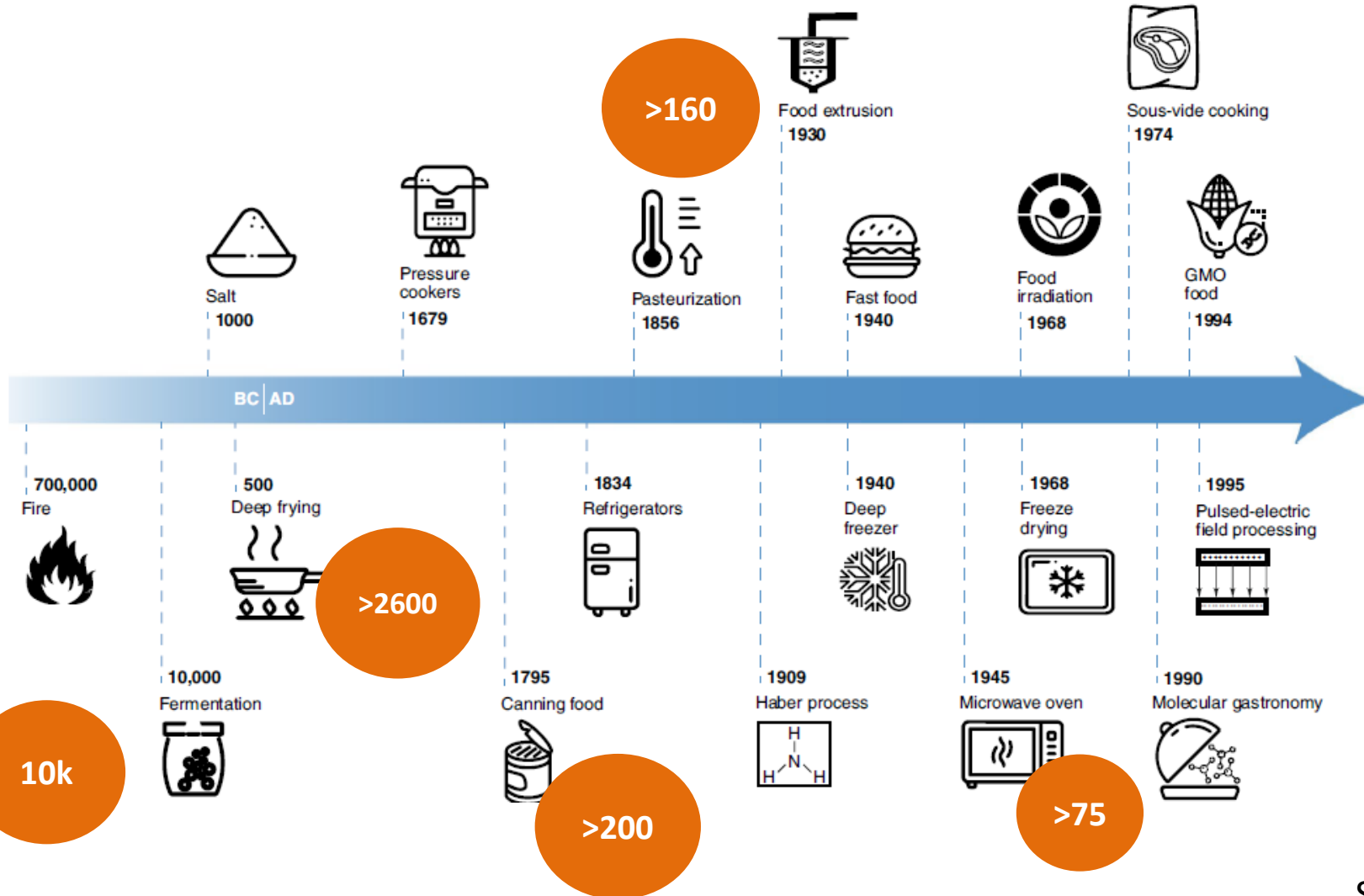


Consumers don't understand the need for processing or the 'food system'



Nicholson et al (2019) CGIAR Report Setting priorities to address the research gaps between agricultural systems analysis and food security outcomes in low-and middle-income countries

'Evolution rather than Extinction'; Many Processes have been around a long time...



'Evolution rather than Extinction'

New Food processes do not necessarily replace old, so there is less pressure to accept innovations in food processing

There is a need to communicate how food is produced and distributed in a way that informs consumer choice based on facts, rather than fear or 'emotion'

Conclusions: **Beyond Ultra-Processed**

Processing Classifications; Current approaches to classify foods by degree of processing are not fit for purpose if they are to help guide healthier consumer choice and intake.

Focus on Mechanisms: Food texture / Energy density moderate energy intake from processed food and understanding other mechanisms will create new opportunities to reformulate and improve the food supply.

Sustainability; Processing will be central in meeting the demands of the growing population and improve the sustainability of our food supply.

‘Beyond Ultra-processed’; Reformulating foods to improve nutrient density and sustainability of our diets is paramount and should be the primary focus of how we communicate processing to consumers.



Peters et al Voeding Magazine 2 - 2019

Thank You

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<https://restructureproject.org/>

