The Gut-Brain Axis and Contemporary Environmental Exposures: Ultra-Processed Foods, Plastics, and Mental Health

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Disclosure

I have no actual or potential conflict of interest in relation to this presentation.

Learning Objectives

At the conclusion of this activity, participants will be able to:

- Describe the core pathways of the gut-brain axis and their relevance to common psychiatric disorders
- Critically evaluate current evidence linking ultra-processed foods and plastic exposures to metal health outcomes
- Discuss proposed biological mechanisms connecting environmental exposures to psychiatric symptoms

Relevance

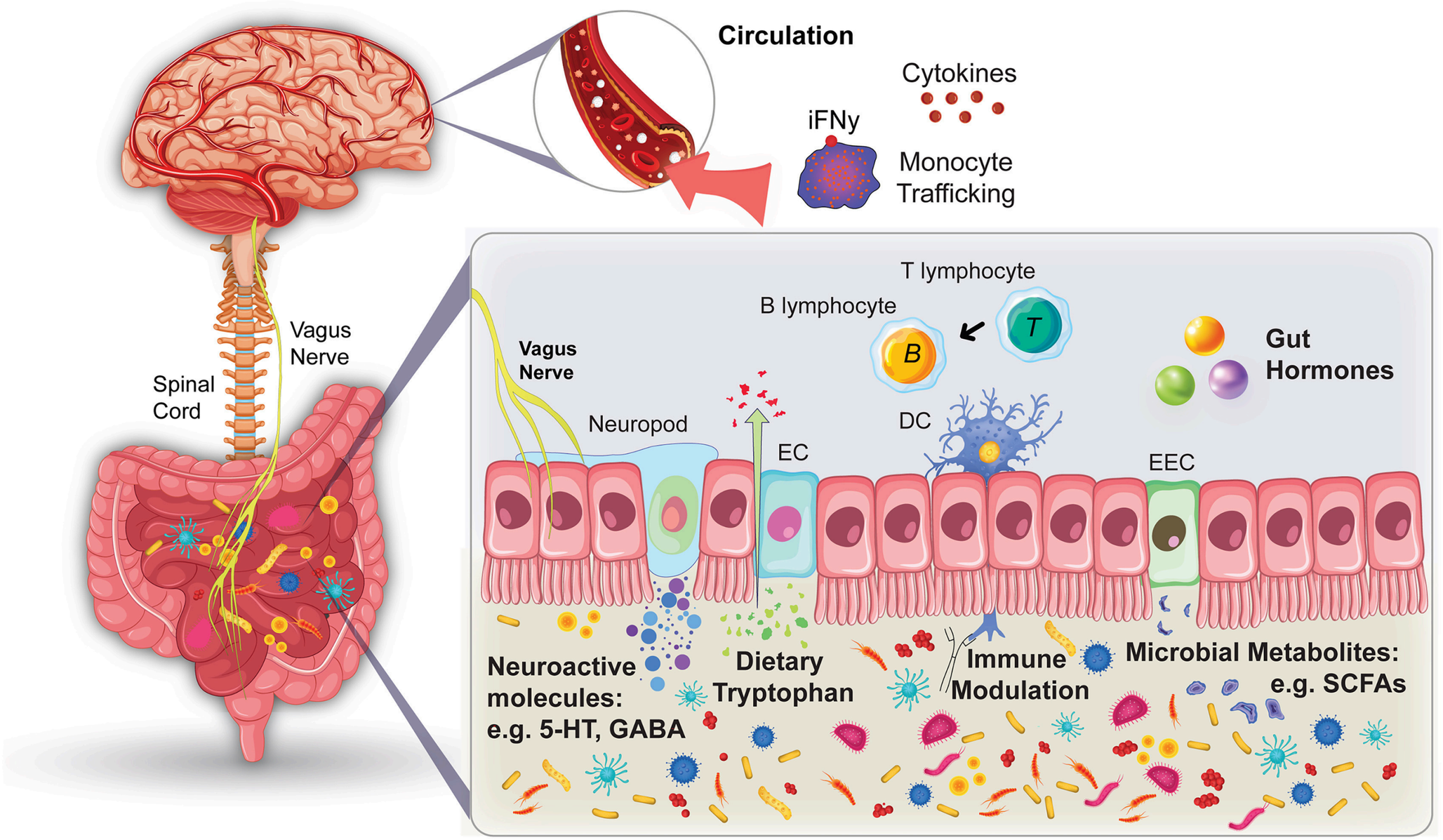
- Ultra-processed foods (UPFs) and plastics have become increasingly ubiquitous and difficult to avoid:
  - UPFs make up up to 60% of caloric intake for adults in the US
  - Global plastic production has increased 230-fold since the 1950s
- Research is emerging suggesting links between exposure to UPFs and plastics and negative impacts on the brain

APA Position

- In July 2026, the APA released a position statement on single use plastics:
  - “MNPs trigger inflammation and cellular changes, potentially increasing risks of cancer, cardiovascular disease, and neurodegenerative conditions like Alzheimer’s and Parkinson’s disease….Prenatal exposure has been linked to lower IQ, behavioral problems, ADHD symptoms, and metabolic disorders.”
  - “While individuals can try to reduce their exposure, widespread societal use and environmental contamination ensures unavoidable contact through air, water, and food. Therefore, comprehensive action is urgently required.”
  - “Based on research evidence that shows the negative neurobiological and developmental effects of plastics, with potential long-term neuropsychiatric consequences, production and use of single-use plastics should be reduced while research continues.”

The Gut-Brain Axis

- Bidirectional communication system between the gut and brain
  - Neural pathways
  - Immune signaling
  - Endocrine signaling
  - Microbiome metabolites


Circulation
Cytokines
iFNy
Monocyte
Trafficking
Vagus
Nerve
Spinal
Cord
T lymphocyte
B lymphocyte
Vagus
Nerve
Neuropod
EC
DC
EEC
Gut
Hormones
Neuroactive
molecules:
e.g. 5-HT, GABA
Dietary
Tryptophan
Immune
Modulation
Microbial Metabolites:
e.g. SCFAs

The Gut-Brain Axis and Neuropsychiatric Disorders

- Major depressive disorder
- Anxiety disorders
- Bipolar disorder
- Schizophrenia
- Autism spectrum disorder
- Attention deficit/ hyperactivity disorder
- Neurodegenerative disorders

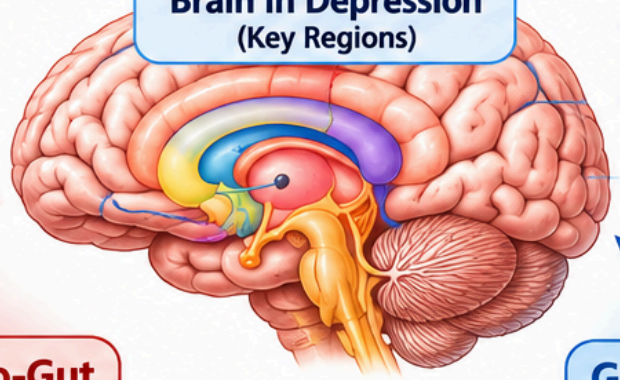
Depression and the Gut–Brain Axis

A Bidirectional Relationship

How Depression Can Affect the Gut

- Chronic stress and altered neuroendocrine signaling (e.g., ↑ cortisol)
- Changes in autonomic nervous system (sympathetic ↑, parasympathetic ↓)
- Altered gut motility (diarrhea, constipation)
- Changes in gut microbiome diversity

Brain in Depression
(Key Regions)



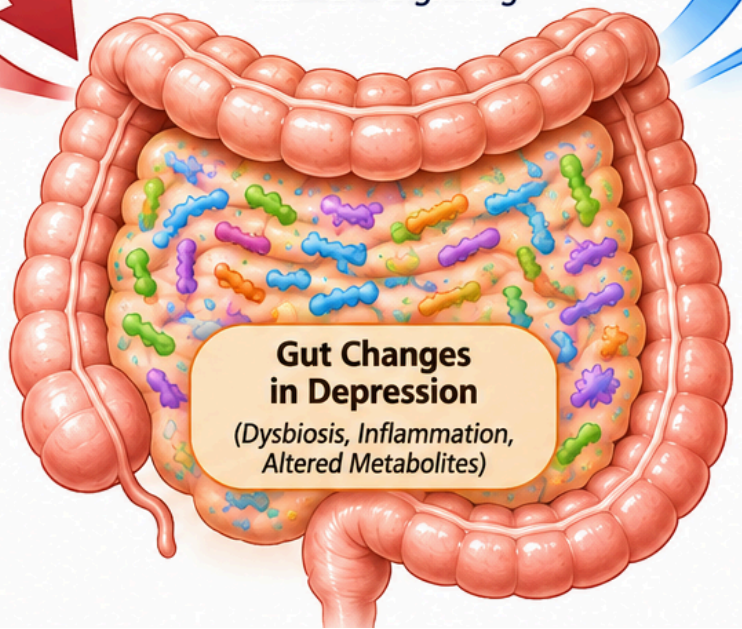
- Prefrontal cortex (reduced activity)
- Amygdala (hyperreactivity)
- Hippocampus (atrophy)

Brain-to-Gut Effects

Gut-to-Brain Effects

Gut–Brain Axis

Neural • Immune • Endocrine • Microbial Signaling



Gut Changes in Depression
(Dysbiosis, Inflammation, Altered Metabolites)

How Gut Health Can Influence Depression

- Microbial metabolites (e.g., SCFAs, tryptophan metabolites)
- Inflammatory cytokines (IL-1β, IL-6, TNF-α)
- Increased intestinal permeability ("leaky gut")
- Altered vagal nerve signaling
- Changes in tryptophan metabolism (serotonin pathway)

Clinical Implications

- ✓ Depression is a systemic disorder involving the gut–brain axis.
- ✓ Supporting gut health may complement traditional treatments.
- ✓ Diet, probiotics, exercise, and stress reduction may help.

Potential Mechanisms Linking Gut Health and Depression

- Inflammation and immune activation
- Altered neurotransmitter production (e.g., serotonin, GABA)
- Reduced SCFA production (e.g., butyrate)
- HPA axis dysregulation (cortisol)
- Changes in neuroplasticity and brain-derived neurotrophic factor (BDNF)

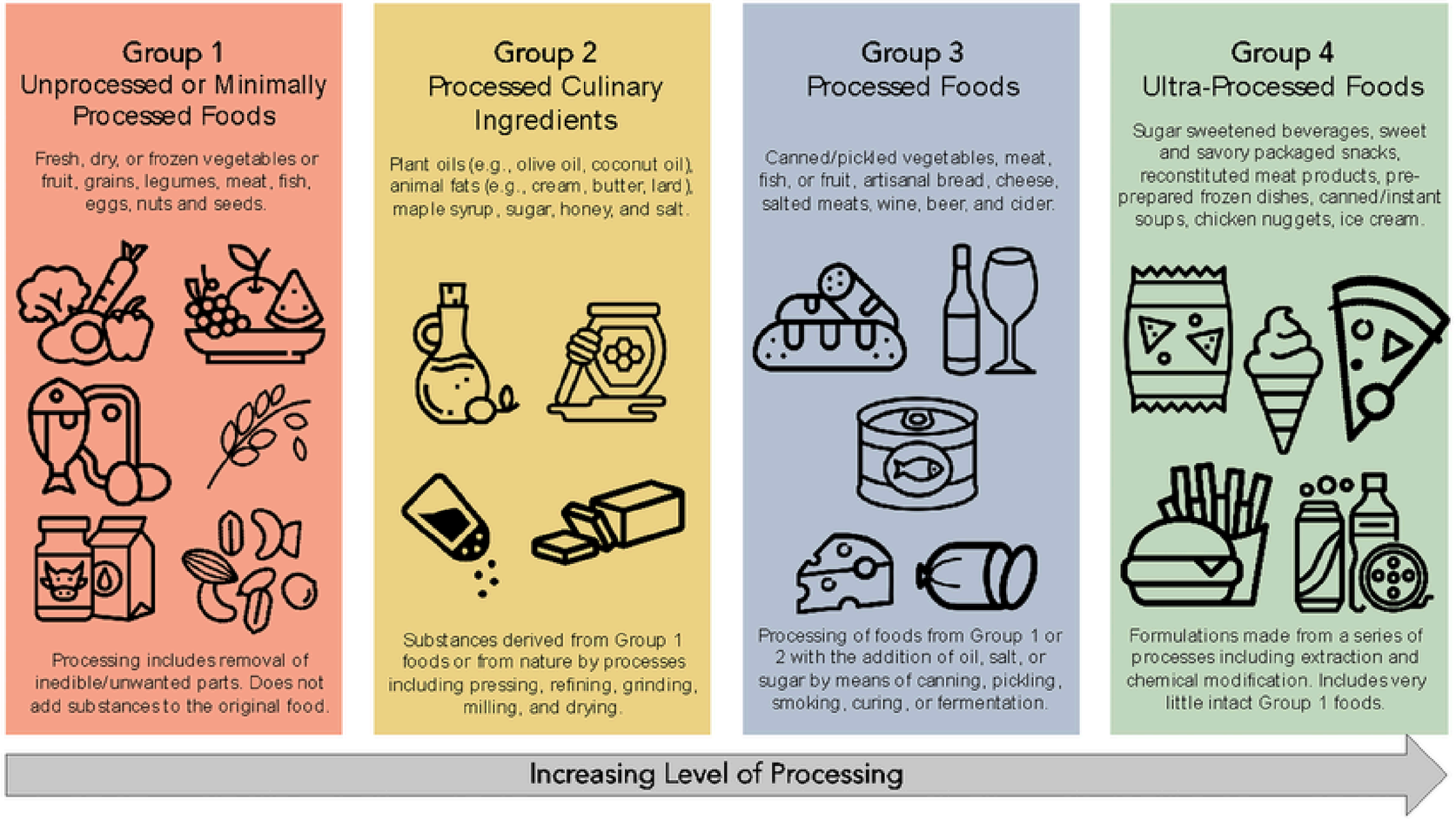
The Gut–Brain Axis Across Neuropsychiatric Disorders

Disorder	Potential gut–brain mechanisms	Psychiatric or neurological implications
Major Depressive Disorder	Altered microbial diversity; reduced short-chain fatty acid (SCFA) production; inflammation; altered tryptophan metabolism; HPA-axis dysregulation	May influence mood regulation, stress response, neuroinflammation, and neurotransmitter-related pathways
Anxiety Disorders	Changes in microbial metabolites; altered vagal signaling; intestinal permeability; immune activation; HPA-axis dysregulation	May contribute to heightened stress reactivity, autonomic arousal, and anxiety-related behaviors
Bipolar Disorder	Reported microbiome differences; inflammatory signaling; altered microbial metabolites; possible medication-related microbiome changes	May be associated with mood regulation and inflammatory processes; findings remain preliminary
Schizophrenia	Gut microbial changes; immune activation; altered intestinal barrier function; tryptophan–kynurenine pathway changes; microbial metabolite signaling	Potential links to neuroinflammation, neurotransmitter pathways, and cognitive symptoms
Autism Spectrum Disorder	Differences in gut microbial composition; altered microbial metabolites; gastrointestinal symptoms; immune and intestinal barrier signaling	Possible relationships with gastrointestinal symptoms, behavior, and neurodevelopment; causality is not established
ADHD	Emerging evidence of microbiome differences; altered microbial metabolites; inflammatory and metabolic signaling	Potential influence on attention, behavior, and neurodevelopment; evidence is limited and inconsistent
Parkinson's Disease	Gut dysbiosis; intestinal inflammation; altered intestinal permeability; enteric nervous system and alpha-synuclein pathways; possible vagal involvement	Gastrointestinal dysfunction may precede motor symptoms; gut-related mechanisms may contribute to disease development in a subset of patients

Ultra-Processed Foods: NOVA Classification

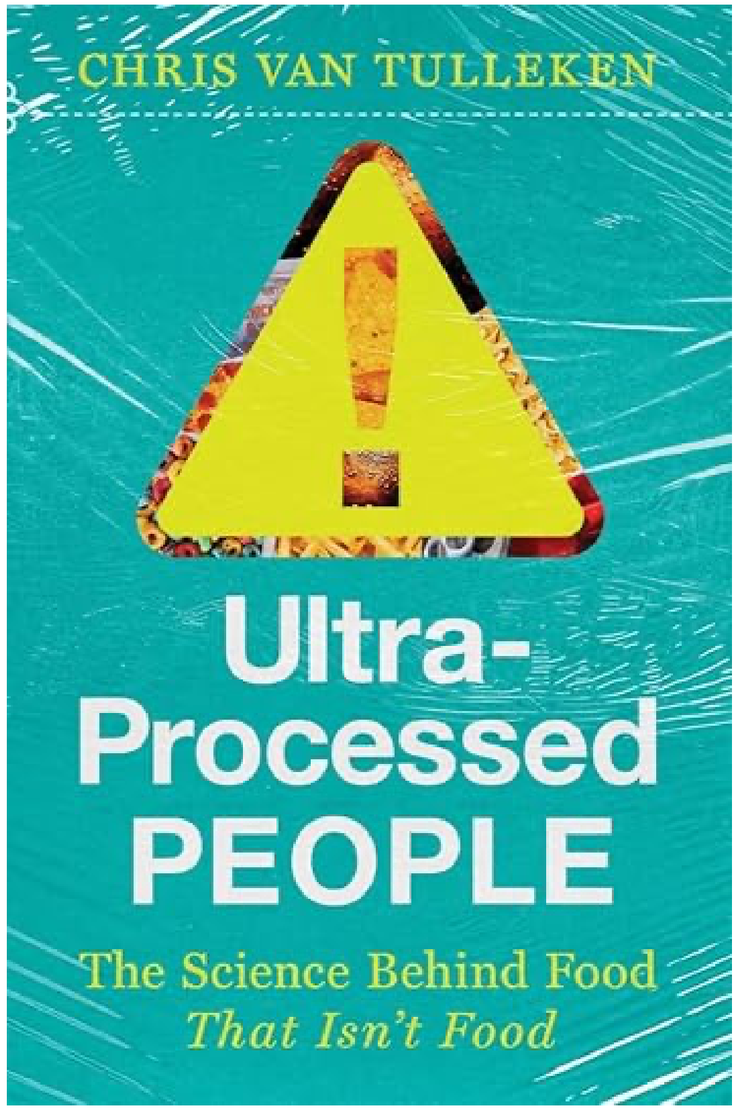
Industrial formulations containing:

- Refined starches
- Added sugars
- Emulsifiers
- Artificial flavorings and colorings
- Stabilizers and preservatives



Ultra-Processed People

- “The secret to…ultra-processed ice creams, like all UPFs, is that they are constructed from the cheapest possible versions of those three essential molecules: fats, proteins, and carbs.”
- Ingredients often made from commodity crops
- Often less nutritious



Ultra-Processed Foods

- Became more widespread in the 1950s
- Up to 60% of adult caloric intake in U.S., Canada, and the U.K.
- Disproportionate exposure in lower-income populations
- Increasing globally



Psychiatric Impacts of UPFs

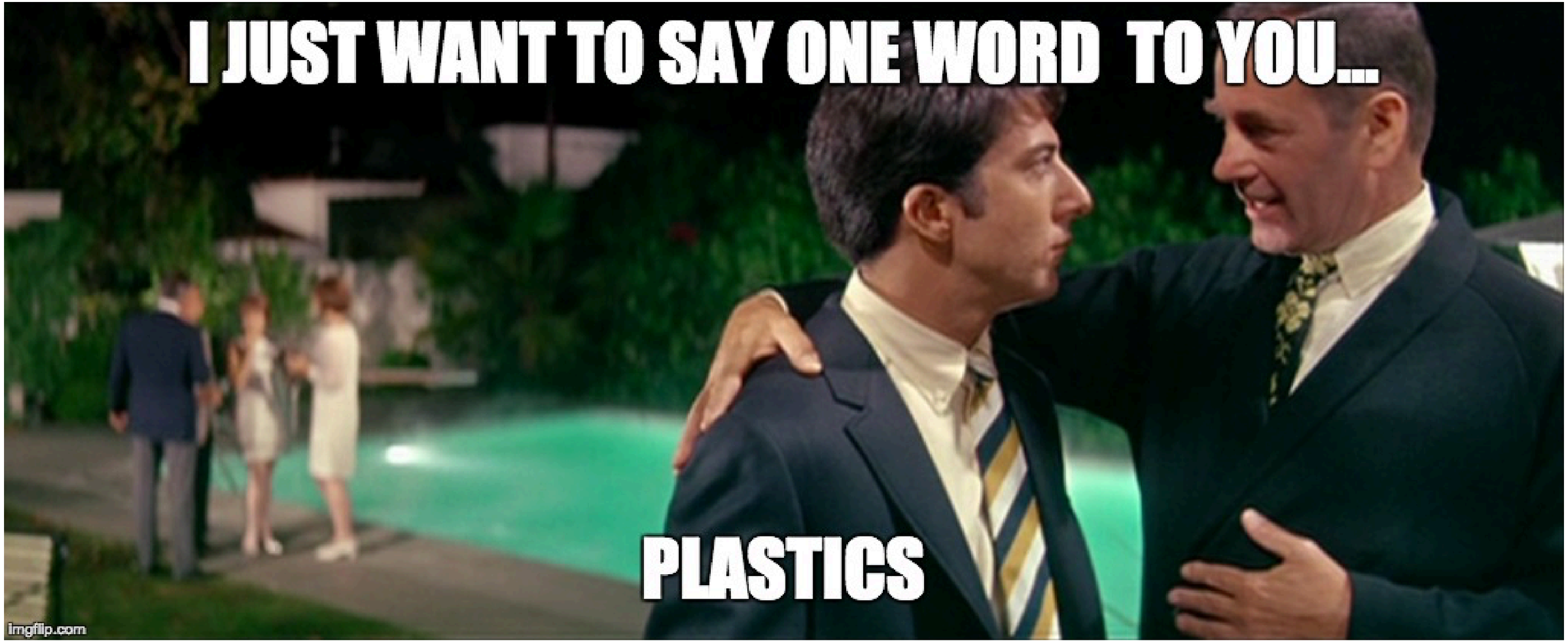
Associations between increasing UPF intake and:

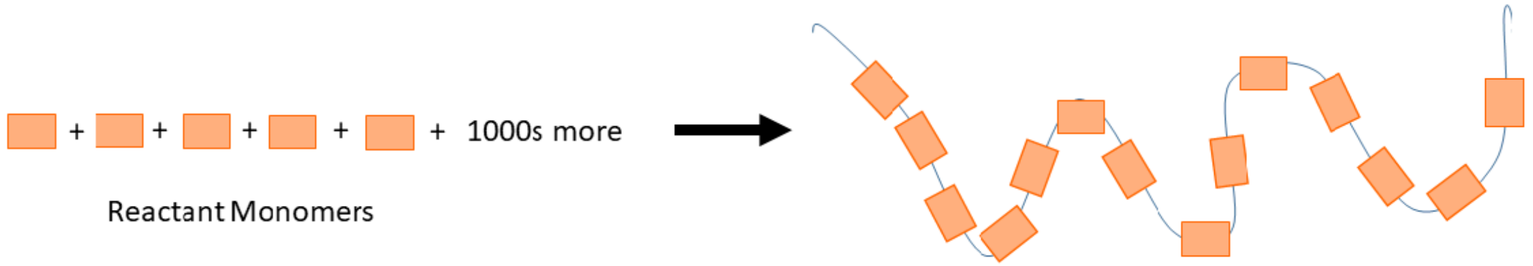
- Depression
- Anxiety
- Cognitive decline
- Behavioral and emotional symptoms in early childhood

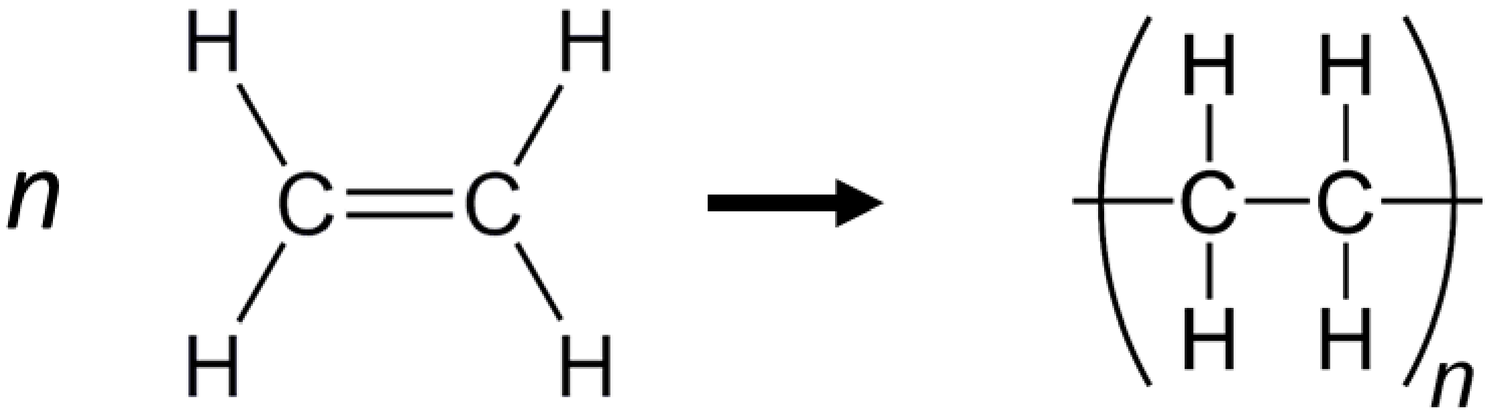
- Dietary improvement → symptom reduction
- Overall dietary patterns more predictive than isolated nutrients

Potential Mechanisms

- Microbiome disruption
- Increased intestinal permeability
- Chronic low-grade inflammation
- Glycemic instability
- Reduced nutrient density


I JUST WANT TO SAY ONE WORD TO YOU...
PLASTICS
imgflip.com





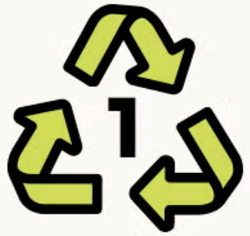
Ethylene Monomer

Polyethylene Chain

n = many

https://tmkorter.expressions.syr.edu

PLASTIC RECYCLING SYMBOLS



PET
(POLYETHYLENE TEREPHTHALATE)

COSMETIC CONTAINERS
PLASTIC BOTTLES
MOUTHWASH BOTTLES
PREPARED FOOD TRAYS



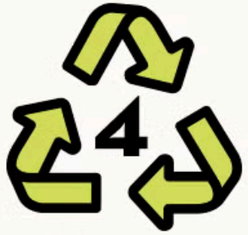
HDPE
(HIGH DENSITY POLYETHYLENE)

DETERGENT BOTTLES
GROCERY BAGS
MILK BOTTLES
SHAMPOO BOTTLES



PVC
(POLYVINYL CHLORIDE)

GARDEN HOSE
WINDOW FRAMES
BLOOD BAGS
BLISTER PACKS



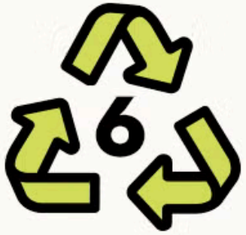
LDPE
(LOW DENSITY POLYETHLYENE)

6 PACK RINGS
CLING FILM
BREAD BAGS
SQUEEZBLE BOTTLES



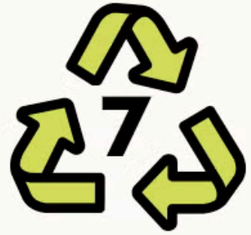
PP
(POLYPROPYLENE)

YOGURT CONTAINERS
MEDICINE BOTTLES
CAPS
STRAWS



PS
(POLYSTYRENE)

DISPOSABLE PLATES AND CUPS
EGG CARTONS
MEAT TRAYS
TAKE-OUT CONTAINERS



OTHER

SUNGLASSES
NYLON
BULLETPROOF MATERIALS
3 AND 5 GALLON WATER BOTTLES

r/PlasticFreeLiving

Create Post | Joined

Best

Community highlights

Compilation for brands with (truly) plastic-free products
48 votes • 36 comments

u/bluglass21 • 2 days ago

Friday night hoji-cha- plastic free tea bags!

r/tea • 2 days ago

Friday night hoji-cha



Live with Less Plastic
A community dedicated to reducing plastic in our everyday lives.

Created Oct 26, 2019
Public

110K Weekly visitors
1.2K Weekly contributions

COMMUNITY BOOKMARKS

- Wiki
- Plastic-Free Items
- Getting Started

R/PLASTICFREELIVING RULES

1. Keep posts relevant

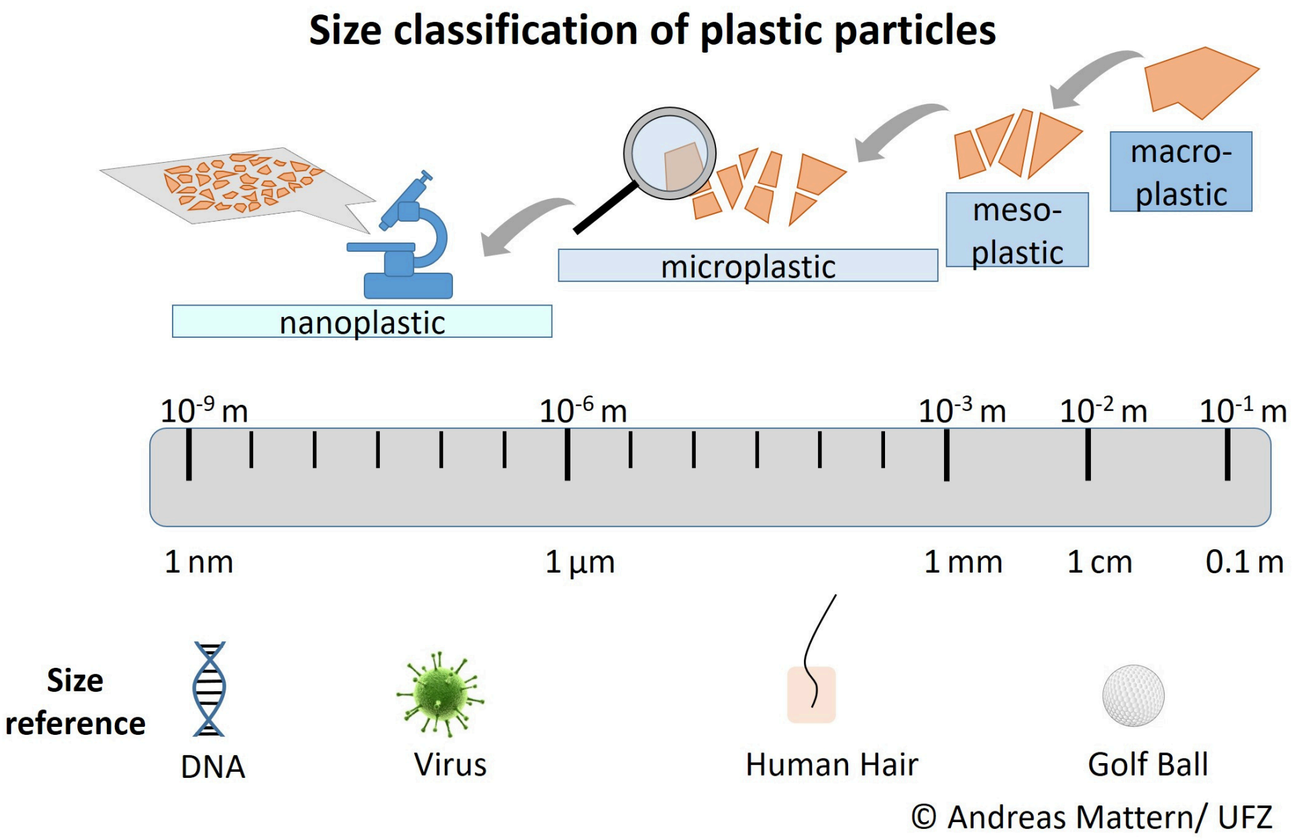
   This is a place to discuss alternatives to plastic products, using less plastic, and the effects of plastics on the environment or our health.

2. Be civil, kind, and respectful

   We don't tolerate shaming, non-constructive criticism, or otherwise hateful speech. Remember that plastic-free living can mean different things to different people.

Plastic-Associated Exposures

- Bisphenol A (BPA)
- Phthalates
- PFAS (“forever chemicals”)
- Microplastics and Nanoplastics



Impacts on the Body

- Endocrine disruption
- Immune activation
- Oxidative stress
- Possible impacts on mood, cognition, and behavior

Evidence Linking Plastic Eposure to Mental Health

Areas of emerging evidence:

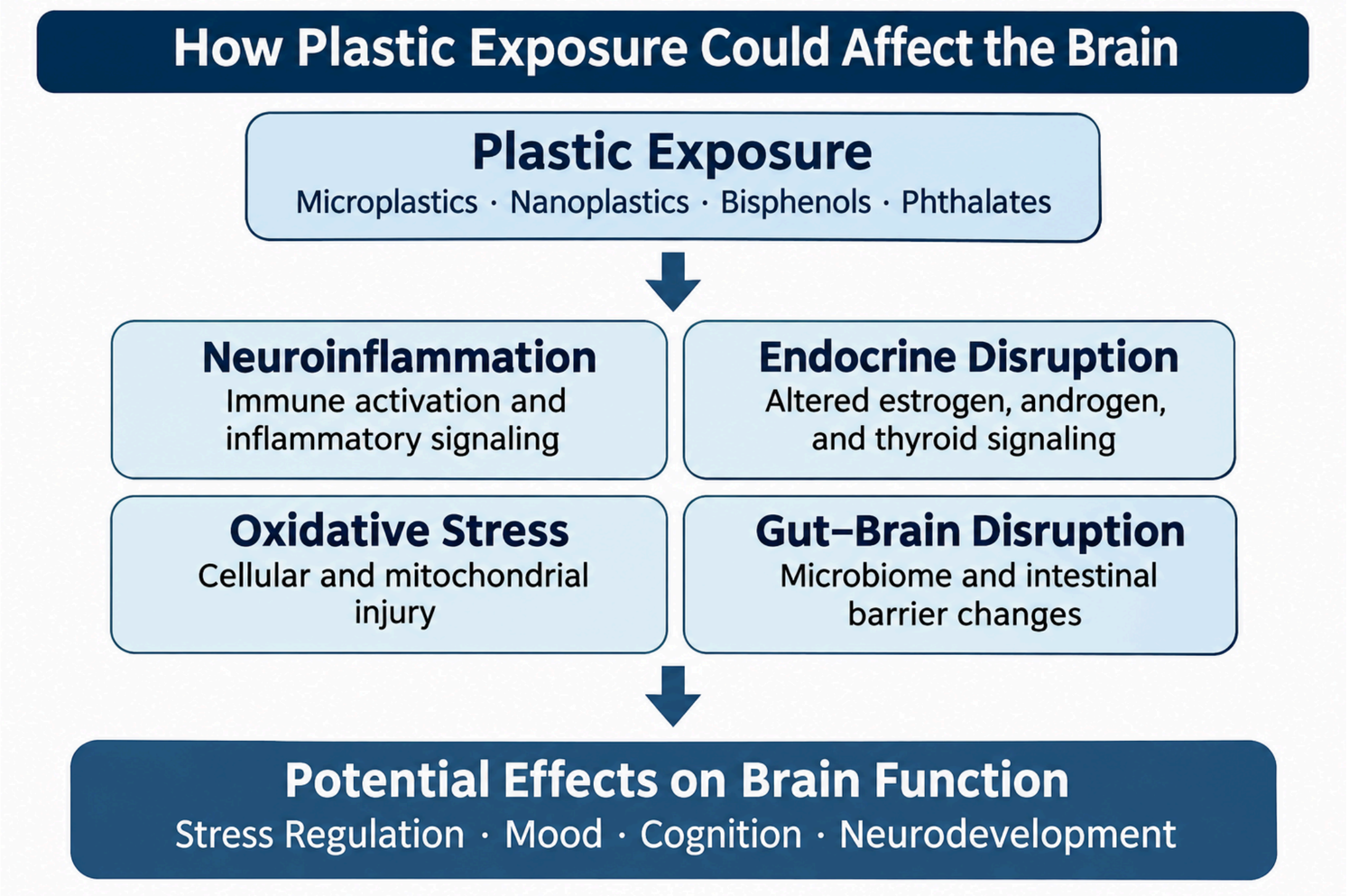
- Anxiety
- Depression
- ADHD-related symptoms
- Neurodegenerative disorders
- Cognitive effects

Limitations:

- Correlation-heavy literature
- Exposure measurement challenges
- Difficulty isolating causality

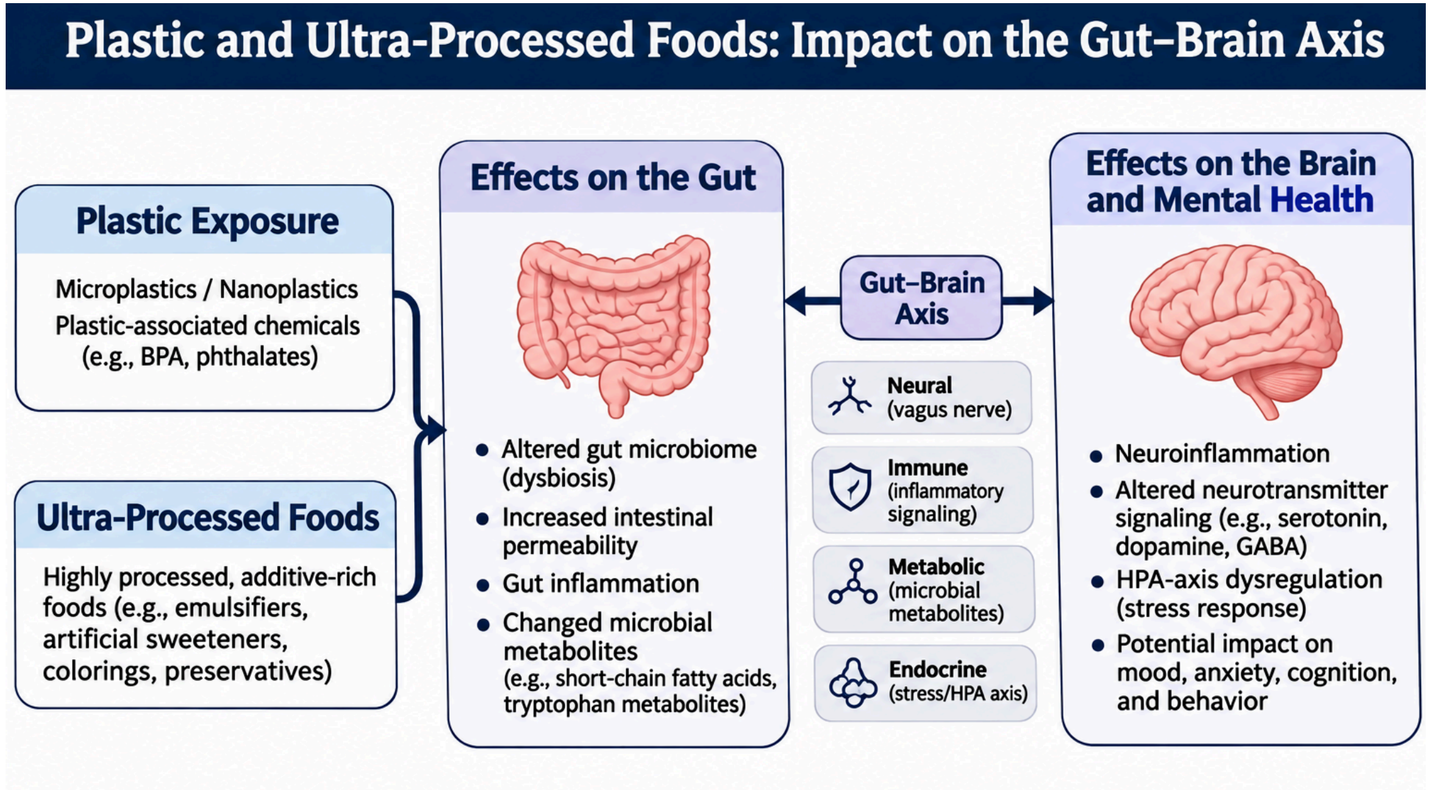
Potential Mechanisms

- BPA: serotonin, systemic inflammation
- Phthalates: dysbiosis, intestinal inflammation
- PFAS: dysbiosis, neuroimflammation
- MNPs: dysbiosis, neuroinflammation



Converging Pathways

- UPF and plastic exposures are not independent
- They share negative impacts on the GBA through:
  - Gut dysbiosis
  - Gut barrier dysfunction
  - Systemic and neuroinflammation



Evidence-Informed Interventions

- Discourage use of plastic for hot food storage and for food heating purposes
- Reduce packaged food exposure where feasible
- Incrementally increase minimally processed foods
- Increase dietary fiber (plentiful in many whole foods) and fermented foods such as kimchi, yogurt, and sauerkraut
- Support Mediterranean-style dietary patterns
- Collaborate with registered dietitians as needed
- Promote sleep, exercise, stress reduction
- Use water filters that remove MNPs; avoid bottled water
- Reduce exposure to household dust (wet cleaning, HEPA vacuum)

What About Removal?

- Micro- and Nanoplastics:
  - Chitosan (tested in rats)
  - High fiber diet (tested in mice)
- PFAS:
  - Plasma or blood donation
  - Therapeutic phlebotomy
  - Cholestyramine
  - High fiber/high folate diet, exercise

Health Inequities

- Food deserts
  - Access to whole foods varies
  - Food preparation capacities vary
  - UPFs often cheaper, more available, easier to prepare
- Environmental injustice
- Disparities in exposure burden


The
Precautionary
Principle

Future directions

- Close the FDA's "Generally Regarded as Safe" loophole
- Legislation:
  - Microplastics Safety Act
  - Fighting Fibers Act
  - Farewell to Foam Act
- Research:
  - Longitudinal human studies
  - Human RCTs

Summary

- The gut–brain axis offers a biologically plausible framework linking environmental exposures and mental health.
- Ultra-processed foods and plastic-associated chemicals may contribute to psychiatric symptoms through inflammatory, endocrine, immune, and microbiome-mediated pathways.
- Evidence is evolving and should be interpreted cautiously.
- There are steps that can be take to reduce exposure to UPFs and plastics, and possibly to remove plastics from the body.

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