# How Thermal Degradation in Take-Out Containers Leads to Cognitive Decline

Saindhavi Jawahar

## Introduction

In our fast-paced 21st century society, the modern food industry utilizes single-use plastics to prioritize customer convenience, saving both time and money. The hidden tax of this well-known convenience is none other than our cognitive abilities and mental wellbeing. According to a global study, individuals who used plastic containers on a daily basis, were found to have a Mind Health Quotient (MHQ) score approximately 25 points lower in comparison to those who used plastic containers less frequently (Sapien Labs, 2022). This profound baseline decline in cognitive indicators is heavily supported by broader demographic analyses tracking environmental pollutant exposures (Galloway et al., 2017; Landrigan et al., 2020). Regardless of economic development, this issue persists across the globe -spanning from major metropolitan hubs like New York to developing regions such as Thailand. This issue highlights a paradigm of contemporary society: favoring short-term convenience at the expense of long-term neurological capabilities.

## Thermal Stress & Acidity

Food containers are traditionally made using numerous chemical components, such as Bisphenol A (BPA) and Di(2-ethylhexyl) phthalate, to make the material more flexible. Even if their quantity is low in packaging, upon consumption, their concentration increases to levels that could be detrimental to normal human functionality (National Institutes of Health [NIH], 2020). Upon exposure to heat or acidic substances—such as sauce or dressing—the intermolecular forces holding these chemical additives within the polymer matrix weaken. Heat acts as kinetic energy and causes the atoms in the plastic container to vibrate intensely. Moderate heat can then easily disrupt these secondary bonds, causing thermoplastic to warp or melt through thermal degradation. Acidity works via a similar degradation pathway. Thermodynamic and kinetic modeling confirms that polymer lattice breakdown accelerates significantly under combined thermal and low-pH conditions (Wong et al., 2018). Whether it is using a plastic container to reheat leftovers or transporting hot takeout food from a restaurant, the leaching of chemical molecules occurs instantaneously. BPA and other chemicals—which are known as endocrine disruptors—can play the role of hormones and disrupt actual hormone production (Center for Research, 2021; Rochester & Bolden, 2015).

## Microplastics & Nanoplastics

There are three main mechanisms by which such micro- and nanoplastics (MNPs) are able to enter our bodies: oral ingestion, inhalation, and skin contact (Practical Neurology, 2023). The effect they have on neurological processes depends entirely on how close they get to the Central Nervous System (CNS). In order to do this, there are two options: crossing the blood-brain barrier or bypassing it entirely. The blood-brain barrier is a semi-permeable membrane consisting of endothelial cells, astrocytes, and pericytes that all work together to protect the CNS. When micro- and nanoplastics enter through ingestion, they have the capability to penetrate the intestinal linings and thus enter the bloodstream. Then, they can pass through the barrier using receptor-mediated endocytosis, facilitated by a biomolecular corona of native proteins, or by physically loosening the cells. Synthetic polymer structures have an established affinity for interacting directly with cellular lipid bilayers, forcing active transport mechanisms (Kannan & Vimalkumar, 2021; Mattsson et al., 2018). In fact, new research conducted using animal models revealed that entry through ingestion is possible and highly likely to result in passing through the blood-brain barrier (NIH, 2023; Schwabl et al., 2019). However, inhalation opens up a different perspective. These particles of plastic directly enter the nasal olfactory epithelium. This method is dangerously effective since it immediately takes the particles into the olfactory bulb of the brain, completely evading systemic circulation barriers (Prüst et al., 2020). Consequently, numerous researchers believe that microplastics and nanoplastics could be linked to degenerative neurological diseases such as dementia or Alzheimer's.

**Cognitive Decline**

Researchers at the University of New Mexico have found that the concentration of MNPs in the human brain has almost increased by 50% just over the past 8 years (University of New Mexico [UNM], 2024). Patients with dementia appeared to have a higher concentration, however it's unsure which action caused the other. Once in the brain, micro- and nanoplastics trigger neuroinflammation due to pressuring the brain's immune cells into a constant state of attack. This releases oxidative stress and damages existing neurological pathways and surrounding neurons. Chronic glial cell overactivation is highly documented as a primary trigger for rapid neurodegenerative decay (Colonna & Brioschi, 2020). Furthermore, MNPs can infiltrate a cell's mitochondria, reducing energy production below the standard requirement for basic brain function. Consequently, this weakens the synapses between nerve cells -causing frequent memory loss and making it harder to process newer information. Cellular bioenergetic failures consistently impair down-stream synaptic plasticity and structural signaling (Trigo et al., 2022). Micro-and nanoplastics could also act as catalysts that accelerate the creation of toxic clumps and plaques in the brain and further cause progressive dementia. A study done in Thailand using 509 participants revealed that microplastic consumption does truly have an underlying link with the risk of developing Alzheimer's (International Journal of Creative Research Thoughts [IJCRT], 2022). The plastic in our landfills is now accumulating in our brain and resulting in cognitive decline, potential risk of neurological conditions, and worsening memory loss.

**Conclusion**

An ordinary, everyday choice, such as ordering hot takeout delivered in a plastic container, can cause a ripple effect that ultimately compromises long-term neurological health. Younger adults nowadays tend to construct their daily routines around the convenience of food delivery applications -without realizing the potential degradation of their cognitive capabilities. Eliminating plastic waste entirely remains impractical; therefore, the best approach to this global issue lies in the hands of the commercial food industry. Businesses and restaurants must learn to adopt biocompatible packaging that prevents the creation of neurotoxic nanoparticles when exposed to heat or acidity. Meanwhile, neurosurgeons of the future need to accurately evaluate patients by taking into account social determinants of health, consumption patterns, and environmental pollutants. The first step toward prioritizing long-term neurological power over short-term convenience could be achieved by a deliberate choice you make tomorrow.

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