

Much of this lecture relies on data presented in the excellent recent book by my colleague and friend Caleb Finch.



Bush fire in Tanzania, these are set by people every year towards the end of the dry season. Most trees survives and grass quickly grows back. Humans have been setting landscape fire such as these for tens of thousands of years.

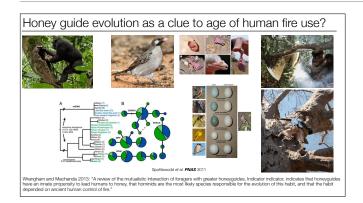


Some major Pleistocene sites with traces of fire. Following earliest traces at Koobi Fora and Chesowanja, ca 1.5 Ma,

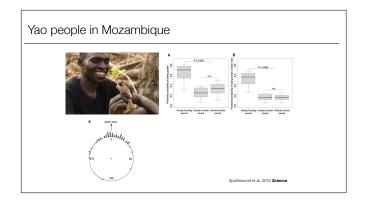
Europe/Mediterranean, 400 000 years onward; southern African: ca 0.5 Ma onwards. In the Far East, Zhoukoudian (ca 0.7 Ma) is followed by other sites with fire traces.



Hadza man (named Janjako) making a friction fire to light a cigarette



Mitochondrial and nuclear DNA relationships among honeyguides using different host species. (A) Mitochondrial phylogeny based on partial 12SrRNA gene sequences. Genetic divergence for the ND2 gene was measured for a representative sample of individuals with divergent 12S sequences. The lineages that interact with humans diverged from those not interacting about 2 million years ago. Interaction with humans is contingent on humans using fire to harvest bee hives......does this indicate that human fire use is 2 million years old??



(A) A Yao honey-hunter and a wild, free-living honeyguide. (This bird was captured using a researcher's mist-net and is neither tame nor habitually captive.) (B) Accuracy of honeyguide initial guiding behavior in relation to direction of successfully located bees' nests. Points represent the difference in bearing between initial guiding trajectory over the first 40 m of travel and the ultimate direction of the bees' nest (here set at 0) and are binned into 5° intervals. Each point represents a journey (n = 58 journeys) to a separate bees' nest that was at least 80 m away from the point where guiding began. Sometimes a honeyguide led humans to more than one nest consecutively (n = 50 guiding events). The circular distribution is unimodal (Rayleigh test, P <

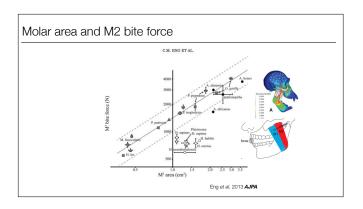


Greater honey guide (Indicator indicator) on a baobab tree in Southern Tanzania, Lake Eyasi region.



brief cooking allows pealing, detoxifies anti-nutrients and gelatinizes starch

Eating cooked tubers would not impact teeth with grit from the soil, as pealing is easy after cooking, also nutrients are more accessible and toxins largely detoxified...



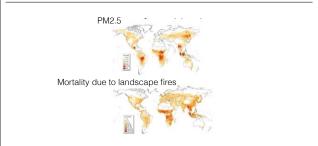
Compared to other primates, humans and our extinct relatives have remarkably low bite force!Logarithmic plot of M2 molar area and M2 bite force. Bite forces have been calculated from skeletal data and estimates of jaw muscle architecture, and related to actual measurements in modern humans and nonhuman primates. Note that the human difference from other primates preceded the dates of well documented use of cooking.





Unburnt and burnt savannah grass land in souther Tanzania kitchen in fiel research Camp in Tanzania, open fire kitchens generate much smoke.

Landscape (biomass) fires and attributed mortality



Landscape (biomass) fires and attributed mortality

A. PM2.5, 1997-2006; geosatellite images were filtered to exclude PM2.5 from fossil fuels and natural dust.

B. Global mortality attributed to landscape fires (Johnston et al 2012).



Tobacco was adopted as a mind-altering and symbolic plant by mat native American cultures. It became the first globally traded good.



Tobacco adds have worked to get the majority of US citizens to smoke. Anti-Tobacco adds are equally effective.

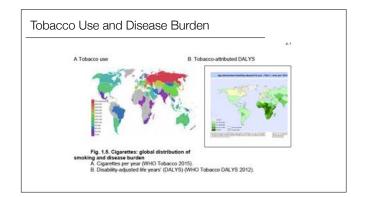
Edward Bernays, Sigmund Freud's nephew was one of the inventor of mass marketing and was instrumental in launching the "independent women smoke" meme that is working still today....Over 6 million directly tobacco related deaths each year globally.



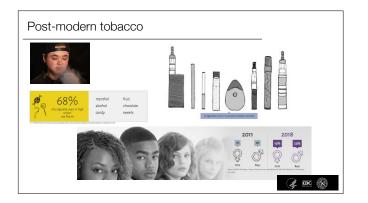
Tobacco adds on TV and Radio were banned in the USA in the year 1971. In 2009, The Family Smoking Prevention and Tobacco Control Act, which granted the Food and Drug Administration (FDA) the authority to regulate tobacco products, included the authority to regulate some of the industry's marketing practices. The act banned the use of vending machines and product sampling (except in adult-only facilities), and it restricted the sale of tobacco in retail establishments to face-to-face transactions between retailers and consumers. It also expanded the existing limits on tobacco brand sponsorships and tobacco branding of non-tobacco items.



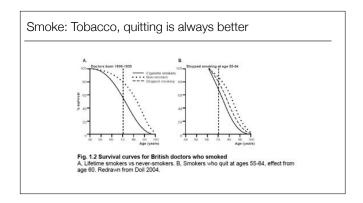
The price of a pack of Marlboro around the world. Higher prices often are due to more taxation, which is proven to reduce cigarette consumption.



Massive Disease Burden of tobacco use, an entirely cultural phenomenon.....The "epitomy of human made disease"



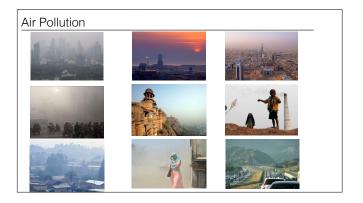
Targeting the next generation of nicotine addicts



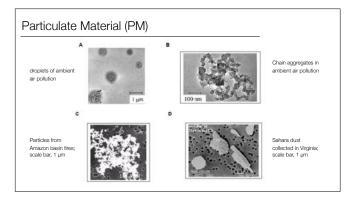
Lower survival in smokers, even quitting late in life is associated with higher survival.

A small fraction of humans appear remarkably unaffected by cigarette smoking, for unexplained reasons.

Could these individuals reflect a potential biological adaptation to smoke toxicity?

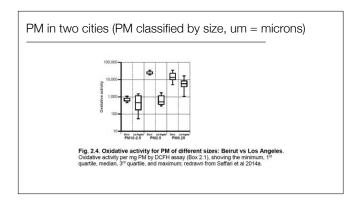


Air pollution in Bangkok, Saudi Arabia, China, India. Cameroon, Bangladesh and on I-5 in Los Angeles.



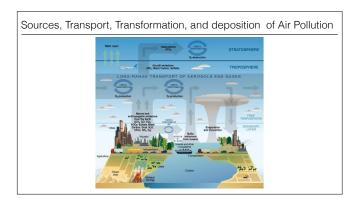
Airborne ultrafine particles under the electron microscope.

A, Aggregates in droplets of ambient air pollution (Los Angeles CA, UCLA site) (Xiong and Friedlander, 2001). B, Chain aggregates in ambient air pollution (San Jacinto CA, AQMD site) (Xiong and Friedlander, 2001). C, Particles from Amazon basin fires; scale bar, 1 μ m (Smog Blog, June 5 2005). D, Sahara dust collected in Virginia; scale bar, 1 μ m (Smog 324 Blog, June 5 2005).

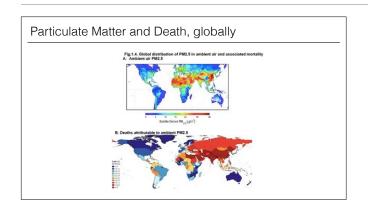


Particulate matter in Beirut and LA.

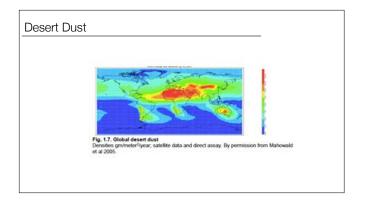
Midium size PM (2.5 microns) is much higher in Beirut reflecting diesel exhaust under low stringency air quality standards.



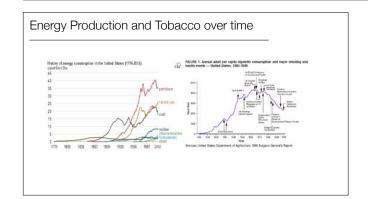
Smoke pollutants are generated by fires, engines and cigarettes. The compounds reach the atmosphere where they can react and combine. They then rain deposit on land and water and reach all living things.



2.5 micron particulate matter in polluted air and human mortality globally



The health consequences of dust storms are less clear than for smog surges. Goudie (2014) summarizes the mixed reports: while cardiovascular admissions and deaths increased during dust days in some cities (Barcelona, Nagasaki, Rome) in proportion to PM10, other cities with similar levels did not show these associations. Some studies considered that dust of crustal origin was 20% as toxic as carbonaceous PM2.5 (Lelieveld et al 2015). Another model of dust and premature mortality assumed that background dust of 7.5 μ g/m3 "does not have negative effects on human health" (Giannadaki et al 2014). In contrast, no safe lower limit is recognized for particles from burning of fossil fuels or tobacco. Because of these uncertainties, estimates of dust-related mortality are not



Changes in energy production by fuel type and changes in USA cigarette consumption

Three smokes

- 1. biomass burning in household smoke
- 2. cigarettes
- ambient air pollution caused by hydrocarbon emission from industry and traffic

No other living species exposes itself to such levels of smoke!

Mortality from Airborne Toxins

Annual excess mortality, millions
Ambient air pollution (AAP)
4.2 (Cohen et al 2017)
Household air pollution (HAP)
4.3 (WHO Indoor AP, 2017)
(Eigenette smoke.

Direct
5 6.4 (68D Tobacco Collaborators)
6.5 Total from airborne toxins of human origin
15.15 million
15.15 million

A side effect from all our burning: over 15 million extra human deaths yearly.

Particulate Material (PM)

Table 1.2: Global Aerosols by Size and Source

	PM<25 um	PM<1 um	
NATURAL	megatons/year		
Landscape fires	5-50	2-75	
Volcanoes	4-10,000	0.4-100	
Sea spray	1,000-10,000	20-100	
Erosion	1,000-3,000	300	
MAN-MADE	20.000		
Industrial	40-130	20-60	
Fossil fuels	5-25	5-25	
Biomass burning & Household air pollution	50-190	50-190	

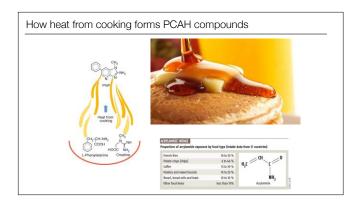
PM, particulate material; the number represents its diameter in microns.

Adapted from Kreidenweis et al 1999, Table 4.1 and Sternberg et al 2015 Table 8.2.

Particulate Material (PM) and how it deposits into our bodies

PM size classes, diameter ¹	U.S. EPA standards, 2012	WHO standards	Body deposition
Coarse: PM10µ	150 µg/m ³ ; 24 h av,	20 μg/m³, ann av	head-thorax airways:
	not exceeded once/y	50 μg/m³, 24 h av	nose, mouth, throat, and beyond larynx
Fine: PM2.5µ,	12 μg/m³; 3 y av	10 μg/m³, ann av	lung, alveoli (respirable fraction);
('accumulation mode')		25 μg/m³, 24 h av	brain ³
Ultrafine: PMO 111	Panding ⁴		lung aluaoli: brain ³

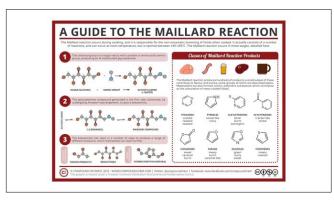
The PM size classes recognized by EPA are defined by size-filters with 50% efficiency for retaining PM of each aerodynamic diameter in microns (micrometers). 2, Coarse PM is mostly trapped in the upper airways. 3, Ultrafine PM can enter the brain by olfactory neuron transport in minor amounts (Chapter 2.7). 4, No standards have been established for PM0.1. The EPA guidelines on PM by size class are scheduled for review in 2017-8 (U.S. EPA, 2016). However, this size class was not mentioned in the most recent EPA document on National Ambient Air Quality Standards of April 28 2017. WHO Air Quality Guidelines - global update 2005.



Heating organic matter (including food) will cause the formation of polycyclic aromatic hydrocarbons.

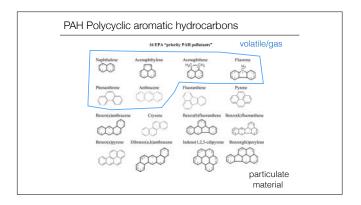
These tend to be colorful ranging from yellow to brown to black. They also can be very tasteful.

The Maillard Browning reaction can also create acrylamide, less tasty but more carcinogenic.....most roasted foods including drinks like coffee (roasted coffee beans) and beer (roasted malted grain) contain some....



Maillard Reaction named after a French chemist is one of the sources of all good flavors.... Sugar reacts with amino groups of amino acids in proteins and generates browning reaction products, many of them very flavorful, not all healthy. Our bodies also slowly brown, even under much lower temperature than cooking. The products are called advanced glycation end products (ACE). The higher levels of glucose in diabetics increase the formation of ACE, with detrimental health effects.

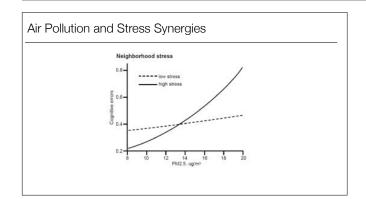
Caramelization in contrast is a form of pyrolysis, as the disaccharide sucrose falls apart into glucose and fructose and these two sugars then form a large number of further compounds.



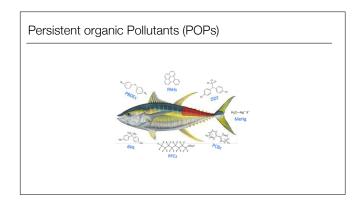
First recognized as carcinogens, the single ring aromatic and multiple-ring (polycyclic) aromatic hydrocarbons (PAH) have expanding roles as environmental toxins. The examples below show their ratings by the International Agency for Research on Cancer (IARC). All are proven carcinogens in animals, with further qualifications as: IARC 1, definite human carcinogens and IARC 2A-B, probable to possible human carcinogens. Hundreds of different PAHs are found in cigarette smoke and ambient air pollution, which mainly form from the incomplete combustion of organic materials. By their chemical nature as hydrocarbons, the PAH have very low solubility in water (WIOC). PAH are further classified by volatility, which, like solubility, decreases sharply above 3-rings. Thus, 2-and 3-ring PAHs are mostly in the gas phase, while 4-6 ring PAH are mostly in PM. The main PAH sources are traffic emissions, biomass (wood and garbage), grilled and smoked meats, chemical industry, and cigarette smoke. Some PAHs also arise directly from evaporation of petroleum products. After inhalation or ingestion, PAH are oxidized to water soluble forms (WSOC) by detoxifying enzymes including cytochromes CYP1A1, which are controlled by the aryl hydrocarbon receptor (ArH) and by other detoxifying systems regulated transcriptionally by Nrf2. BaP and other PAH also interact with estrogen receptors. Their broad pathophysiological effects include asthma, obesity, and impaired brain development.

Effects of polycyclic aromatic hydrocarbons (PAH) on the developing brain.

Effects of polycyclic aromatic hydrocarbons (PAH) on the developing brain. A powerful relationship between prenatal polycyclic aromatic hydrocarbon (PAH) exposure and disturbances in parts of the brain that support information processing and behavioral control have been identified by researchers. The study showed reductions in nearly the entire white matter surface of the brain's left hemisphere -- loss associated with slower processing of information during intelligence testing and more severe behavioral problems, including ADHD and aggression Frederica Perera et al. Effects of Prenatal Exposure to Air Pollutants (Polycyclic Aromatic Hydrocarbons) on the Development of Brain White Matter, Cognition, and Behavior in Later Childhood. JAMA Psychiatry, March 2015. The study showed reductions in nearly the entire white matter surface of the brain's left hemisphere -- loss associated with slower processing of information during intelligence testing and more severe behavioral problems, including ADHD and aggression. Postnatal PAH exposure -- measured at age 5 -- was found to contribute to additional disturbances in development of white matter in the dorsal prefrontal region of the brain, which is associated with concentration, reasoning, judgment, and problem-solving ability.



Particulate matter pollution and stress synergies, if stress and pollution co-exist, these exacerbate each other.



Persistent organic pollutants (POPs) are characterized by endurance in the environment and resistance to elimination by organisms. This refractory behavior leads to their bioaccumulation, and the detection of numerous environmental pollutants in fish and seafood as well as humans. Many, including organochlorine pesticides (OCP), polychlorinated biphenyls (PCB), polybrominated diphenyl ethers (PBDE), polycyclic aromatic hydrocarbons (PAHs), perfluorochemicals (PFCs), and methyl mercury (MeHg) have been flagged as potential health hazards.

Human Lifespan: opportunity for pollutant effects? Generations 10² 10⁴ 10³ 10² 10⁴ 10³ 10² 10⁴ 10³ 10³ 10⁴ 10⁵ 10⁴ 10⁵ 1

Sketch of human life expectancy (LE) evolution, suggesting one or more intermediate stages of increasing LE from the shared ape ancestor. The chimpanzee LE can vary widely between sites and may approach the lower bounds of hunter-foragers (Wood et al 2017). Exposure to airborne particles includes East African dust from savannahs and domestic smoke. Early Homo LE are hypothesized to be intermediate between pre-industrial humans and the great apes, based on allometric calculations for body size lifespan relationships (Finch 2007). The life expectancy portion of the figure is adapted from Finch 2007.

Summary



Smoke is dangerous and damages health during all phases of life.

The three smokes are: burning biomass outdoors and indoors, air pollution from traffic and industry, cigarette smoke.

Harmful components of smoke are mainly microscopic particulate matter and polycyclic aromatic hydrocarbons.

PM and PAH can enter the body and damage various organs.

The effects of the three smokes are among the most important contributors to human made disease, with an estimated excess mortality of ~15 million deaths per year, globally

Humans may have started to biologically adapt to the bad health effects of smoke.

Technological solutions to smoke exist and need to be implemented globally.