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"Theory of Food" as a Neurocognitive Adaptation

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ABSTRACT Human adult cognition emerges over the course of development via the interaction of multiple critical neurocognitive networks. These networks evolved in response to various selection pressures, many of which were modified or intensified by the intellectual, technological, and sociocultural environments that arose in connection with the evolution of genus *Homo*. Networks related to language and theory of mind clearly play an important role in adult cognition. Given the critical importance of food to both basic survival and cultural interaction, a "theory of food" (analogous to theory of mind) may represent another complex network essential for normal cognition. I propose that theory of food evolved as an internal, cognitive representation of our diets in our minds. Like other complex cognitive abilities, it relies on complex and overlapping dedicated neural networks that develop in childhood under familial and cultural influences. Normative diets are analogous to first languages in that they are acquired without overt teaching; they are also difficult to change or modify once a critical period in development is passed. Theory of food suggests that cognitive activities related to food may be cognitive enhancers, which could have implications for maintaining healthy brain function in aging. Am. J. Hum. Biol. 24:123–129, 2012.

Normal human behavior depends on mastering a number of complex cognitive abilities that integrate multiple sensory, motor, perceptual, attentional, and experiential domains (Gazzaniga, 2000). Although these abilities are in many ways neurologically hard-wired, they typically emerge over a normative course of development in childhood. This development must occur in an environment that is at least minimally supportive of neurocognitive growth and maturation. The neural networks underlying these abilities that develop in childhood become the foundations for adult cognition. Although these cognitive abilities are remarkably complex, they become "second nature" once mastered. For example, compare the apparent ease with which people acquire their first language with the gear-grinding difficulty of second language learning that occurs after the critical developmental period during childhood.

Language development highlights a salient fact about these complex cognitive abilities in humans: they can be strongly influenced by the cultural environment. The neurocognitive biology of language, with its brain regions and networks dedicated to the production and perception of language, suggests that this ability is hard-wired and likely evolutionarily adaptive (Pinker, 1994). However, the specific languages that people speak are of course determined by the cultural environment. Furthermore, there is increasing evidence that language structure may have a deep-seated influence on cognition in myriad ways (Boroditsky, 2011). Although other complex cognitive activities are less obviously culturally or environmentally influenced, that does not mean that they are not shaped by the developmental context. Consider something as fundamental as walking. Although much of the neurological control of gait occurs at the subcortical level, the planning and organization of walking behavior is initiated in the frontal cortex (Sheridan and Hausdorff, 2007). The neurocognitive networks involved with walking are both hard-wired and shaped by the environment in which they are formed. The cultural component of that environment must make some contribution to the neurological development of gait control, even if it is relatively minor compared with other factors.

This article is not about walking and talking but about food and eating. I will argue that how humans "think" food—the neurocognitive underpinnings of how we go about deciding what is food and eating it—is similar in fundamental ways to these other complex cognitive activities. Like language, how people think about the food they acquire, process, and eat develops in a biologically normative way, but its final expression is significantly shaped by the cultural environment. In the same way that language is apparently effortless and naturally produced by human speakers, people typically have a "normal" diet that seems as natural as breathing. Only when a diet is changed by circumstance or choice does its deep-seated cognitive foundation become apparent.

In general, food is as important to human survival as reproduction, social behavior, or technological prowess. Since the hominin lineage split from the great apes, diet has clearly been a significant factor in the evolution of various hominin types. For example, one of the major branches of the hominin family tree, the robust australopithecines, was distinguished by a dental and cranial anatomy that likely represented an adaptation to a diet that was increasingly reliant on grasses and sedges, compared with a more typical ape-ish diet (Cerling et al., 2011; Sponheimer et al., 2006).

One of the early hominins that apparently did not go down this grassy path was ancestral to *Homo*, a genus

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characterized by dental reduction and increased brain size, among other traits. Changes in diet have long been hypothesized to have been of critical importance in the evolution of *Homo*, especially in terms of providing adequate nutrition to grow and support a large brain (Aiello and Wheeler, 1995; Allen, 2009). Increases in meat or marine resources or tubers have all been hypothesized to be critical factors in increasing the quality of the hominin diet (Crawford et al., 1999; Langdon, 2006; Milton, 2003). The development of technological skills important for procuring or preparing food has long been thought to have an important role in a positive feedback loop between technology and increased cognitive ability. For example, Wrangham (2009) has argued that cooking with fire was instrumental in increasing the quality of the hominin diet by making meat and certain plant foods more nutritionally accessible. Overall, the cognitive flexibility and adaptability that emerged concomitant with increased brain size contributed to an expansion or diversification of the diet of *Homo*, which in turn allowed for the migration to and settlement of a range of environments in the Old World (Ungar et al., 2006).

So whatever the precise nature of their contributions or influences, food and diet were obviously both generally and specifically critical for the evolution of human brain and behavior. The mind that emerged during this evolution was unique in its creative scope and intelligence (however defined); it constructed a sociocultural environment that was just as critical to shaping human adaptations as the ecological environment. Some of these adaptations, such as language, are essentially cognitive in nature, and thus the mind is both the shaper of and shaped by the biocultural, selective environment.

For humans, the dietary environment is also fundamentally shaped by the cultural and cognitive environments. Human diets, in all their variety, do not consist simply of the accessible, edible, and familiar but are the product of nutritional, cultural, and cognitive imperatives (see for example, Jones, 2007). The complexity of the human diet as a mental phenomenon suggests that like language and other complex cognitive abilities, mastering it requires a combination of implicit and explicit learning over the course of childhood development. I suggest that what emerges during this process is a cognitively unified perspective on diet—a "theory of food" (ToF)—that synthesizes a variety of mental processes, including those related to homeostatic monitoring, the senses, memory, emotion, and categorization (Allen, 2012).

THEORY OF FOOD IS ANALOGOUS TO THEORY OF MIND

Language provides one model of the kind of complex cognitive ability that may be represented by ToF. However, a better model may be found in the influential hypothesis known as "theory of mind" (ToM). Comparative psychologists David Premack and Guy Woodruff introduced the ToM concept in 1978 (Premack and Woodruff, 1978a,b). They were interested in comparing the cognition of chimpanzees and humans in terms of their ability to predict or estimate or impute the mental states of others. ToM provided them with a means of comparing cognition across these two species.

Premack and Woodruff argued that to be able to function in an interactive social group, especially one composed of such socially complex creatures as human beings, an individual needs to have an implicit theory about the mental states of others. Social actors need to be able to make judgments about the motives or veracity of the social actions of others. A more formal way of saying this is that people are "endowed with a representational system that captures the cognitive properties underlying behavior" (Leslie, 2000, p 1235). Premack and Woodruff said that the "theory" part of ToM is in recognition of that fact that it reflects both a state of mind that is not observable by outsiders and it is used by individuals to predict the behavior of others. ToM is a complex cognitive ability that has been shaped by natural selection in response to the evolution of, and in, interactive social environments.

Like language, ToM appears to undergo a fairly predictable process of development in children, with increasing sophistication with increasing age. Numerous tests have been developed to examine different types and levels of ToM ability in children (Leslie, 2000). Children as young of 4 years of age have no problem discerning a false belief (in another social actor) in experimental settings. Even by the age of 2 years, children are quite expert at determining if another individual is pretending. For example, a 2-year-old child seeing her mother speak into a banana as though it is a telephone knows that the mother is pretending. This knowledge reflects the child's (accurate in this case) ToM about the mother's mental state.

ToM has become an important focus for research in many fields. In psychiatry, it has been widely used to assess social function in conditions such as schizophrenia and, especially, autism (Baron-Cohen, 2000; Pickup, 2008). ToM deficits emerge in autistic children at 18 months or even earlier, leading to what Baron-Cohen (2009) calls a kind of "mind-blindness." People with autism or Asperger syndrome are unable to mind-read: they have difficulty imagining the thoughts and feelings of others. Thus "they find other people's behavior confusing and unpredictable, even frightening" (Baron-Cohen, 2009, p 69).

The presence of ToM deficits in autism suggests that a neurobiology of ToM exists, and that it is not working correctly. Unfortunately, research on autistic individuals has not led to the identification of a specific affected region or regions. In fact, neuroimaging research on ToM has shown that many brain regions and networks are potentially active during ToM activities, varying according to experimental tasks (Carrington and Bailey, 2008). Parts of the frontal lobe (the medial prefrontal cortex/orbitofrontal regions) and the superior temporal lobe are activated most consistently in these studies, suggesting that they are more critical than other areas for ToM, but not always. Like other complex cognitive functions, ToM seems to be dependent on a widely distributed, overlapping complex of neural networks. ToM emerges from the combined interactions of these various networks.

A model proposed by Marcel Adam Just and Sashank Varma (2007) attempts to account for the dynamic processes in the brain that underlie forms of complex cognition, such as ToM or ToF. They start with a basic principle, which is generally agreed upon by all cognition researchers: "Thinking is the product of the concurrent activity of multiple brain areas that collaborate in a large-scale cortical network" (p 154). According to Just and Varma, these cortical networks change according to the demands of the thinking-related task. Although there is some specialization in the cortex, cortical areas can generally perform multiple functions, and different functions can be performed in multiple cortical areas. This flexibility allows not only for the reformation of networks following brain injury but also for the dynamic recruitment of regions to attend to tasks on a regular basis. Although the brain may develop primary neural networks for specific complex cognitive tasks, variations on a theme are possible because of the recruitment of different cortical areas toward similar—but not identical—goals.

The forms of these flexible and complex large-scale neural networks are ultimately shaped by natural selection and proximately shaped by the developmental environment. The organization of the neural networks underlying complex cognitive abilities such as language or ToM is clearly not reformulated *de novo* in each individual based on the developmental environment; on the other hand, they are not so hard-wired that they cannot accommodate developmental variability. For humans and some other primates, such as chimpanzees (Call and Tomasello, 2008), the social dimension is one of the most critical aspects of these environments; hence, it is reasonable to hypothesize that something like ToM has evolved as a cognitive adaptation to this environment. Similarly, food is also a critical aspect of the human biocultural environment. The very complexity of the human diet, in its nutritional, physiological, ritual and symbolic, emotional, technological, and social contexts, suggests the adaptive potential in uniting these various cognitive strands into a higher level ToF network.

THEORY OF FOOD

ToF is an internal, cognitive representation of our diets in our minds. My hypothesized ToF is analogous to ToM and shares with it many of the basic features of complex cognition. ToM evolved because humans (and other primates) live in highly interactive social groups that place a premium on the ability to read the minds of other social actors. Similarly, our ToF evolved not only because food is important for survival and we must learn how and what to eat as we grow up but because our complex language-based cultural environment embeds food in an extensive web of other cognitive associations.

All primates to some extent learn how to eat as they grow up, observing what their mothers and other members of their social group do with food items (Fragaszy and Visalberghi, 2004). ToF, like ToM, is not necessarily unique to humans. However, I suggest that like ToM, our sociocultural environment and enhanced cognitive abilities take ToF to a level that is not seen in other primates. In the same way that the sexual dichotomies of biology become the continuum of gender under culture and sexual reproduction goes from being between a male and a female to a social institution, food and eating are much more than ingestion and digestion. Although physiology is obviously important, the sociocultural context (and ultimately the cognitive context) has just as large a role in defining what is and is not food and what should or should not be eaten. Humans need a ToF not simply for sustenance but to make use of one of the basic currencies of human social existence (Counihan and van Esterik, 2008; Harris and Ross, 1987).

Similar to ToM and language, the form of an individual's ToF is likely shaped during a critical period in childhood. Developmental psychologists have long charted the normal progression of diet development from infancy through weaning and the transition to more adult table foods. This period of "early life programming" has been undergoing increased scrutiny with the onset of the obesity epidemic in the developed world (Cottrell and Ozanne, 2008). The importance of the food environment during this developmental stage for establishing lifelong food habits (both psychological and physiological) is highlighted by the fact that researchers are targeting this period for potential obesity interventions (Anzman et al., 2010). Targeting this critical period for dietary intervention is tacit recognition of the fact that "first diets," like first languages, have a privileged place in both minds and bodies.

Like ToM, an individual's ToF is necessarily shaped by both genetic and environmental factors. Individual genetic variation likely plays a role in shaping some aspects of ToF. For example, individual genetic variation in tasting ability is reasonably common. There are "supertasters," individuals who are highly sensitive in laboratory testing to the chemical propylthiouracil [PROP—which is similar in structure to phenylthiocarbamide (PTC)] (Duffy, 2007). These individuals (most of whom are women) do not simply experience PROP as bitter, like most people do, but intensely bitter. Their sensitivity is probably the result of the fact that they have increased numbers of taste structures on the tongue (fungiform papillae and taste pores). These supertasters are also more sensitive to the creaminess of fat and oral pain (Duffy, 2007). Another possible axis of variation that could influence ToF involves the dopamine reward pathways in the brain. These pathways have become of increasing interest to diet and obesity researchers as the idea of "food addiction" has gained popularity (Corsica and Pelchat, 2010; Pelchat, 2009). Studies on both on both rats and humans suggest that some dopamine receptor variation is correlated with obesity and eating behavior (Johnson and Kenny, 2010; Stice et al., 2009; Wang et al., 2001). ToF, like all forms of complex cognition, will therefore vary among individuals because of both genetic and environmental factors.

Just as it has been difficult to identify a unitary ToM brain neural network, it will probably also be impossible to pinpoint a single network that accounts for ToF. Since ToF can be as much about not eating as eating, we would not even predict that those parts of the brain associated directly with ingestion should form a sort of default network. The absence of a single dedicated neural network involving regions x, y, and z in a predictable sequence does not mean that there cannot be an evolved propensity for developing a ToF. Complex cognitive processes, such as language and ToM, are undoubtedly adaptations, and the complex, distributed nature of the networks underlying these processes is no barrier to their concerted functional evolution (for networks associated with language, see Ben Shalom and Poeppel, 2008; Price, 2000). We are in the early days of understanding the biological basis of complex cognition. Historically, experimental methods have necessarily favored understanding them via the separate components of individual networks rather than as an intact operating system involving multiple, interacting networks. With functional neuroimaging, the components of networks and even their interactions (Zielinski et al., 2010) are beginning to be understood. And with tools available to identify these kinds of networks, more of them will be discovered, beyond the "obvious" ones such as those involved with language.

Like many aspects of human biology, ToF did not evolve in a modern, agricultural, industrial food environment (Lindeberg, 2009). The "normal" developmental environment for ToF may therefore include limitations on the amount and availability of high quality, nutrient-dense foods, marked seasonality of foods contributing to greater variety, and periods of food shortage. Almost all adult individuals in traditional environments (both hunter-gatherer and traditional agricultural) likely had an understanding of the processes of food acquisition and preparation, from the hunt or harvest to eating. Meals would often be taken with members of extended kin groups rather than centered on the nuclear family. Food was more connected to religion and ritual activities.

Michael Pollan (2008) has argued that in the modern dietary environment, people think more in terms of nutrients than food, which has in turn has led to confusion and ambiguity about what should or should not be eaten. This is to some extent an example of the tyranny of choice and affluence, although dietary concerns and the obesity epidemic cut across all socioeconomic levels in the developed world (McAllister et al., 2009). Thinking of food as nutrients only removes it from the broader contexts in which ToF evolved. Although it is difficult to say how exactly factors such as seasonality, familial connections, ritual, and so on might specifically influence the development of ToF, it is clear that food and eating have in many ways been removed from multiple traditional and evolutionary contexts.

Taken as a whole, the modern food environment is in some ways relatively impoverished compared with a more traditional environment when it comes to people's relationship with their food. It is not impoverished in the sense of calories or nutrients available, anything but. However, starting in childhood, many people only eat a small number of foods by choice, which appeal to them largely for their fat or sugar content (Birch and Fisher, 1998); there is no need to have a more expansive palate given the ready availability of highly palatable, energy-dense foods. In most developed countries, the social and ritual contexts of food consumption have been de-emphasized. While there is no doubt that some foods and meals maintain ritual significance in developed societies (e.g., Siskind, 1992), the cultural significance of food and food habits is much more pervasive in traditional societies (e.g., Holtzman, 2009). Another issue is that where food is abundant, and there is reasonable certainty of its continuous availability, eating becomes divorced from hunger. Emotional eating, eating only to push the pleasure buttons in the brain, eating out of boredom, or to put off doing something else—these are all options that would have been rare in the evolutionary past (Allen, 2012). All of these factors mean that the typical ToF a person might have today in the modern, developed world is not only just different from a more "traditional" ToF in content but also fundamentally different in terms of its underlying cognitive associations.

THEORY OF FOOD: SOME IMPLICATIONS

ToF may have originally evolved in hunter-gatherer and traditional agricultural environments, but most people do not live under those conditions today. For people living in the current food and eating environment of the developed world, ToF will have implications that are quite different from what they might have been in the past. As mentioned earlier, it is the prevailing opinion of nutritionists, public health officials, clinicians, and others who worry about the health of nations, that too many people in the developed world are too fat, and that the problem is getting worse rather than better (Kessler, 2009; Power and Schulkin, 2009). Losing weight generally requires dieting, and as most people are aware, dieting is difficult. Individuals who are successful weight loss maintainers (SWLs)—who lose at least 13 kg and keep it off for at least a year—are interesting enough as a research population that a national registry of them is maintained in the United States. Functional imaging research on SWLs has shown that they activate the frontal lobes much more when looking at images of food items compared with normal weight and obese individuals (McCaffrey et al., 2009). This suggests that SWLs are more able (for whatever reason) to exert conscious, executive control over their dietary choices than those who are less successful for gaining weight. Their implicit ToF has been to some extent successfully replaced or supplemented by a more explicit mode of control.

ToF provides one perspective for understanding why dieting is so difficult. It forms as children grow up and implicitly acquire knowledge and habits associated with food and eating. In the same way that children acquire their first language, ToF becomes enmeshed in the cognitive makeup of an individual. Adopting a new diet, in effect modifying a ToF, is to some extent like learning a second language, except more so—it is like replacing a first language with a new one. ToF is likely not as cognitively ingrained as language, but changes in it nonetheless could have profound effects on overall cognition. At the individual level, ToF enmeshes the things we eat in a larger cognitive web. The human species' basic behavioral plasticity and flexibility means that new foods and dietary patterns can be adopted. However, changes of this kind take time and effort, especially if the components of the old diet remain readily available. Obviously, contingency is an issue here. People will readily change their diets if the alternative is extreme hunger or starvation, although even in times of extreme food shortage, there are often culturally prescribed responses to such shortages (Farb and Armelagos, 1980).

Variation in personality traits and sensory preferences should influence variation in the formation of ToF. Links between risk for alcoholism and heightened hedonic response to sweet taste and high novelty seeking (Lange et al., 2010; Mennella et al., 2010) indicate a complex interrelationship among personality factors in terms of the consumption of food and psychoactive substances. Interrelationships of this kind suggest that while ToF is strongly influenced by the external cultural and familial environments, it is also at the individual level a product of genetic predispositions. These predispositions, if they were understood in the broader ToF context, could influence clinical interventions regarding weight loss and control. Although dieting is synonymous with restraining and restricting food intake, in a more global cognitive sense, it is an expansion of the baseline repertoire of eating habits. A broader perspective on dietary change and modification, not simply focused on factors related to reducing food consumption, may actually help to inform the development of more successful behavioral interventions for weight loss.

Beyond dieting to lose weight, are there any other implications for ToF in the modern dietary environment? I suggest that an awareness of ToF provides a way to escape the hegemony of taste, texture, and satiety in modern diets. There is, of course, nothing wrong with taste, texture, and satiety: most people want to eat things that taste good, are enjoyable to chew, and leave us feeling full. For countless millennia, humans and their immediate and more distant ancestors assessed potential foods based on these qualities and used these assessments to determine whether or not they were good to eat (Harris, 1985). Taste, texture, and satiety were critical to their survival and thus lead to the evolution of those cognitive buttons for sweet, for salt, for fat, and for fullness (Beauchamp et al., 1994; Power and Schulkin, 2009). However, these "upfront" qualities, in the sense of both ingestion and cognition, can overwhelm all other aspects of the eating experience (Kessler, 2009). In the modern environment of easily accessible and plentiful food, eating can too easily become about consuming the crispiest, saltiest, fattiest, and often cheapest foods until full to the gills.

There is nothing, of course, wrong with eating foods that are filling and taste good. However, a human ToF is necessarily much more than about ingestion and digestion. For example, the intimate and profound connections between memory and food are well known. Neurologically, these are at least partly mediated by strong connections within the limbic system, linking the olfactory centers of the brain with the emotion-regulating amygdala and the hippocampus, which is critical for memory formation. However, what is becoming more clear is that there are direct and intimate connections between the hippocampus and the gut, which are maintained by a variety of gut-brain hormones; the hippocampus is rich in receptors for insulin, leptin, and ghrelin (Harvey et al., 2006; Moult and Harvey, 2008; Olszewski et al., 2008). Thus, the potentiation of food-related memories can be achieved via sensory, emotional, and homeostatic routes. Humans are unique in possessing language-mediated declarative memories, the formation of which is mediated by the hippocampus. This extends food-related memory potentiation to a higher cognitive level. It is unlikely that there are unique processes or pathways for food-related declarative memories (or any specific kind of autobiographical memory, for that matter, Damasio, 1999); however, the lower level potentiation of food-related memories should enhance their formation at a higher level. Compared with other animals, the human ToF would be enhanced by virtue of complex associations maintained in declarative memories, which combined with lower level sensory and emotional associations, serve to make food memories especially acute. This would be dually adaptive, both for finding food and for using food memories as a mnemonic for tracking complex, emotion-laden, social relationships.

An implicit sense of time may also figure into ToF. From acquisition to preparation to consumption, food and eating take up a significant part of the day. Time is a valuable commodity for any primate, and too much time spent on one food can cost an opportunity to obtain another, more nutritious one. For humans, perceptions of many foods probably carry with them an implicit calculus of how much time it would take to prepare or eat. In the age of fast food, of course, the time constraints of food need not be much of a concern, but at other times, food and eating would provide some of the significant markers of the passage of time over the course of a day (Johnston, 2011).

On a more long-term level, keeping track of food seasonality is a complex cognitive activity that engages not only memory but also the ability to categorize and organize the complex food environment (Atran, 1998). In addition, as our ancestors developed the ability to mentally "time travel," to anticipate and discuss future events, knowledge of the seasonality of plants and animals undoubtedly became part of the strategies they used to obtain food (Suddendorf and Corballis, 2007). Seasonality influences the feeding of many animals, but for humans this seasonality could be consciously anticipated by their knowledge of the movement of the sun, the stars, and the moon, among other calendrical signs and signals. Our place in the "food-time" continuum is something that would be implicitly monitored via our ToF.

I will discuss one last possible implication of the ToF, namely that food, food preparation, and eating are potentially cognitive enhancers. The ToF implies that food is at the center of multiple brain networks encompassing several cognitive domains. Certainly, the efficient function of neural networks depends to some extent on their use, as repetition strengthens the connections between neurons firing simultaneously during a cognitive task (Fuster, 2009). Since ToF encompasses activity in multiple brain regions, "exercising" its networks should bolster or help maintain cognitive performance in diverse brain regions.

I have relied on ToM and language as analogous examples for a proposed ToF, so I will look to them again for how brain function can be enhanced via complex cognitive activity. Cognitive enhancement is a very active area of research in gerontology, as aging populations in the developed world will potentially—and inevitably, if interventions are not developed—lead to a great increase in rates of dementia. It is widely appreciated that physical exercise helps people maintain both body and mind as they get older. However, it is also increasingly becoming clear that exercising the mind specifically is greatly beneficial for maintaining cognitive health (Daffner, 2010; Reed et al., 2011). During aging, both the continued acquisition of knowledge and engagement in cognitively challenging activities help to build up "cognitive reserve" against the inevitable forces of brain atrophy and declining function (which are made worse by conditions such as Alzheimer disease) (Allen et al., 2005). There is validity to the "use it or lose it" notion when it comes to brain aging, although unfortunately it is not enough to stave off the effects of pathology indefinitely. In addition, maintaining positive social relationships is also important for successful aging. Both physical and mental functioning is better maintained, and the onset of dementia is delayed, in individuals who have active and meaningful social lives (James et al., 2011; Rohr and Lang, 2009). This is not a matter of reverse causation, where aging individuals who do better cognitively are more socially active. Longitudinal studies clearly show that social activity is a buffer against cognitive decline.

Thus, when elderly people engage in intellectually stimulating activities and have a meaningful social life, they do better cognitively than if they do not. This suggests then that exercising the brain's language and ToM facilities is cognitively enhancing. Most knowledge-based activities are dependent on language, as are most (but not all) aspects of social interaction. ToM, of course, is essential to social interaction. I suggest that similarly, engaging ToF in a meaningful way could also enhance cognition in the elderly. What do I mean by meaningful? It does not have to be too much, but an active role in food choice and eating scheduling might be beneficial and something even quite infirm people could participate in. Continuing to be involved in the acquisition and preparation of food would be even better, as those activities involve a range of cognitive abilities.

CONCLUSIONS

Humans evolved to be actively engaged with their food environments. Interactions with and within these food environments can be extraordinarily complex, in that they are mediated not only by ecological factors but also by the technological, sociocultural, and ultimately, cognitive contexts in which food is thought, acquired, processed, distributed, and eaten. The hypothesized ToF is a cognitive model of how the brain organizes this complex environment. Human adult cognition is an extraordinary biological phenomenon. It emerges fully over the course of the development via the interaction of multiple discrete, but necessarily overlapping, critical neurocognitive networks. These networks evolved in response to various selection pressures, many of which were modified or intensified by the intellectual, technological, and sociocultural environments that arose in connection with the evolution of genus *Homo*. Networks related to language and ToM clearly play an important role in adult cognition. Given the critical importance of food to both basic survival and cultural interaction, ToF may also represent another complex network essential for normal cognition.

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