The Evolution of ADHD

Social Context Matters

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Attention-deficit hyperactivity disorder (ADHD) affects an estimated 8 percent of children (12 percent of boys) and 4.4 percent of adults in the U.S. ADHD has a large heritable component (around 70 percent), suggesting that genes play a role in its etiology and that it can be modified by natural selection. Thus, ADHD's high prevalence begs the question: Why hasn't natural selection removed the genes that underlie ADHD from the human population? To begin to answer this question, and to better understand the phenomenon of ADHD, we must consider our current social environment, and the likely past environments that we have experienced over our evolutionary history, alongside genetic and molecular evidence.

We live in different social and ecological contexts than our ancestors. Widespread formal schooling and formal teaching are recent inventions of the past few hundred years. Before about 10,000 years ago, all humans were nomadic hunter-gatherers, without agriculture or domesticated animals. While our ancestors faced social pressures and needed to focus their attention to learn and practice complex foraging and hunting skills, the nature of the social and educational demands were qualitatively different from those we now face. While today we specialize in narrowly defined skills, hunter-gatherers were likely generalists, needing to acquire and practice a broad variety of subsistence and social skills.

From studies of modern hunter-gatherers, we can surmise that learning took place through play, observation, and informal instruction, rather than through the highly regimented classrooms almost all of us have experienced. It is no surprise that ADHD is usually diagnosed in children who have trouble focusing "properly" in school, and it continues to be a problem for adults when their work or lifestyle requires focusing in particular, regimented ways. There is good reason to believe that in our evolutionary past, ADHD was often not much of a problem and was perhaps even an asset.

Some intriguing evidence for this hypothesis comes from work on the genetics of ADHD. One gene associated with ADHD is called dopamine receptor D4 (*DRD4*), alleles of which change the sensitivity of a subtype of dopamine receptors that are expressed in the prefrontal cortex. ADHD is a complex trait (regulated by many genes), and the ADHD-associated allele in the *DRD4* gene (called *DRD4* 7R) only accounts for a small portion of the cases of ADHD. Nonetheless, a variation of the *DRD4* gene provides a window into the evolutionary forces that shaped our brain.

The 7R (ADHD-associated) allele of the *DRD4* gene is peculiar in that it seems to have originated about 45,000 years ago and was then positively selected for. That is, the 7R allele conveyed some advantage to those who carried it—it increased their "fitness." We can infer this based on patterns of "linkage disequilibrium" in the *DRD4* gene. Linkage disequilibrium is a well-established technique in genetics that compares the rate of recombination (crossing over) that is expected to occur by chance with that which is actually observed. The deviation in DNA sequences in the population from chance expectations gives evidence about the nature of natural selection that occurred.

Based on these linkage disequilibrium patterns, we have good reason to believe that the *DRD4* 7R allele was selected for in past environments and therefore likely was evolutionarily advantageous. But the story gets more interesting. The frequency of the 7R allele varies dramatically across populations, from less than 1 percent in some populations to more than 70 percent in others. In a study conducted by Chuansheng Chen and colleagues, many of these differences *across* groups were explained by aspects of the groups' histories. Populations with longer histories of migrating tended to have a greater frequency of *DRD4* 7R alleles.

While we can't be sure why the 7R allele is more prevalent in more migratory populations, it might be that people with behavioral traits related to ADHD were more likely to want to migrate away from their homes. Or perhaps people with this allele were better at adapting to the new environments they found themselves in once they did migrate. Entering an unfamiliar environment can be overwhelming, and it takes time to learn what is most critical to pay attention to. Perhaps those with what we would now recognize as ADHD were better able to adapt to these new environment by learning different methods of hunting and gathering or negotiating new social and/or cultural norms.

Additionally, Chen and colleagues reported that populations that *currently* practiced a nomadic lifestyle tend to have higher frequencies of the 7R (ADHD-associated) allele than sedentary populations. We have extended Chen's work with evidence gathered from work with a group of pastoralists of Kenya known as the Ariaal. The Ariaal are traditionally herders of camels, cattle, sheep, and goats. They traditionally live in the desert and don't stay in one place for long, because they must keep finding food and water for their herds. While many Ariaal continue to practice this traditional lifestyle, more recently a subgroup of Ariaal have become less nomadic, settling in one location. This settled group practices more agriculture, sells more goods on the market, and their children go to school.

We analyzed the *DRD4* genotypes of about 150 adult Ariaal men, about half from the nomadic group and half from the settled group. Specifically, we looked to see if we could correlate the presence of the 7R allele with a measure of health (as determined by men being less underweight) of the Ariaal men. We found that

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Photo of Ariaal men by Peter Gray

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the nomadic men who had the 7R ADHD-associated allele were less underweight than the nomadic men who didn't have the ADHD allele. But among the settled men, the reverse was true: The settled men with the ADHD-associated allele were slightly more underweight than the men without the ADHD allele.

These results are concordant with the previous findings associating *DRD4* with migration patterns. Given the association of the *DRD4* 7R allele with ADHD more generally, these results suggest that there is something about the nomadic context that allows people with ADHD-like behaviors to be more successful in an evolutionary sense. Perhaps nomadic Ariaal with a more diffuse attention better scan their dynamic environments, noticing the status of their herd, the signs of water or food or raiders sneaking up. This different attention span might serve less well for settled Ariaal, who must focus on schooling, growing crops, and selling goods at market.

Altogether, there are multiple lines of evidence suggesting that the ADHD-associated allele of the *DRD4* gene promotes behavioral/psychological traits that are helpful in some social and ecological contexts but detrimental in others. The direct clinical importance of these findings is limited. However, they should push us to consider the role of social context in ADHD in our own society. Are there areas in our society where children and adults with ADHD might better use their traits?

There is good reason to believe that ADHD in children is primarily a problem of not being able to adjust to the demands of school. In our society, schooling is compulsory, generally dictates to children how they should learn, and employs an essentially uniform pedagogical approach—no matter the varied circumstances of the children. Although formal studies are lacking, there is good anecdotal evidence, compiled by psychologist Peter Gray, that children who are given more freedom to direct their own education and lives no longer need ADHD medications, can better use their behaviors/psychology as an asset, and are able to lead more productive and healthy lives. This is not to say that ADHD medications don't have a valuable role to play. However, it would probably be better to view such medications not as a cure for a disease but as a stop-gap measure to help a person cope with the demands of a society we should be working to make more inclusive.

It is interesting to note that the adult incidence of ADHD is about half that of children. As adults, we generally have more freedom than children to choose roles that fit our strengths and to use medications strategically. Such freedom allows adults with ADHD to select jobs where they are not disabled by their different attention patterns. In fact, adults may be able to find niches where their ADHD is a clear benefit. Individuals with ADHD have been described as paying attention to what is interesting rather than what is "important." But what is "important" is often a reflection of particular social values. In some fields, like the arts or sciences, what is interesting *is* what is important. If individuals with ADHD can sustain their attention by paying attention to what is interesting, their often tremendous energy can lead to productive careers in these creative fields.

Children and adults with ADHD are often made to believe that their ADHD is strictly a disability. Instead of understanding that their ADHD can be a strength, they are often given the message that it is a flaw that must be solved through medication. We hope that increased attention to social context and understanding of our evolutionary legacies will help those with ADHD pursue their interests in a way that is more productive for themselves and for society.

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Further Reading

Eisenberg DTA, Campbell B, Gray PB, Sorenson MD. Dopamine receptor genetic polymorphisms and body composition in undernourished pastoralists: An exploration of nutrition indices among nomadic and recently settled Ariaal men of northern Kenya. *BMC Evolutionary Biology*. 2008; 8(173). http://www.biomedcentral.com/1471-2148/8/173/abstract.

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