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What do we know about the relationship between attention deficit hyperactivity disorder and substance use disorders?

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While it is well documented that attention deficit hyperactivity disorder (ADHD) and substance use disorders (SUD) commonly co-occur, little is known about the reasons for this association. Since genetic influences are operant in both disorders, one hypothesis is that the co-occurrence of the disorders is due to common genes. One way to assess for a genetic relationship between ADHD and SUD is through a familial risk analysis. A familial risk analysis compares the prevalence of an illness in relatives of individuals with a given disorder based on the presence or absence of the same illness in relatives. Since both ADHD and addiction are known to be familial illnesses, we can expect relatives of individuals with ADHD and addiction to have a higher prevalence of the same disorders.

The way in which these two disorders aggregate in families can give insights as to the nature of the association. Several possibilities can be posited. One is that ADHD and addiction are independent disorders. If that were to be the case, we would expect that different relatives of affected individuals with each condition would be affected with the same disorder. For example, a child with ADHD would have an excess of relatives with ADHD and a child with addiction would have an excess of relatives with addiction. Another possibility is that the genes that produce one disorder (ADHD or addiction) would express both risks in relatives. For example, a child with ADHD would have an excess of relatives with ADHD or addiction affecting different relatives. A third possibility is that the dual condition of ADHD and addiction would manifest itself in the same way in relatives. In other words, a child with ADHD and addiction will have an excess of relatives with both disorders afflicting the same relative. This latter scenario is known as co-segregation and it usually suggests that the combined condition is driven by unique sets of genes.

We were able to test these hypotheses in our large longitudinal family studies of boys and girls with and without ADHD and their first degree relatives (parents and siblings) at the Massachusetts General Hospital (Yule et al., 2017). These children were first assessed in childhood and followed prospectively onto young adult years through the peak period of risk for the development of addictions. Our sample consisted of 404 subjects with a mean age of 22 years and their 1,336 relatives. All individuals who participated in the study were systematically assessed with structured diagnostic interviews. Our findings showed that addiction in a child significantly increased the risk for addiction in relatives irrespective of having ADHD, and that ADHD in the child significantly increased the risk for addiction in relatives irrespective of whether the child had an addiction. Our results also showed that children with both ADHD and an addiction co-occurring together had an excess of relatives in which both conditions were present in the same relative (co-segregation). We observed that the risk for addictions was not specific to alcohol or drugs indicating that what it is inherited is the propensity to develop an addiction and not a specific type of addiction. Finally, we documented that these risks were equally operant in boys and girls indicating that these risks are due to ADHD and not the sex of the affected individual.

Taken together, these patterns of familial aggregation point to three overlapping risks for the development of addictions in ADHD that include common familial etiological fac-

tors due to genes associated with ADHD, genes associated with addiction, as well as genes associated with their combined presence. This triple risk may explain why the risk for addiction is so high in individuals with ADHD.

While these findings provide strong evidence supporting the hypothesis that genetic influences are operant in mediating the risk for addiction in ADHD, we were also interested in examining whether environmental risks within the family are also operant. Our findings revealed that exposure to maternal SUD, but not paternal SUD, was associated with a modest risk for addiction in their offspring (Yule, 2013). Taken together, these findings suggest that genetic influences are the most important determinant of risk for addiction in children with ADHD. Although modest, exposure to an active maternal addiction also has a detrimental effect in moderating the risk for addiction in their offspring.

Our findings have important clinical and public health implications. Clinically, when a youth presents for treatment of ADHD, clinicians should screen for addiction in the child and the family. Likewise, when youth present for the management of addiction, they and their family should be screened for ADHD. Since ADHD typically onsets years before the onset of addiction, ADHD children could benefit for early intervention strategies aimed at mitigating the risk for subsequent addiction. Treatment for ADHD has also been shown to be an important intervention to decrease risk for addiction among youths with ADHD (Biederman, Wilens, Mick, Spencer, & Faraone, 1999; Wilens, Faraone, Biederman, & Gunawardene, 2003). McCabe et al. recently showed that initiating treatment with stimulants at an earlier age and treating youth with ADHD for a longer period dramatically decreased children with ADHD's risk to use substances in adolescence in such a way that it was the same as the risk for children without ADHD (McCabe, Dickin-

son, West, & Wilens, 2016). Nicotine use among youth with ADHD is also an important marker of individuals at increased risk to progress to alcohol or drug abuse or dependence (Biederman et al., 2006; Biederman, Petty, Hamerness, Batchelder, & Faraone, 2012).

In summary, the bidirectional association between ADHD and SUD seems to be due to strong genetic links between the two disorders. All children within families with ADHD should be closely monitored for addictions.

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