The DRAM, Vol. 1(3) – One zygote or two? Understanding the influence of genes and environment use, and problematic use on adolescent substance use behavior

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For decades, scientists have debated whether risky behavior is the result of nature (i.e., genetics and/or other biological factors), or nurture (i.e., environment). Though scientists now agree the interaction of these two factors influences behavior, they still have to determine how much and in what way these causes work. This week the DRAM reviews research by Rhee, Hewitt, Young, Corley, Crowley, and Stallings (2003) that estimated the relative contribution of genes and environment to adolescent substance use behaviors. To address this question, researchers compared different types of twins and other siblings whose genetic and environmental similarity is known.

Rhee et al. (2003) recruited 345 monozygotic (MZ) twins, 337 dizygotic (DZ) twins, 306 pairs of biological siblings, and 74 sets of adoptive siblings. All study participants were between ages 12 and 19; the mean age was 15.9. Participants answered select questions from the Monitoring the Future survey (Johnston, O'Malley, & Bachman, 2001) and completed the substance abuse module of the Composite International Diagnostic Interview (CIDI-SAM; Robins, Cottler, & Babor, 1995) to report on substance use initiation, substance use, and problematic substance use. Authors controlled for sex and age in their analyses.

To examine the relative influence of genes and environment, Rhee et al. (2003) tested a saturated statistical model (i.e., ACDTE – a model including all of the influences listed below) that accounted for multiple sources of variability in substance use behavior. Additive genetic influences (A) are non-interacting traits inherited genetically that affect behavior. Environmental influences shared by siblings (C) are shared experiences that make sibling behavior similar. Non-

additive genetic influences (D) are interacting traits (i.e., genetic influences that include gene-gene interactions) inherited genetically that affect behavior. Environmental influences shared only by twins (T) are shared experiences unique to twins that make twin behavior similar. Non-shared environmental influences (E) are experiences that make family members different from one another.[1]

The authors compared the full model to several other models that used some, but not all of the above sources of variability (e.g., ACTE or ADE) to determine which model best explained adolescents' reports of substance initiation, use, and problematic use.

	a^2	c^2	d^2	t^2	e^2
Initiation					
ACE	0.39 (0.05 to 0.72)	0.32 (0.03 to0.57)	NA	NA	0.29 (0.19 to 0.43)
Use					
CTE	NA	0.38 (0.22 to 0.54)	NA	0.40 (0.23 to 0.58)	0.22 (0.15 to 0.30)
Problematic Use					
AE	0.83 (0.72 to 0.91)	NA	NA	NA	0.17 (0.09 to 0.28)

Note: Values are parameter estimates and numbers in parentheses are 95% CI.

Figure. Best fit models for initiation, use, and problem use of any drug (adapted from Rhee et al., 2003). Click image to enlarge.

The results in the Figure suggest that for initiation, additive genetic influences (A) account for approximately 40% of the explained variance in the data, while shared environmental influences (C) account for 30%, and non-shared environmental influences (E) account for 30%. With regard to use, shared environmental influences (C) account for 40% of the explained variance in the data, environmental influences shared only by twins (T) account for 40%, and non-shared environmental influences (E) account for 20%. For problematic use, additive genetic influences (A) account for 80% of the explained variance in the data, and non-shared environmental influences account for (E) 20%.

Thus, genetic influences (A) explained more and shared environmental influences (C & T) explained less of problematic substance use than these factors did for initiation or use. Non-shared environmental influences (E) explained a modest

proportion of initiation, use, and problematic use for any drug.

Because the base rates of specific drug use (e.g., marijuana use) were low, the study had to combine marijuana, alcohol, and tobacco into one category, limiting the specificity and generalizability of the results. Also, the authors report the central values of the proportion of the total explained variance attributable to influences; however, the report does not report the size of the explained variance so the full extent to which these influences explain behaviors remains unclear.

Nonetheless, this research is worthy of attention: Rhee et al. (2003) point out that genetic and environmental influences vary depending on the specific substance use behavior under consideration, suggesting that genes might have the most impact on problematic substance use whereas environmental factors play a larger role during initiation and use. This distinction is very important to consider with respect to the development of interventions and preventions for adolescent substance use and abuse. Researchers and prevention specialists might uncover strategies that can specifically deal with genetic or environmental influences at different levels of substance using behavior. If Rhee et al.'s (2003) findings are correct, primary prevention programs disseminated through community public health programs are particularly important to stop the problem before it begins. Similarly, if genetic influences are the largest influence on problematic substance use, then it is even more important to limit use before it becomes problematic. Finally, these results suggest that once substance misuse emerges, given the larger influence of genetics, a panoply of interventions (e.g., medications, cognitive behavioral treatments, community reinforcement, family support, etc.) is likely to be required for effective treatment.

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[1] If **A** were the only influence on substance use behavior, MZ similarity would be approximately twice that of DZ twins, because MZ twins generally share 100% of their genes, but DZ twins only share up to 50% of their genes. If **C** were the only influence on substance use behavior, adoptive and biological sibling pair behavior similarity would be equal, as would MZ and DZ twin pair behavior similarity. If **D** were the only influence on substance use behavior, MZ similarity would be more than twice that of DZ twins. If **T** were the only influence on

substance use behavior, MZ and DZ twin pair similarity would be equal and greater than other sibling pair behavior similarity. If **E** were the only influence on substance use behavior, behavior similarity would be low in all pair types.

References

Johnston, L. D., O'Malley, P. M., & Bachman, J. G. (2001). Monitoring the future national results on adolescent drug use: Overview of key findings, 2000. Bethesda, MD: National Institute on Drug Abuse.

Rhee, S. H., Hewitt, J. K., Young, S. E., Corley, R. P., Crowley, T. J., & Stallings, M. C. (2003). Genetic and environmental influences on substance initiation, use, and problem use in adolescents. Archives of General Psychiatry, 60, 1256-1264.

Robins, L. N., Cottler, L. B., & Babor, T. (1995). CIDI substance abuse module. St. Louis, MO: Washington University School of Medicine.