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Commentary on Otten *et al.*: Moderators and person-environment interactions in developmental
cascade models

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Concise statement: Moderators should be considered when examining developmental cascade models since they have important implications for refining targeted prevention efforts.

Developmental cascades refer to “the cumulative consequences for development of the many interactions and transactions occurring in developing systems” [1]. In this issue, Otten et al. [2] tested a developmental cascade model, showing support for two pathways where (1) stressful life events and (2) negative parent-child interactions at ages 2-5 both indirectly predicted substance use at age 14; first through inhibitory control at ages 7-8 and then through deviance at ages 9-10. This was done with a strong methodological approach. Indeed, what sets this study apart is not only the use of longitudinal data but also that of a statistical model controlling for the levels of the mediators at the first assessment. This additional feature strengthens the conclusions of the study regarding precedence in the developmental sequence identified [3, 4]. Although many cascade models focus on indirect effects from early predictors to a later developmental outcome, these models may also help uncover other key effects that could influence the course of development. Among these effects we find moderators, whose inclusion is important not only for understanding the development of psychopathologies, but also for refining the design of effective targeted prevention.

The indirect effects identified in developmental cascade models, such as in Otten et al.’s study, are key to identifying *early* prevention targets, which is essential since evidence-based childhood prevention programs typically yield a higher return on investment than interventions delivered later in development [5, 6]. Accordingly, the two pathways identified by Otten et al.’s study suggest that targeting stressful life events and the parent-child relationship in the early childhood environment could both indirectly reduce early adolescent substance use. Whereas the indirect effects examined in cascade models allow for the identification of developmental sequences and the pathways by which variables are associated with each other, the inclusion of moderators would allow the identification of individuals for whom, or environments in which,

these associations are present or strongest [7]. In terms of prevention, whereas the indirect effects allow the identification of what (target domain) to intervene on and when (how early) in early prevention programs, moderators allow the identification of for whom and/or under what circumstances these interventions would be most effective. In turn, this offers potential for optimizing the allocation of resources.

For example, by applying a person-environment interaction model to Otten et al.'s study, we could test if the pathway leading from stressful life events and the parent-child relationship at ages 2-5 years also depends on children's characteristics [8]. Such personal characteristics may include temperamental/personality factors, physiological reactivity and genetic polymorphisms [9]. Previous studies of the prediction of adolescent substance use by family factors, found that this association was moderated by impulsivity in childhood [10, 11]. Other potential person-level moderators of the developmental cascade identified in Otten et al. could notably include difficult temperament, impulsivity, negative affect, stress reactivity and genotypes (e.g., MAOA, DRD4, 5-HTTLPR, polygenic scores), which have all been shown to interact with family factors in the prediction of externalizing behaviors [9, 12, 13], a developmental outcome also associated with substance use [14-16]. Although not tested yet, we have also hypothesized that later temperament would be a mediator between early person-environment interactions and adolescent substance use [13]. Thus, by integrating person-environment interaction theory with Otten et al.'s model, we could test if stressful life events and negative parent-child interactions at ages 2-5 would be indirectly associated with early adolescent substance use through lower inhibitory control at ages 7-8 and higher deviance at ages 9-10, but only for children that were initially more impulsive or difficult. Validating such a model would imply that interventions targeting early stressful life events and/or the parent-child relationship in early childhood could prevent

the future development of lower inhibitory control, higher deviance and higher substance use, but more effectively for more impulsive or difficult children.

This specific question may be worth examining in future studies building upon both person-environment interaction models of the development of substance use and cascade models - but this remains hypothetical and is only one example of how moderation analyses may be useful in this context. Still, including moderators in developmental cascade models, from a person-environment or another theoretical perspective, may be particularly important since they could have important implications for targeted prevention efforts.

References

1. Masten AS, Cicchetti D. Developmental cascades. *Dev Psychopathol.* 2010;22(3):491-5.
2. Otten R, Mun C, Shaw D, Wilson M, Dishion T. A Developmental Cascade Model for Early Adolescent Onset Substance Use: The Role of Early Childhood Stress. *Addiction.* 2018.
3. Cole DA, Maxwell SE. Testing mediational models with longitudinal data: Questions and tips in the use of structural equation modeling. *J Abnorm Psychol.* 2003;112(4):558-77.
4. Selig JP, Preacher KJ. Mediation Models for Longitudinal Data in Developmental Research. *Res Hum Dev.* 2009;6(2-3):144-64.
5. Heckman JJ. Skill formation and the economics of investing in disadvantaged children. *Science.* 2006;312(5782):1900-2.
6. Crowley DM, Hill LG, Kuklinski MR, Jones DE. Research Priorities for Economic Analyses of Prevention: Current Issues and Future Directions. *Prev Sci.* 2014;15(6):789-98.
7. Frazier PA, Tix AP, Barron KE. Testing moderator and mediator effects in counseling psychology research. *J Couns Psychol.* 2004;51(1):115-34.
8. Pluess M. Individual Differences in Environmental Sensitivity. *Child Develop Perspect.* 2015;9(3):138-43.
9. Belsky J, Pluess M. Beyond risk, resilience, and dysregulation: Phenotypic plasticity and human development. *Dev Psychopathol.* 2013;25(4):1243-61.
10. Rioux C, Castellanos-Ryan N, Parent S, Vitaro F, Tremblay RE, Séguin JR. Differential susceptibility to environmental influences: Interactions between child temperament and parenting in adolescent alcohol use. *Dev Psychopathol.* 2016;28(1):265-75.

11. Hentges RF, Shaw DS, Wang M-T. Early childhood parenting and child impulsivity as precursors to aggression, substance use, and risky sexual behavior in adolescence and early adulthood. *Dev Psychopathol.* 2017;1-15.
12. Belsky J, Pluess M. Beyond Diathesis Stress: Differential Susceptibility to Environmental Influences. *Psychol Bull.* 2009;135(6):885-908.
13. Rioux C, Castellanos-Ryan N, Parent S, Séguin JR. The interaction between temperament and the family environment in adolescent substance use and externalizing behaviors: Support for diathesis-stress or differential susceptibility? *Dev Rev.* 2016;40:117-50.
14. Pingault JB, Cote SM, Galera C, Genolini C, Falissard B, Vitaro F, et al. Childhood trajectories of inattention, hyperactivity and oppositional behaviors and prediction of substance abuse/dependence: a 15-year longitudinal population-based study. *Mol Psychiatr.* 2013;18(7):806-12.
15. Krueger RF, Markon KE, Patrick CJ, Benning SD, Kramer MD. Linking antisocial behavior, substance use, and personality: An integrative quantitative model of the adult externalizing spectrum. *J Abnorm Psychol.* 2007;116(4):645-66.
16. Castellanos-Ryan N, Briere FN, O'Leary-Barrett M, Banaschewski T, Bokde A, Bromberg U, et al. The Structure of Psychopathology in Adolescence and Its Common Personality and Cognitive Correlates. *J Abnorm Psychol.* 2016;125(8):1039-52.