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Differential Susceptibility to Rearing Practices

Jay Belsky

23 September 2011

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OUTLINE

I. Diathesis-Stress Model of Environmental Action

II. Evolutionary Challenges: I & II

III. Differential Susceptibility Model of Environmental Action

III. Evidence

- A. Phenotypic: Negative Emotionality
- B. Endophenotypic: Physiological Reactivity
- C. Genetic

IV. Unknowns in the differential-susceptibility equation

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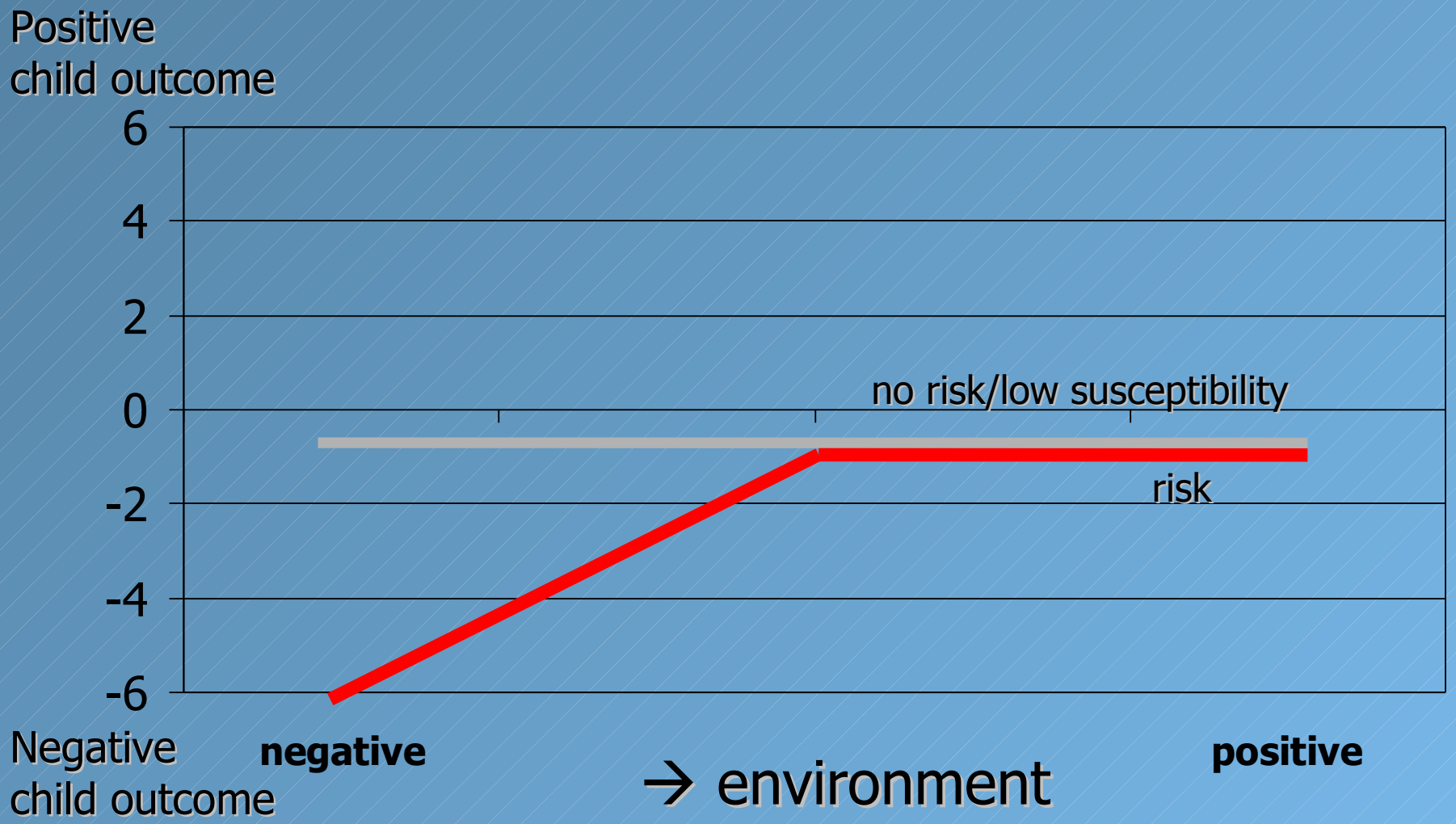
DIATHESIS-STRESS: PREVAILING (MEDICAL/PSCYOLOGICAL) MODEL OF ENVIRONMENTAL ACTION

Diathesis-Stress



Bakermans-Kranenburg & Van IJzendoorn, 2006

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EVOLUTIONARY CHALLENGE I:

Why would nature craft some individuals—but not others—to be disproportoinately likely to succumb to environmental adversity?

From the standpoint of evolution by natural selection, does this make sense?

Where is the evolutionary payoff in this?

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EVOLUTIONARY CHALLENGE II:

WHY WOULD NATURAL SELECTION EVEN CRAFT AN ORGANISM WHOSE FUTURE FUNCTIONING IS INFLUENCED BY ITS EARLIER EXPERIENCES?

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AN EVOLUTIONARY ARGUMENT

THE INHERENT UNCERTAINTY OF THE FUTURE

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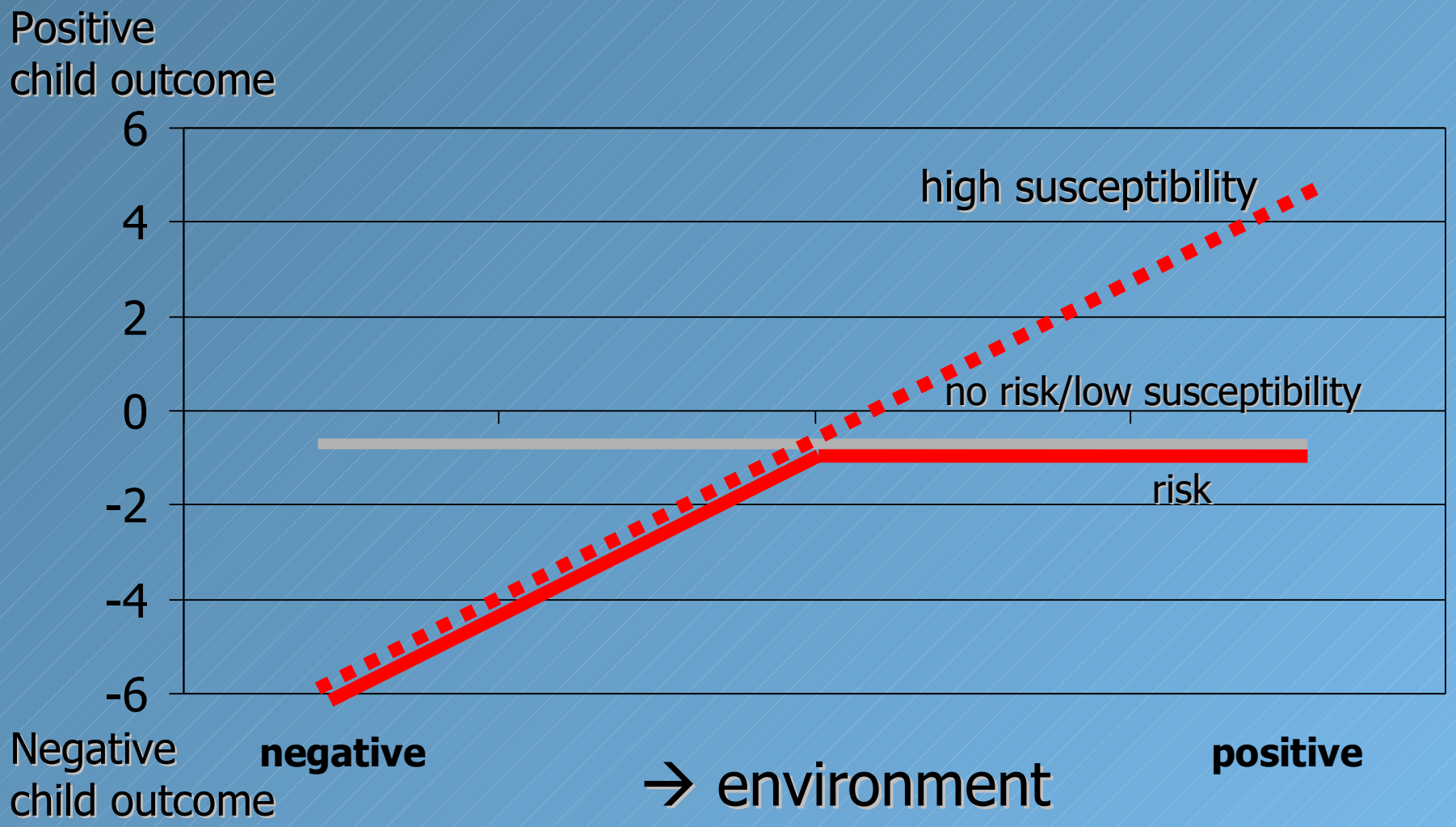
HOW DIFFERENTIAL SUSCEPTIBILTY DIFFERS FROM DIATHESIS STRESS

Diathesis-Stress vs. Differential Susceptibility



Bakermans-Kranenburg & Van IJzendoorn, 2006

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INFANT TEMPERAMENT AS A SUSCEPTIBILITY MARKER

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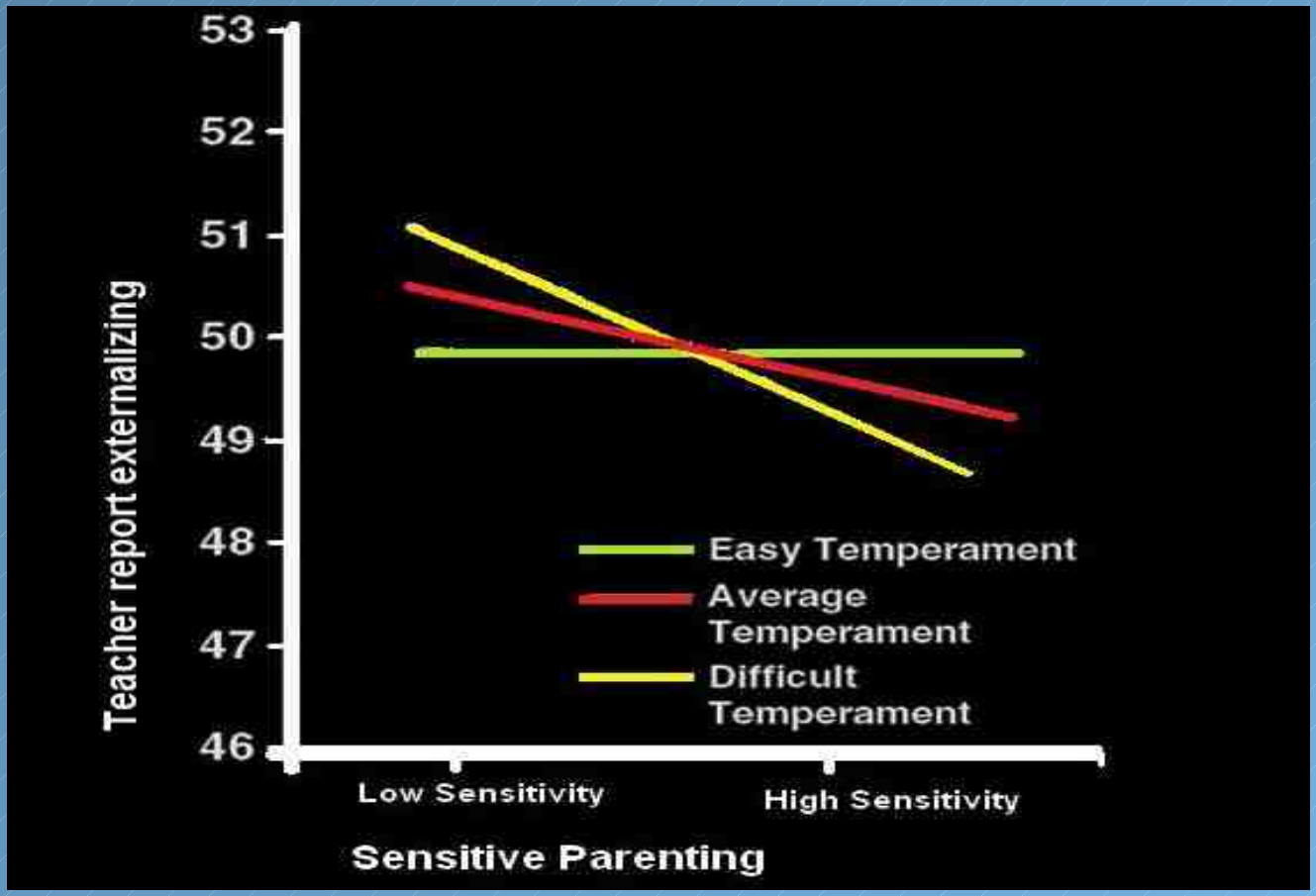
Observed Parenting and Teacher-Rated Behavior Problems in Kindergarten



Bradley, R. H., & Corwyn, R. F. (2008). Infant temperament, parenting, and externalizing behavior in first grade: a test of the differential susceptibility hypothesis. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 49*(2), 124-131.

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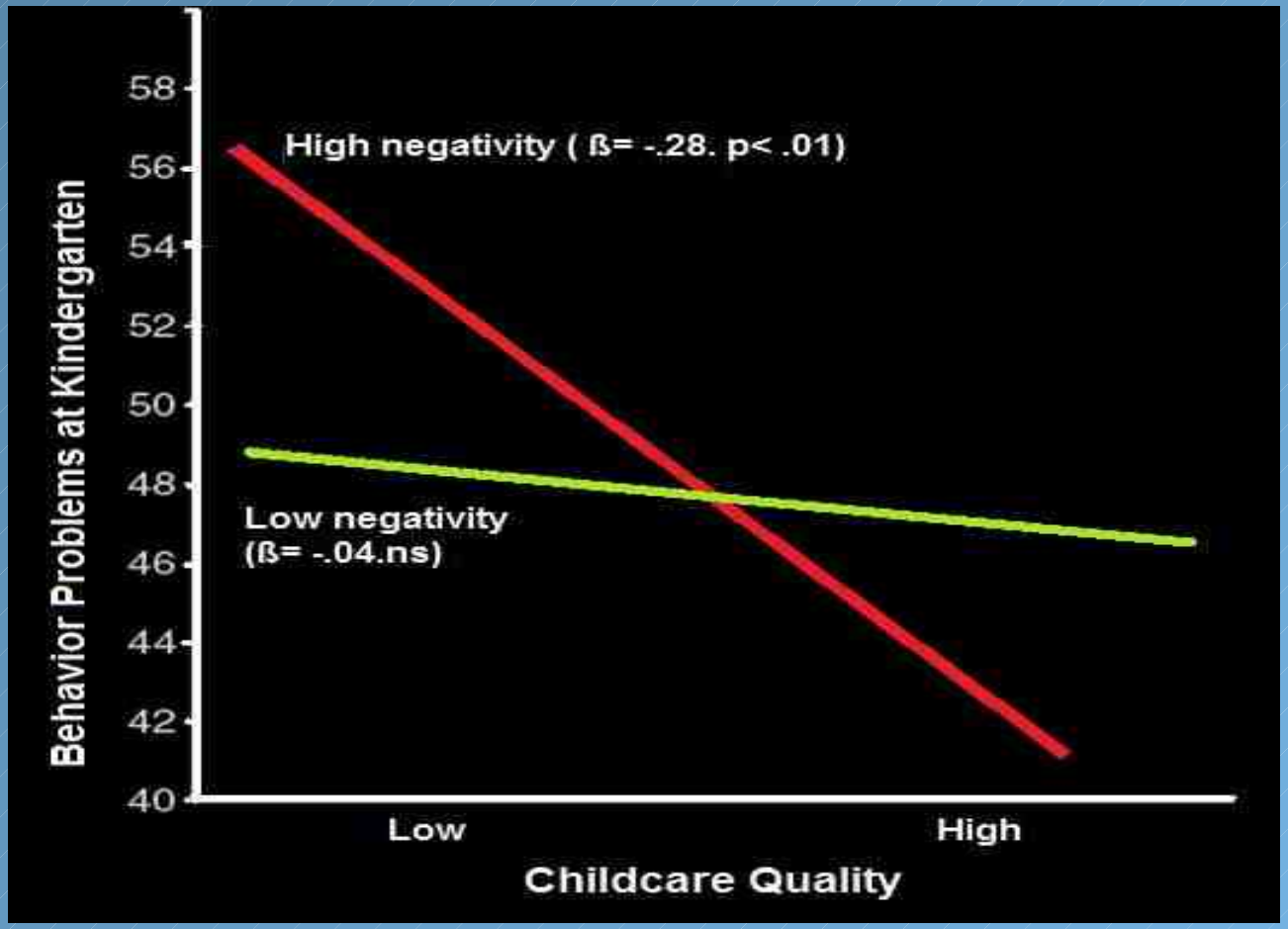
Observed Quality of Child Care and Teacher-Rated Behavior Problems in Kindergarten



Pluess, M., & Belsky, J. (2009). Differential Susceptibility to Rearing Experience: The Case of Childcare. *Journal of Child Psychology and Psychiatry and Allied Disciplines*.

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CAN WE MOVE BEYOND CORRELATIONAL EVIDENCE TO EXPERIMENTAL DATA?

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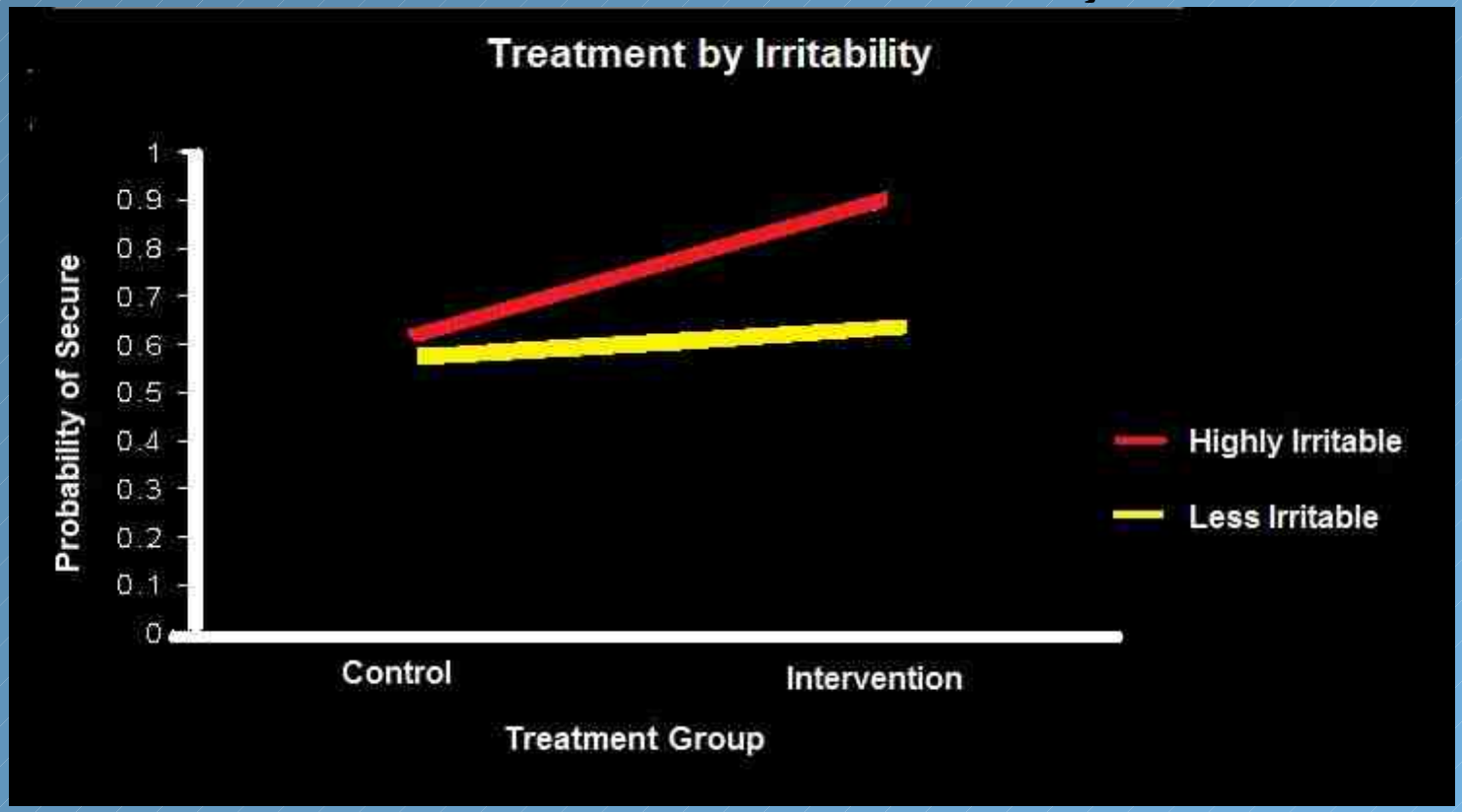
Experimental Enhancement of Maternal Sensitivity via Circle of Security: Effects on Attachment Security



NOTE: Only highly irritable newborns included in study; those labelled "highly irritable" met van den Boom (2004) criteria; but "less irritable" group still more irritable than many other newborns included in sample.

Cassidy, J., et al. (2011). Enhancing infant attachment security: An examination of treatment efficacy and differential susceptibility. *Development and Psychopathology*

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BEYOND TEMPERAMENT:
Endophenotypes as Moderators of Environmental Effects (Boyce & Ellis, 2005)

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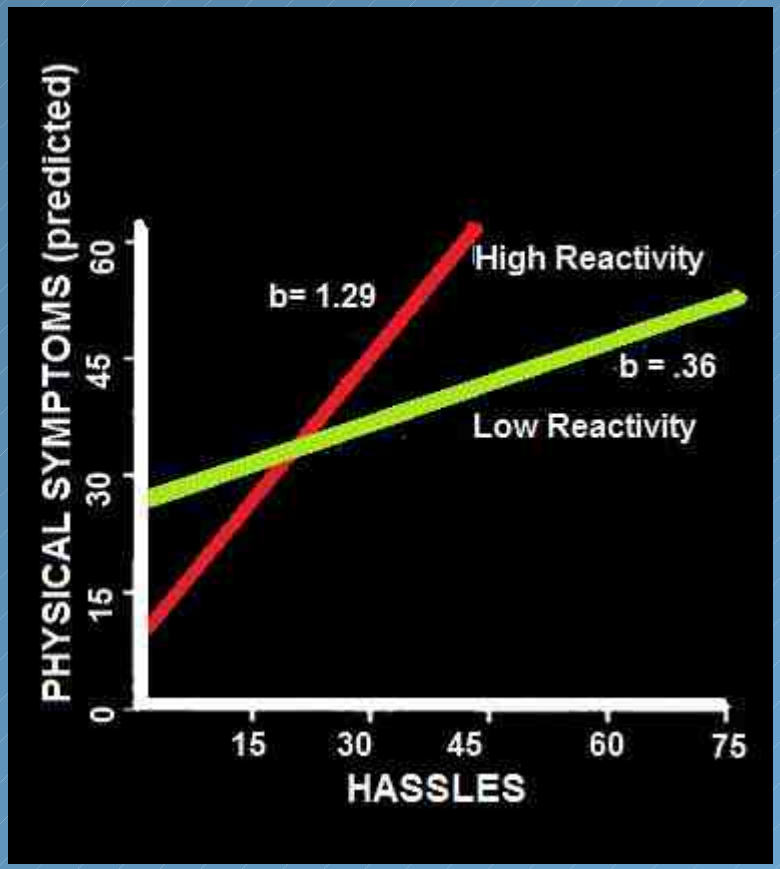
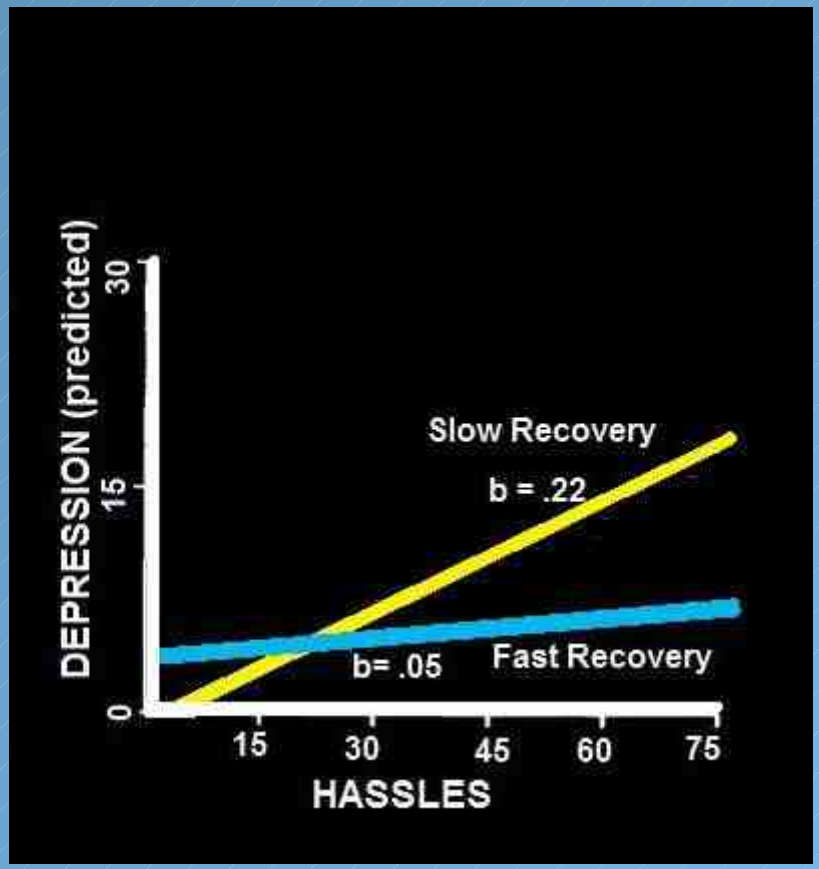
Daily Hassles, Physical Health & Depression (Blood Volume Pulse Amplitude and Heart Rate Reactivity)





Gannon, L., Banks, J., Shelton, D., & Luchetta, T. (1989). The mediating effects of psychophysiological reactivity and recovery on the relationship between environmental stress and illness. *Journal of Psychosomatic Research, 33*(2), 167-175.

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CAN WE MOVE BEYOND CORRELATIONAL EVIDENCE TO EXPERIMENTAL DATA?

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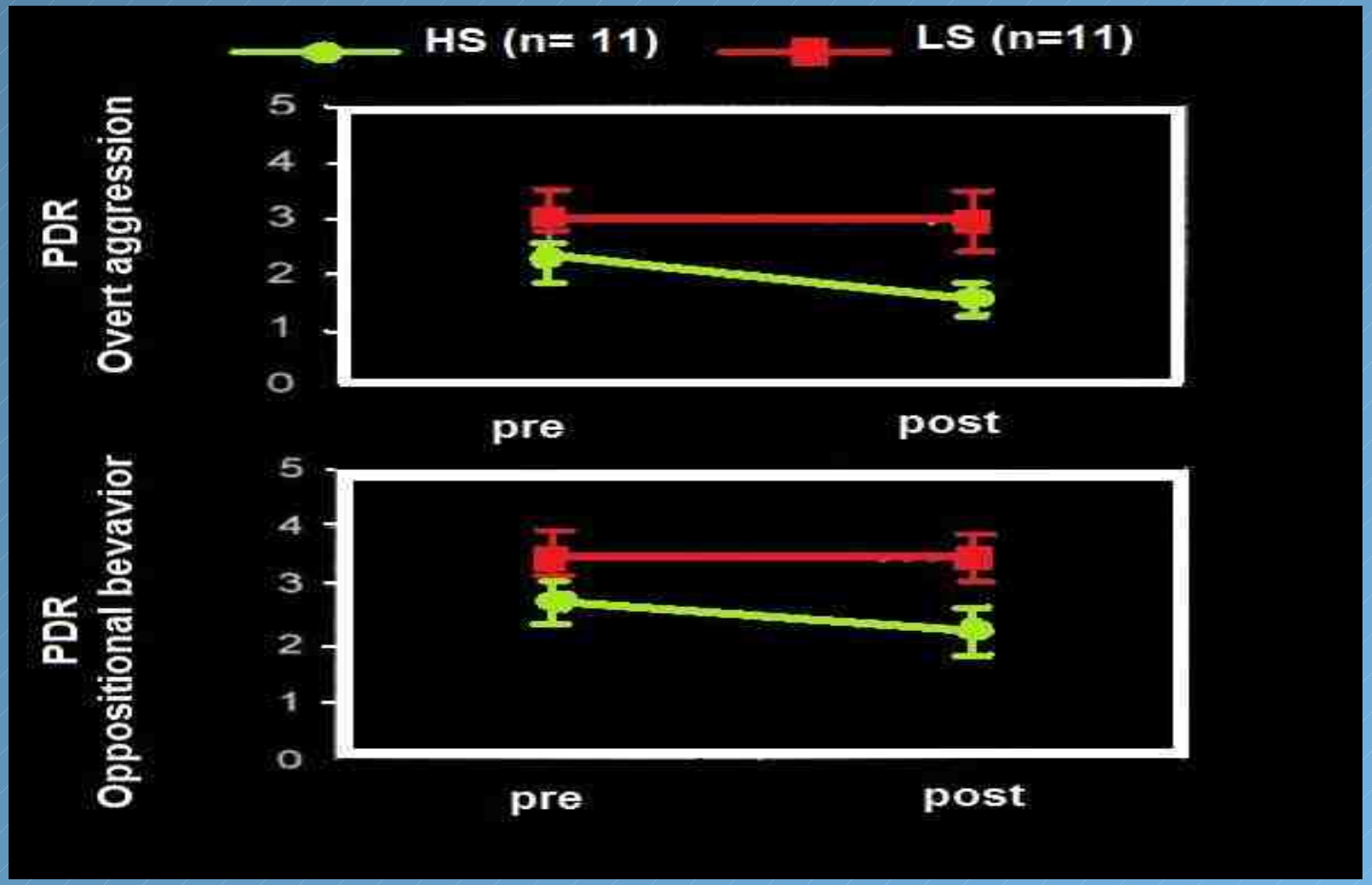
Intervention for Children with Disruptive Behavior Disorder

(Cortisol Stress Reactivity: HS=Highly Reactive)



Pre- and postrtreament comparison of Parent Daily Report (PDR) Overt Aggression scores and Oppositional Behavior scores in high cortisol stress responsivity (HS) and low cortisol stress responsivity (LS) in disruptive behavior disorder subgroups

Van de Wiel et al. (2004). Cortisol and treatment effect in children with disruptive behavior disorder: A preliminary study. *Journal of the American Academy of Child and Adolescent Psychiatry, 43*, 1011-1018.

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BEYOND TEMPERAMENT AND PHYSIOLOGY:

Genes as Moderators of Environmental Effects (GXE)

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The 5-HTTPLPR Gene

The serotonin-transporter gene (5-HTTP) is a good gene to consider because there is some evidence that infants carrying the short (vs. long) allele are more negatively emotional as newborns (Auerbach et al., 2005). Short alleles have also been linked to depression in females and vulnerability to the depression fostering effects of negative life events in adulthood (Caspi et al., 2003).

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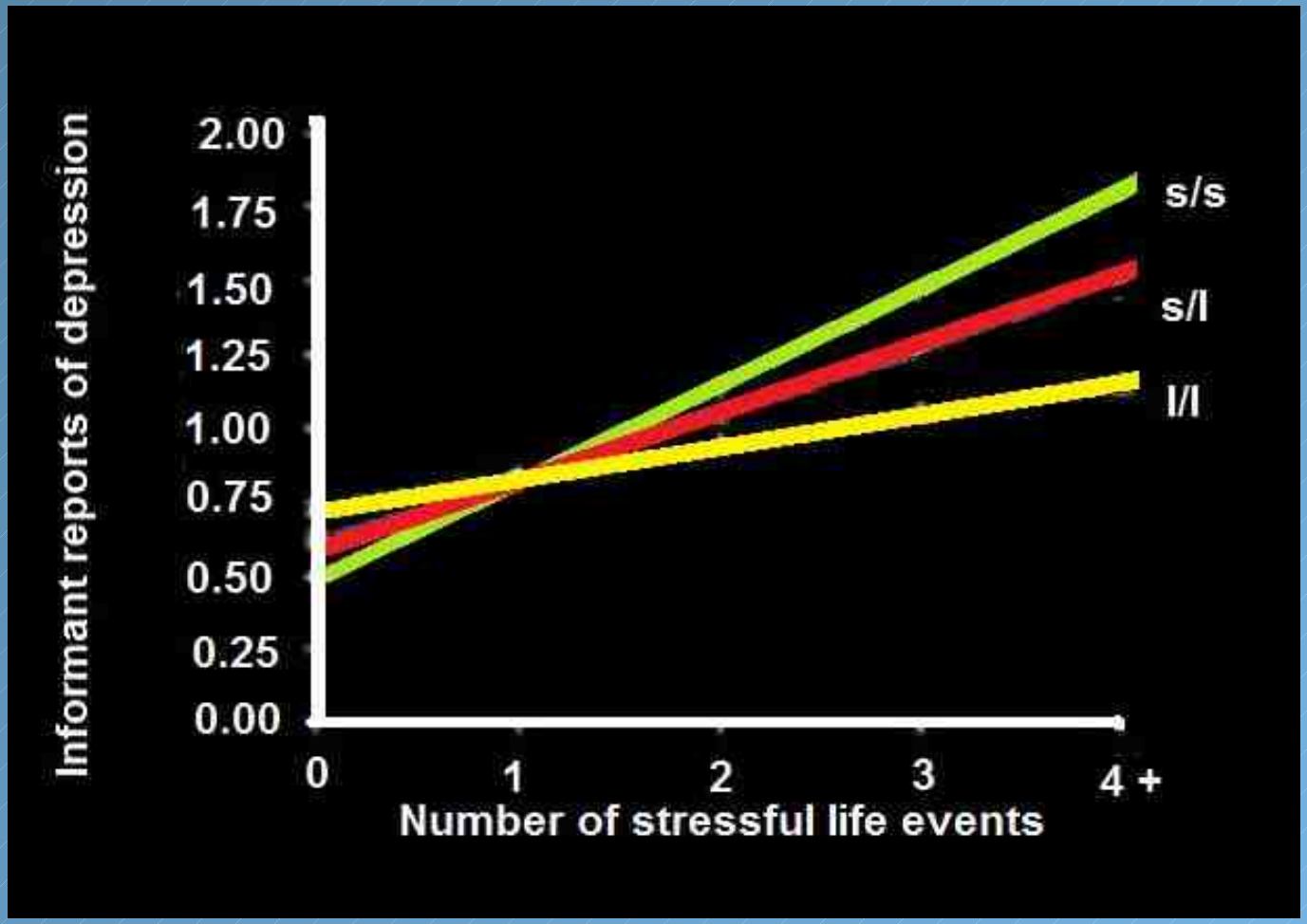
Stressful Life Events and Depression in Young Adulthood



Caspi, A., Sugden, K., Moffitt, T.E., Taylor, A., Craig, I.W., Harrington, H., McClay, J., Mil,l J., Martin, J., Braithwaite, A. & Poulton, R (2003). Influence of life stress on depression: Moderation by a polymorphism in the 5 HTT gene. Science, 301, 386-389.

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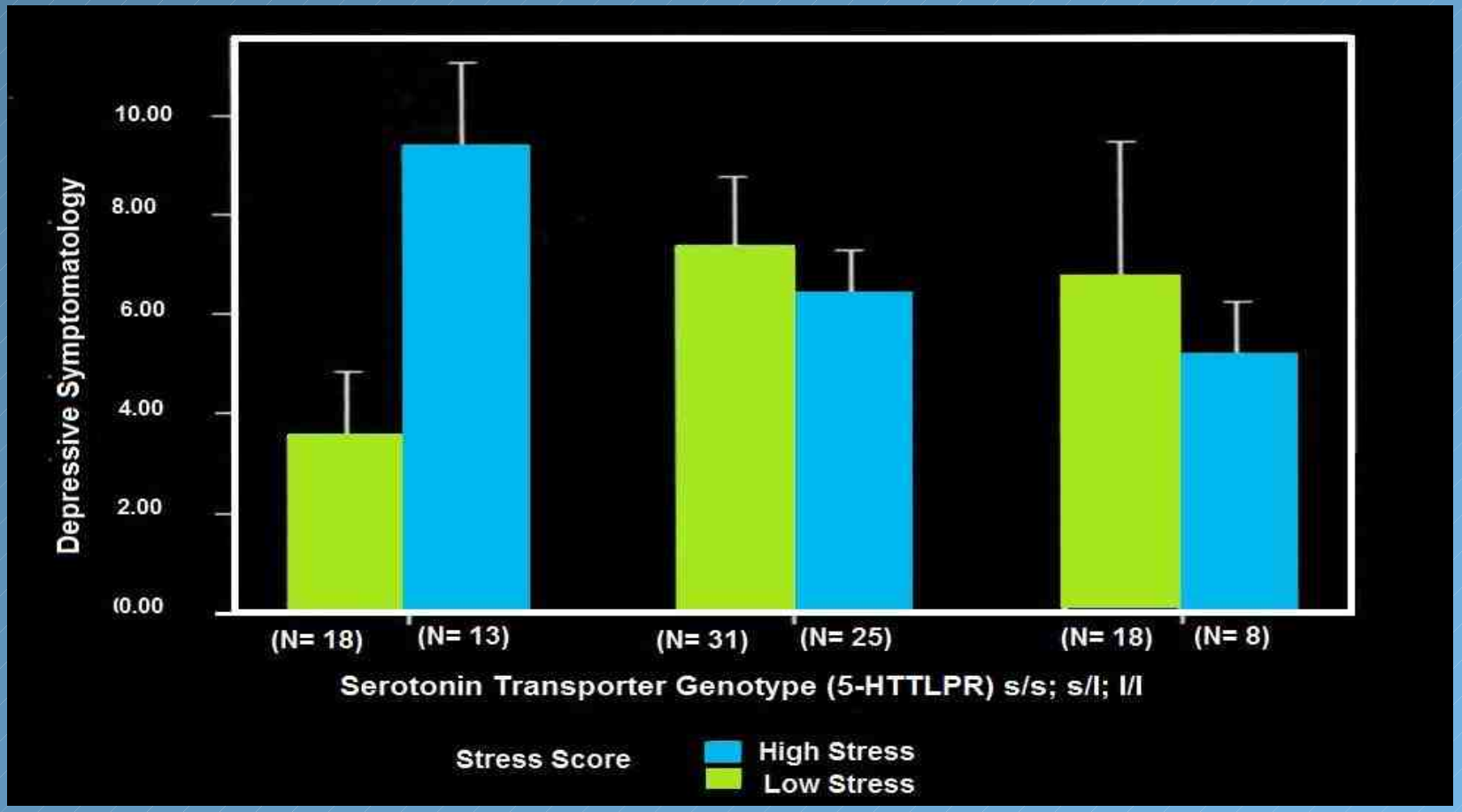
Recent Life Events and Depression in Young Adulthood



Taylor, S. E., Way, B. M., Welch, W. T., Hilmert, C. J., Lehman, B. J., & Eisenberger, N. I. (2006). Early family environment, current adversity, the serotonin transporter promoter polymorphism, and depressive symptomatology. Biological Psychiatry, 60(7), 671-676.

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Perceived Racial Discrimination and Conduct Problems

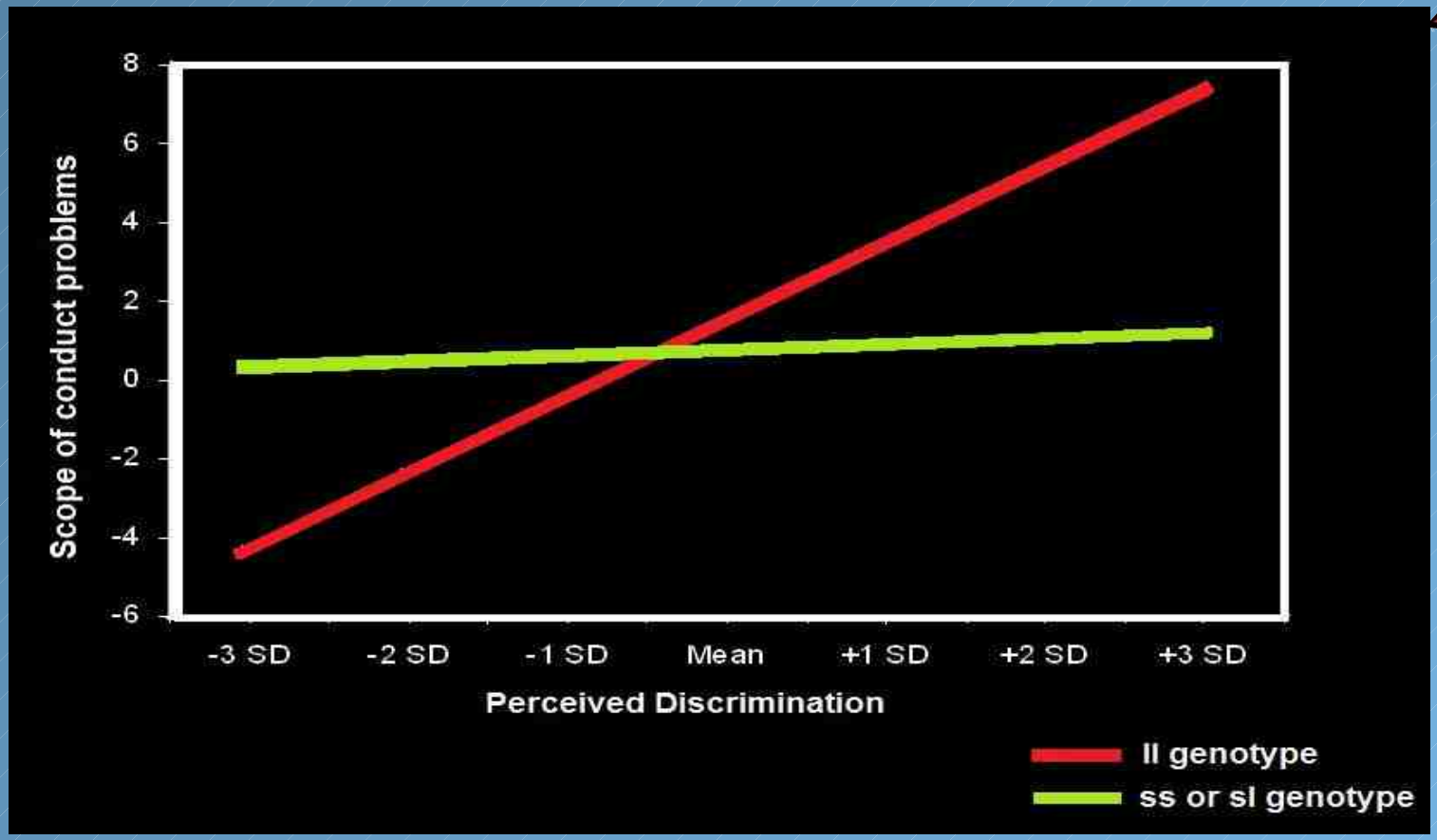

Figure 2. Results of the analysis for male youths only. Slopes of conduct problems for levels of perceived discrimination, ranging from -3 to +3 standard deviations from the sample mean, plotted separately for male youths with the *ll* genotype and male youths with the *ss* or *sl* genotype.

Brody, G.H., et al. (submitted). Perceived discrimination, 5-HTTLPR status, and conduct problems: A differential susceptibility analysis.

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GXE:
The MAOA Gene

The MAOA gene is located on the X chromosome and encodes the MAOA enzyme, which metabolizes neurotransmitters such as norepinephrine, serotonin, and dopamine, rendering them inactive. Deficiencies in MAOA activity have been linked with aggression in mice and humans (i.e., low MAOA activity)—but like other studies looking at direct or main effects of genes on behavior, only inconsistently, perhaps due to GXE

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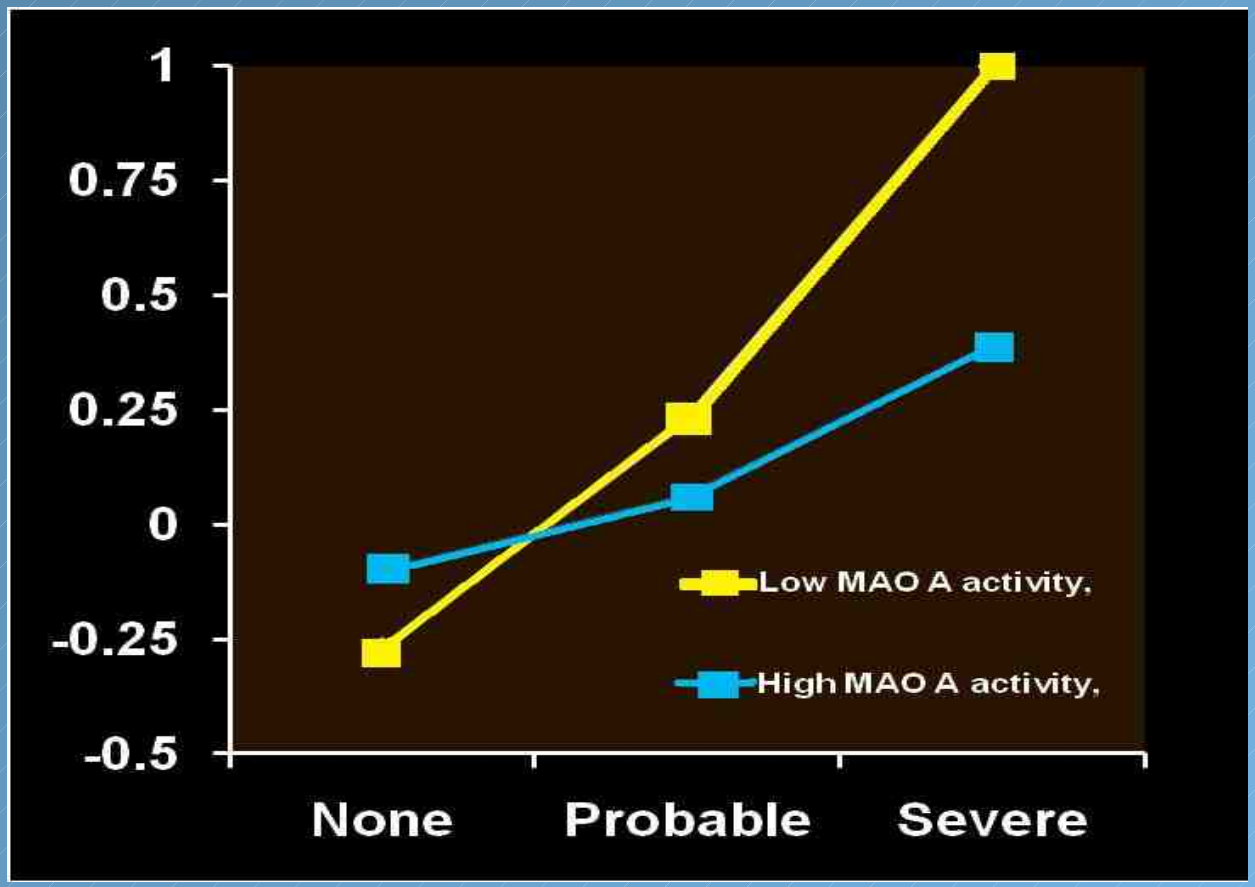
Child maltreatment and Antisocial Behavior



Caspi, A. et al. (2002). The role of genotype in the cycle of violence in maltreated children. Science, 297, 851-854.

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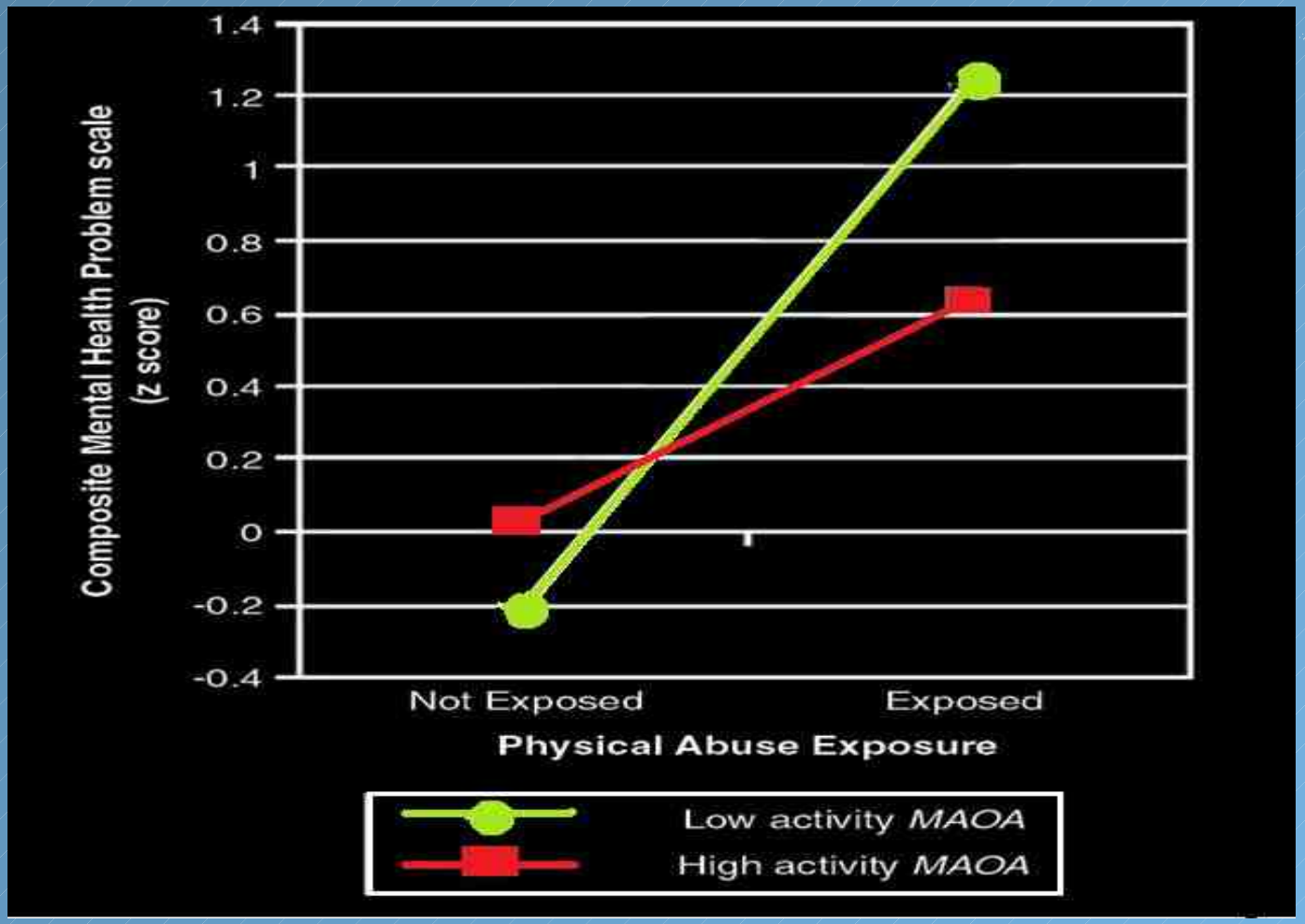
Physical Abuse and Mental Health Problems



Kim-Cohen, J., Caspi, A., Taylor, A., Williams, B., Newcombe, R., Craig, I. W., et al. (2006). MAOA, maltreatment, and gene-environment interaction predicting children's mental health: new evidence and a meta-analysis. *Molecular Psychiatry, 11*(10), 903-913.

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Sexual Abuse and Anti-Social Personality Disorder in Adult Women

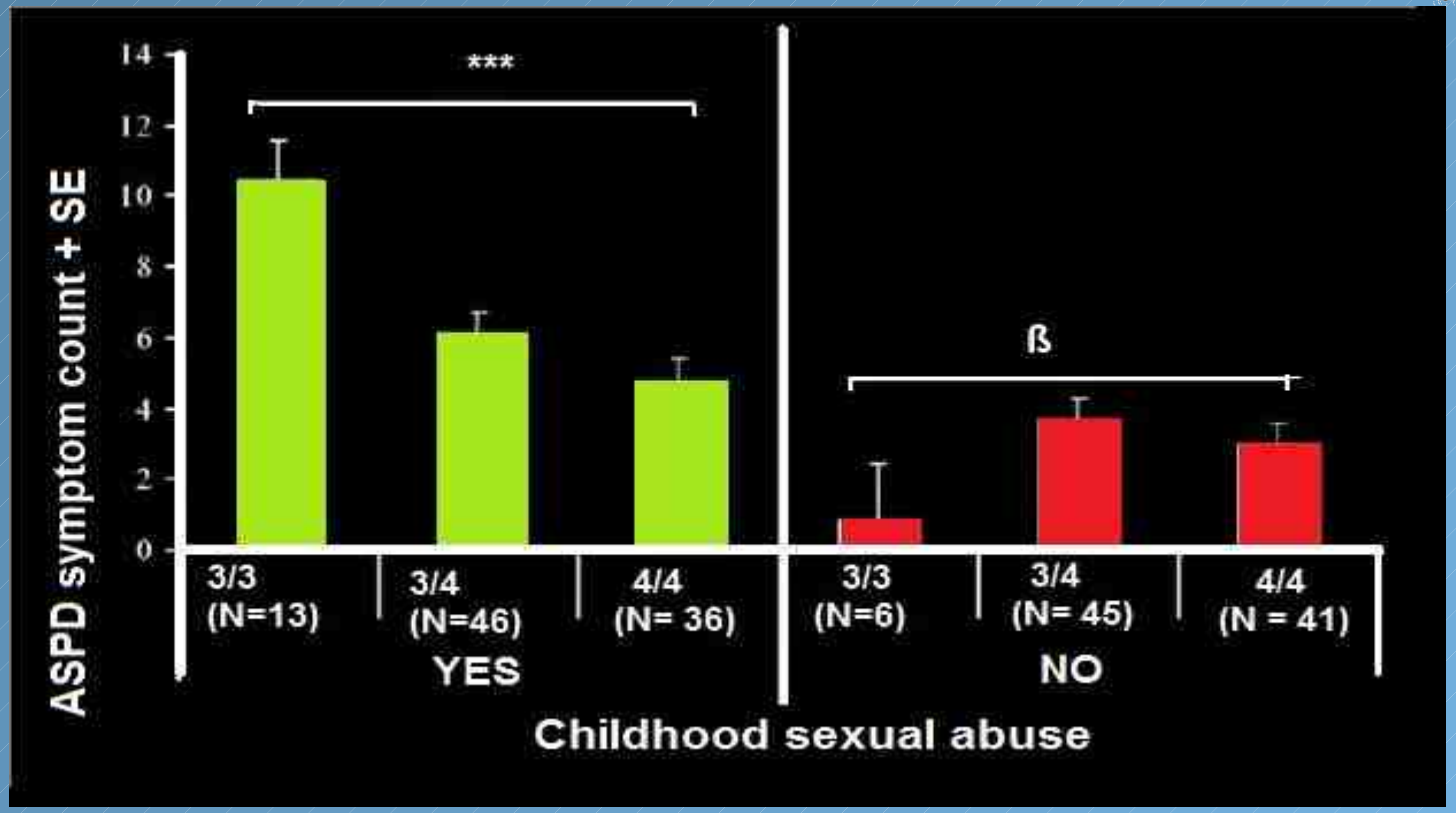

Figure 3 ASPD symptoms count is compared across the three MAOA-LPR genotypes separately within sexually molested ($N=95$) and non-sexually molested participants ($N=92$). 3/3 = homozygous for the low activity allele; 3/4 = heterozygous; 4/4 = homozygous for the high activity allele; β = regression coefficient; CSA = childhood sexual abuse. *** = $P<0.001$.

Ducci, F., Enoch, M. A., Hodgkinson, C., Xu, K., Catena, M., Robin, R. W., et al. (2008). Interaction between a functional MAOA locus and childhood sexual abuse predicts alcoholism and antisocial personality disorder in adult women. Molecular Psychiatry, 13(3), 334-347.

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GXE:
The DRD4 Gene

The *DRD4* gene codes for a type of dopamine receptor, with the dopaminergic system involved in attentional, motivational, and reward mechanisms in the brain. One variant of this gene, the 7-repeat DRD4 allele, has been linked to lower dopamine reception efficiency, and thus to ADHD and externalizing problems in children, as well as behavioral difficulties, including substance abuse and aggression, in adulthood, .

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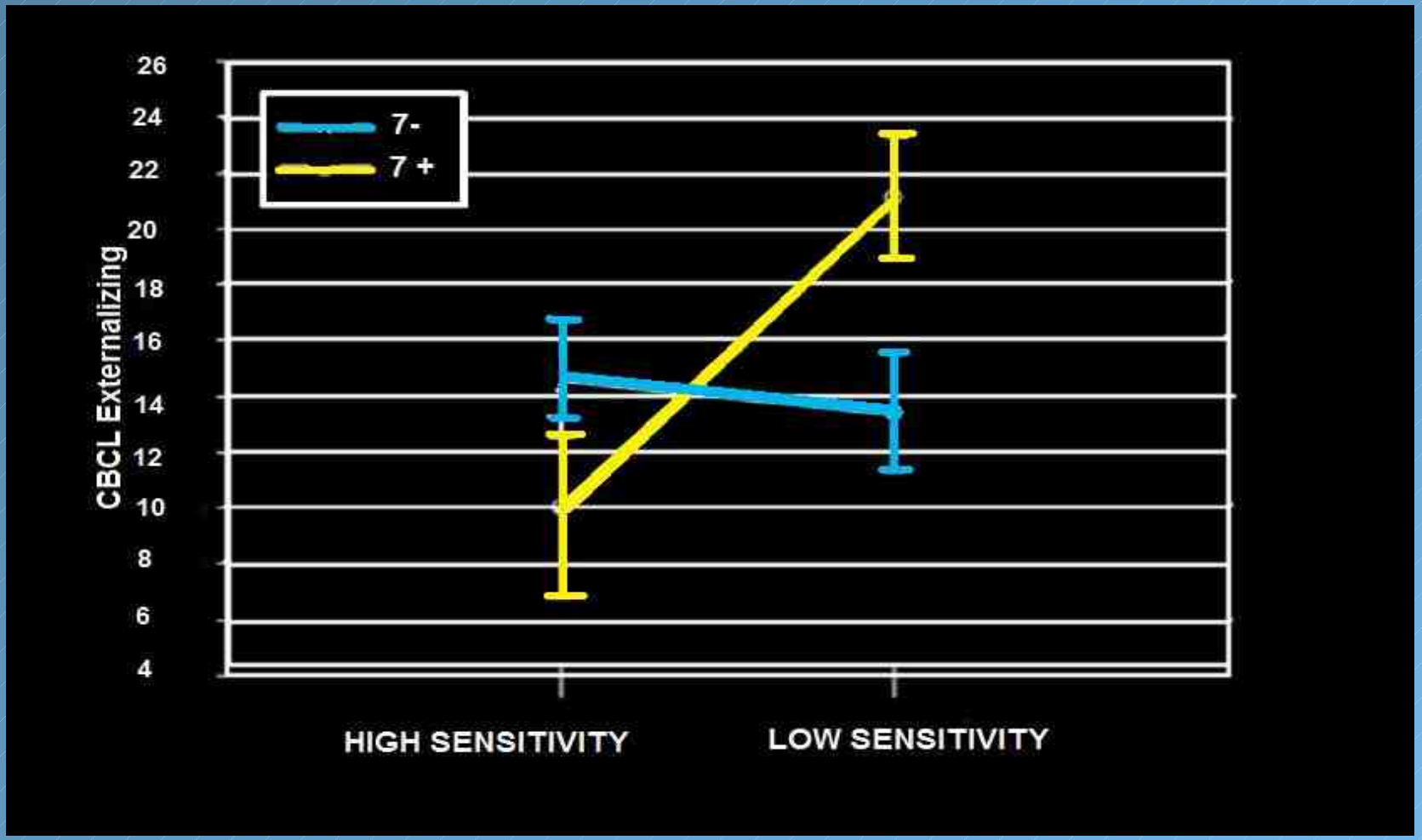

Fig: Externalizing scores (M. SE) of preschoolers with and without the DRD4 exon III 7-repeat allele experiencing sensitive or insensitive parenting.

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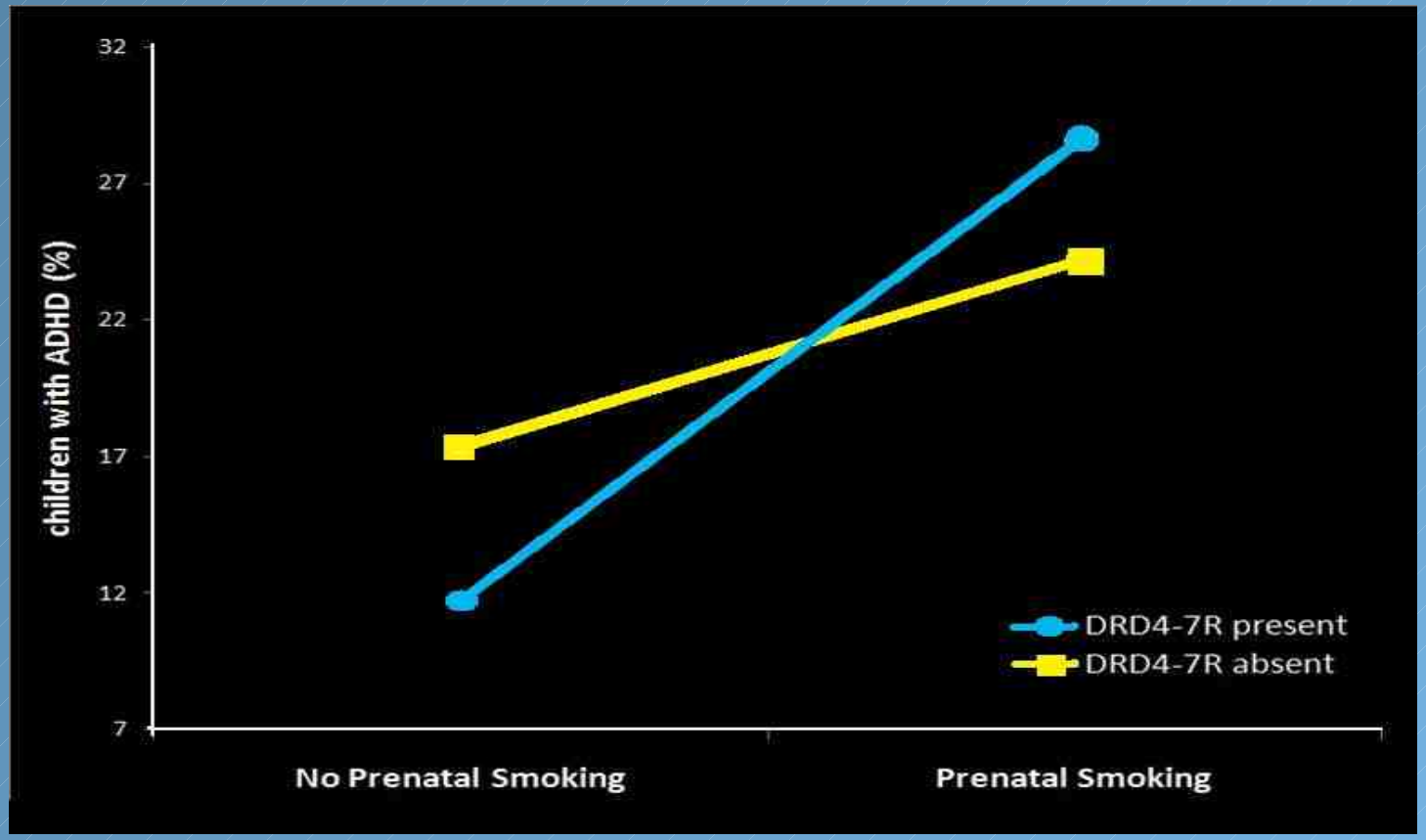
Prenatal Smoking & ADHD



Based on: Neuman RJ, Lobos E, Reich W, Henderson CA, Sun LW, Todd RD (2007): Prenatal smoking exposure and dopaminergic genotypes interact to cause a severe ADHD subtype. *Biological Psychiatry* 61:1320-8.

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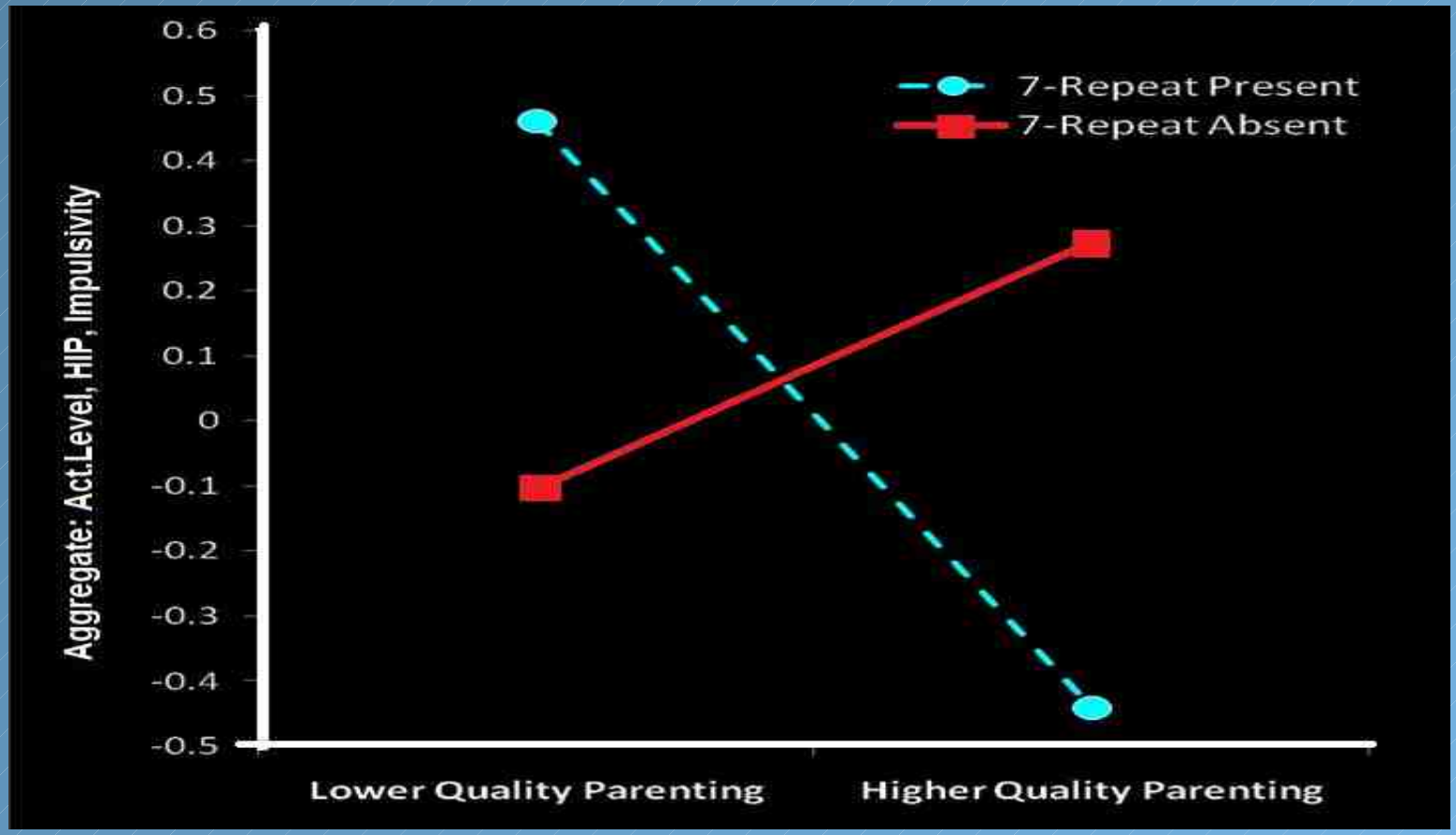
Parenting and Hyperactivity/ Impulsivity



Regraphing of Figure from Sheese, B. E., Voelker, P. M., Rothbart, M. K., & Posner, M. I. (2007). Parenting quality interacts with genetic variation in dopamine receptor D4 to influence temperament in early childhood. *Development and Psychopathology, 19*, 1039-1046.

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EXPERIMENTAL EVIDENCE OF GXE IN THE CASE OF PARENTING INTERVENTION

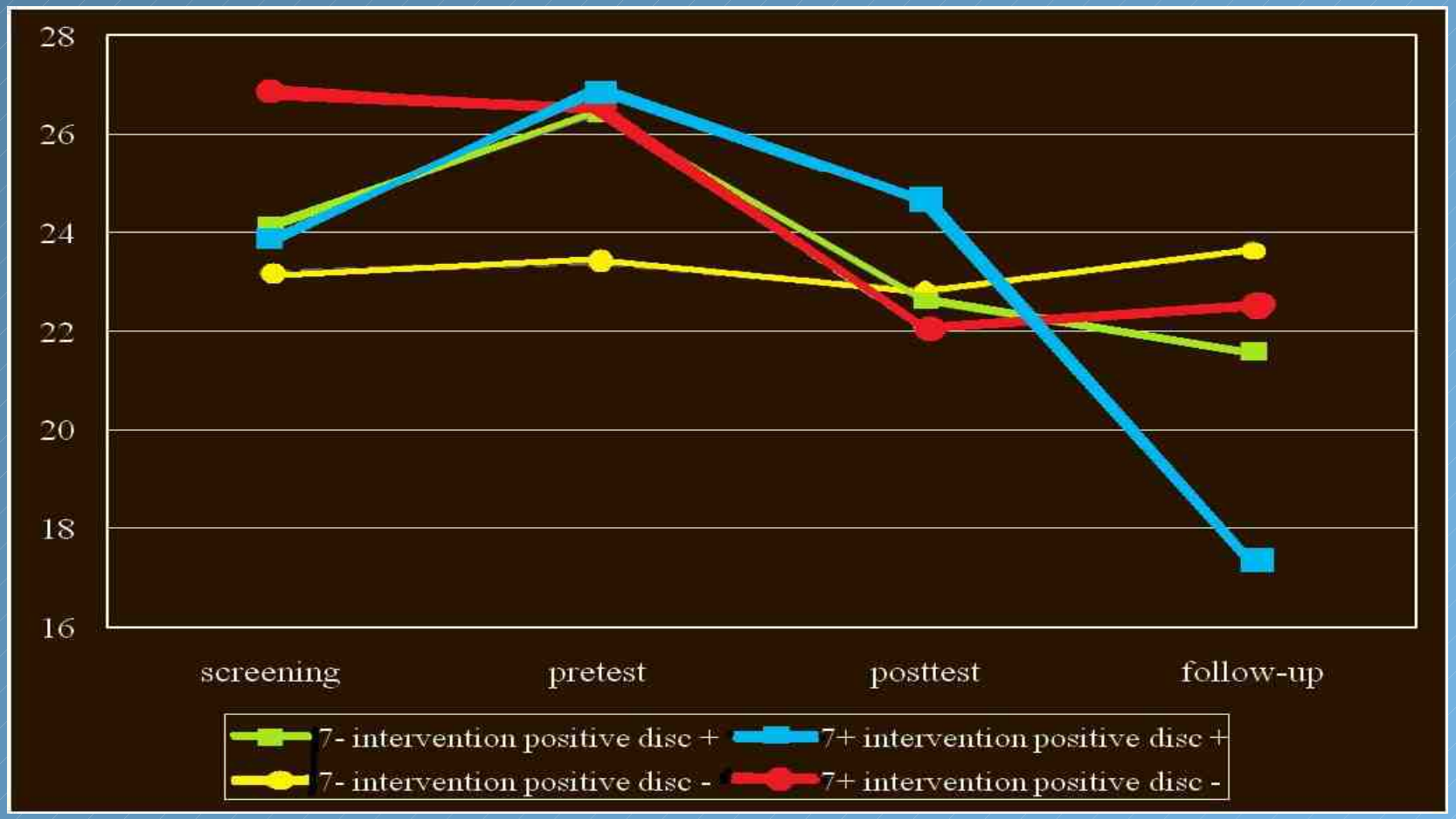
Development of Externalizing Behavior Over Time for Intervention and Control Groups by DRD47-Repeat Allele

CBCL externalizing

Source: Bakermans-Kranenburg et al. (2008). Experimental evidence for differential susceptibility: Dopamine D4 receptor polymorphism (DRD4 VNTR) moderates intervention effects on toddlers' externalizing behavior in a randomized controlled trial. *Developmental Psychology, 44, 293-300.*

Development of Externalizing Behavior Over Time for Intervention and Control Groups By DRD47-Repeat Allele

CBCL externalizing



Source: Bakermans-Kranenburg et al. (2008). Experimental evidence for differential susceptibility: Dopamine D4 receptor polymorphism (DRD4 VNTR) moderates intervention effects on toddlers' externalizing behavior in a randomized controlled trial. *Developmental Psychology, 44, 293-300.*

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BEYOND SINGLE GENES: CUMUALTIVE GENETIC PLASTICITY?

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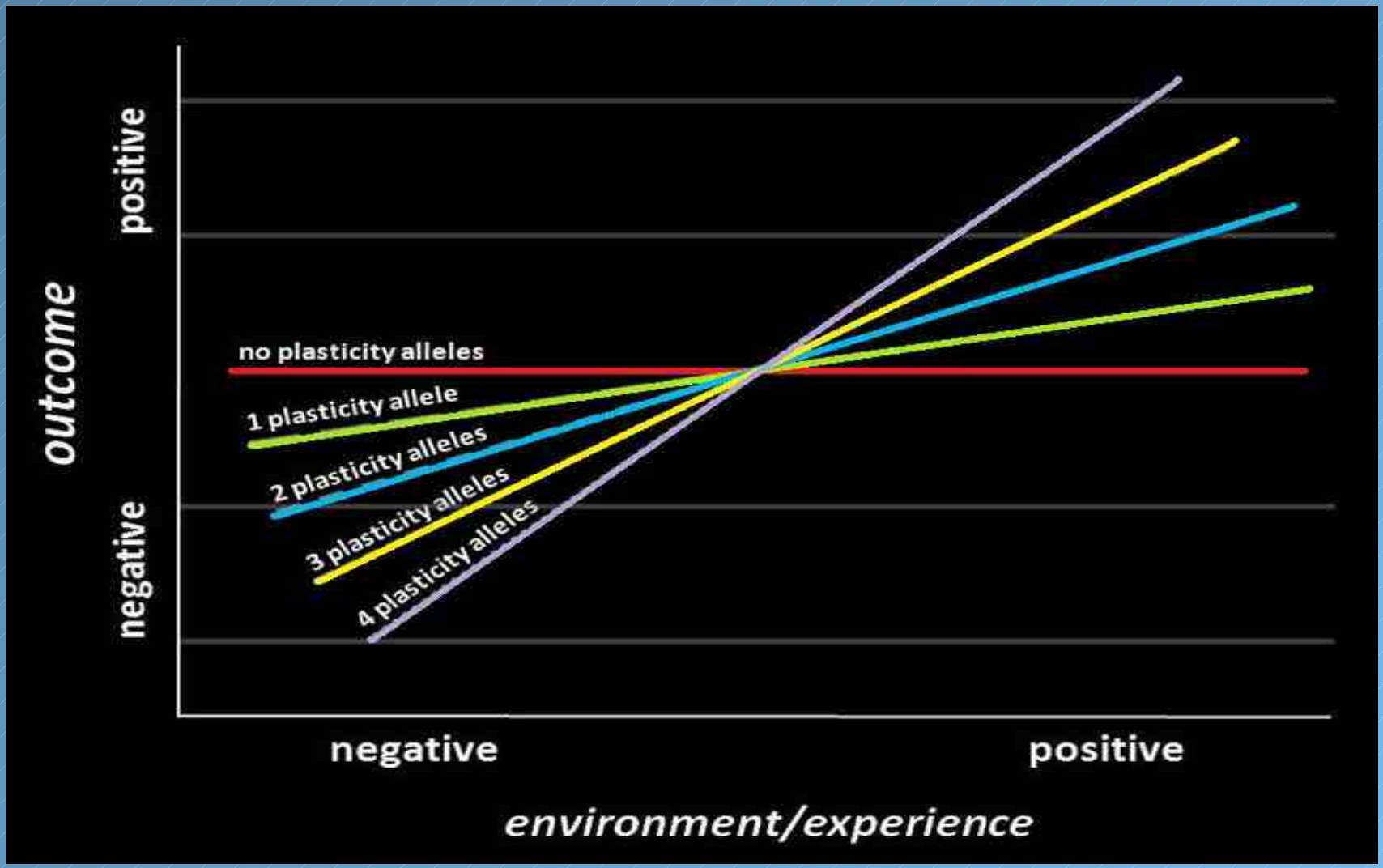
THEORETICAL MODEL OF GENETIC-PLASTICITY GRADIENT



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Plasticity Genes
(DAT1, DRD2, DRD4, 5HTTLPR, and MAOA),
Negative-Positive Mothering
and
Lack of Self Control
in Adolescence

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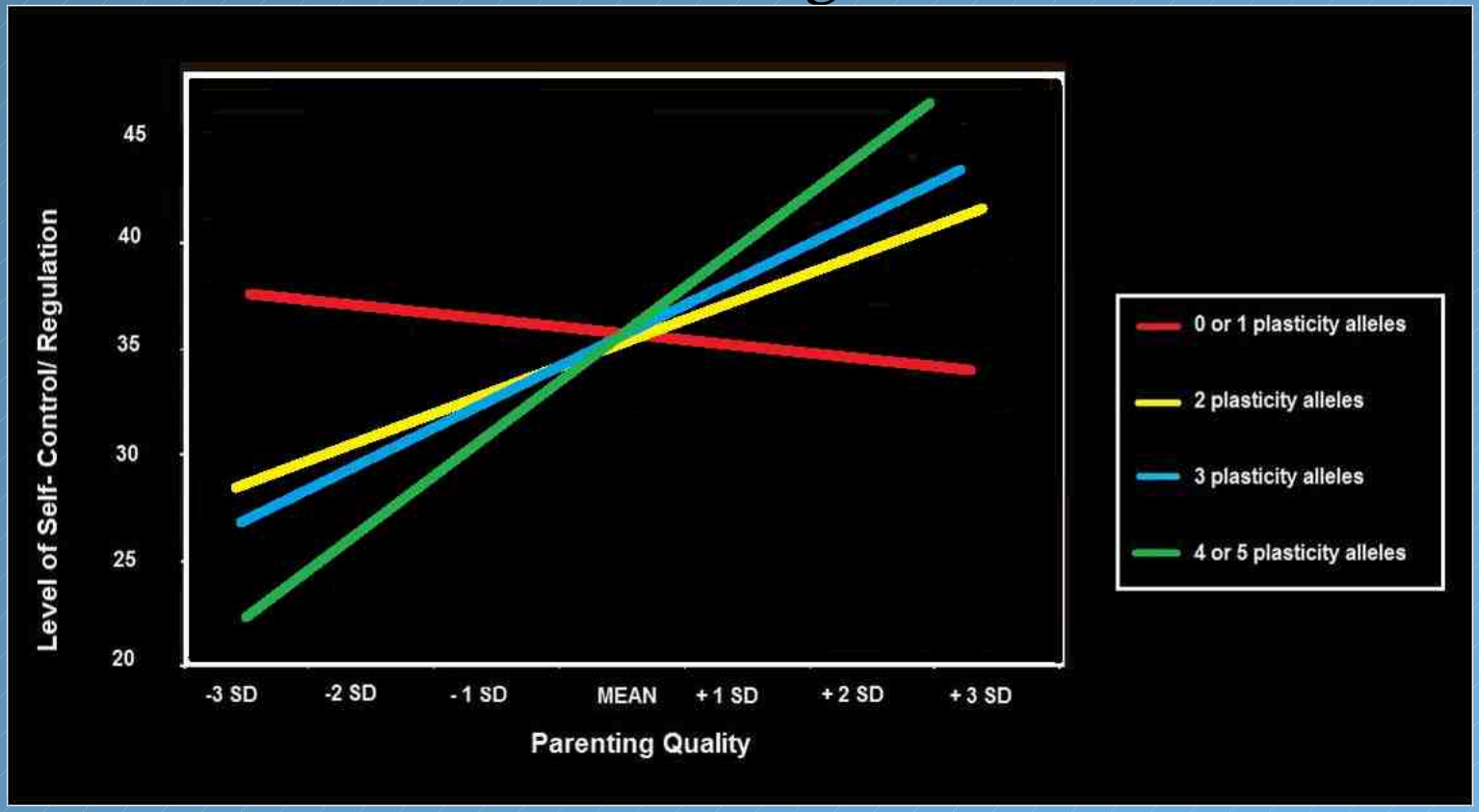
Parenting and Adolescent Boys' Self-Control Regulation



Belsky, J., & Beaver, M. (in press). Cumulative-Genetic Plasticity, Parenting and Adolescent Self-Control/Regulation. *Journal of Child Psychology & Psychiatry*.

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CONCLUSION

--Same susceptible individuals; different markers across studies?
--Language for "upside plasticity"?
--Domain specific or domain general?
--Mechanisms?
--Susceptibility: born or made or "born to be made"?
--GXE interaction or epigenetic mediation: E→G→Behavior
--Implications for Intervention