Biological and Experimental Psychology
School of Biological and Chemical Sciences

Queen Mary
University of London

Individual Differences in Environmental Sensitivity

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CYFS Signature Event Series, University of Nebraska-Lincoln **April 11 2018**

Overview

- **Environmental Sensitivity**
- **Individual Differences**
  - Diathesis-Stress
  - Differential Susceptibility
  - Vantage Sensitivity
- **Mechanisms of Environmental Sensitivity**
  - Neurosensitivity Hypothesis
- **Phenotype of Environmental Sensitivity**
  - Sensory Processing Sensitivity
- **Sensitivity Types**
- **Implications**

Environmental Sensitivity

- Environmental Sensitivity is a fundamental trait found in most species, including humans:
  - ***Ability to register and process external stimuli***
- Do all people have the same degree of Environmental Sensitivity?
  - Differences in Environmental Sensitivity are widely observable and are reflected in many psychological concepts
    - ➢ E.g.: Personality traits, stress reactivity etc.

→ **Some people are generally more and some people generally less sensitive**

Pluess, M. (2015). Individual Differences in Environmental Sensitivity. *Child Development Perspectives*, 9(3), 138-143.

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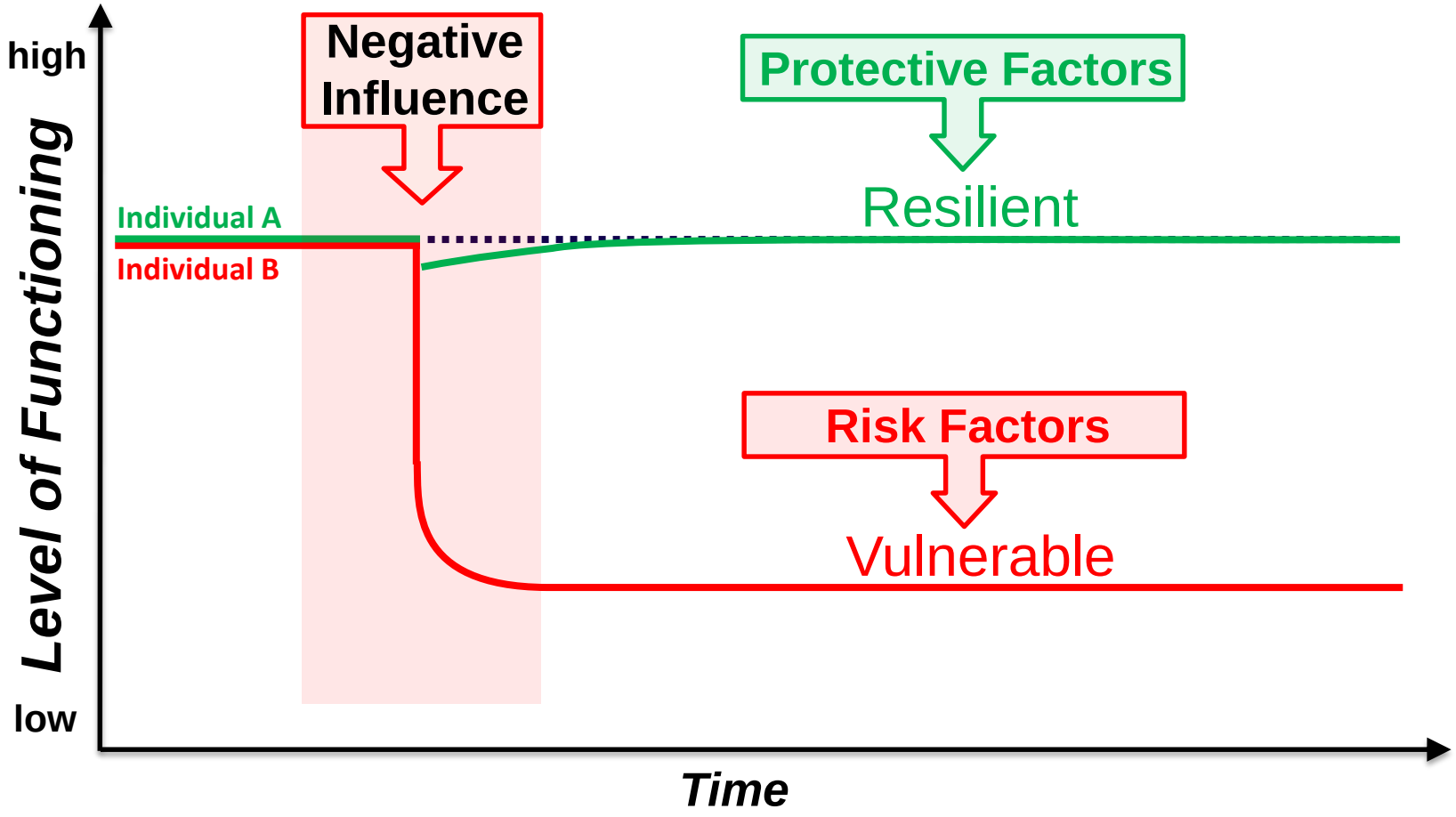
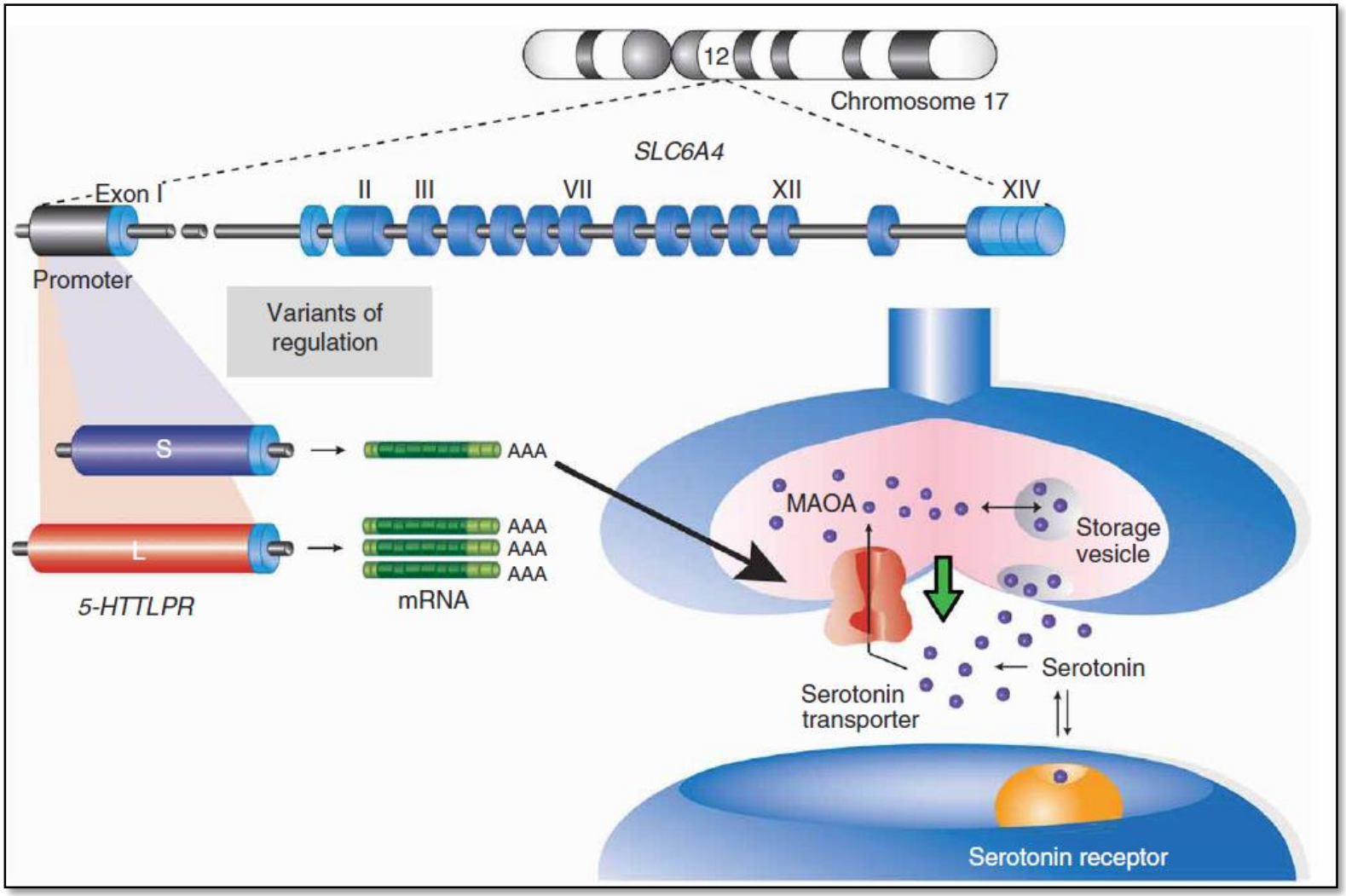
Diathesis-Stress/Dual Risk Model

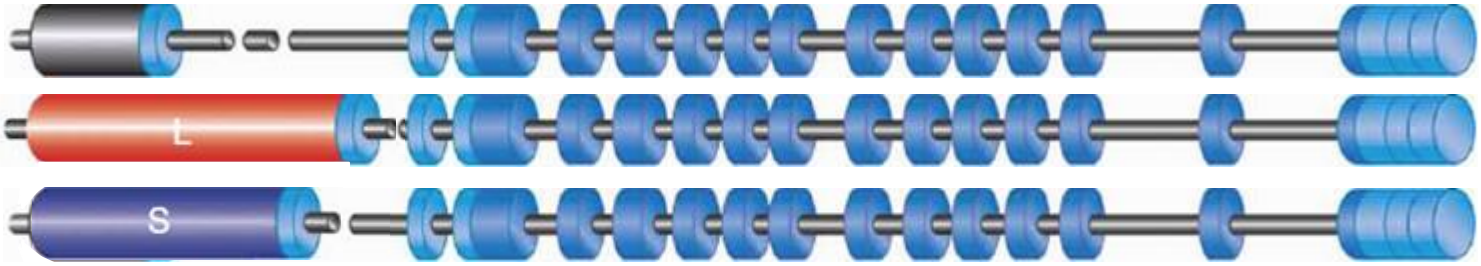


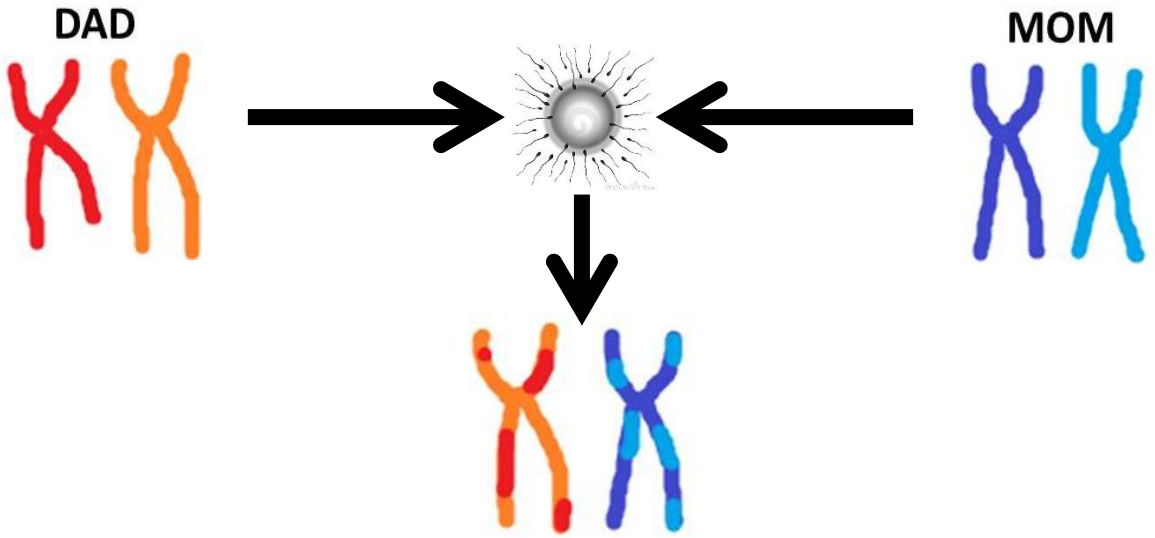
Serotonin Transporter Polymorphism

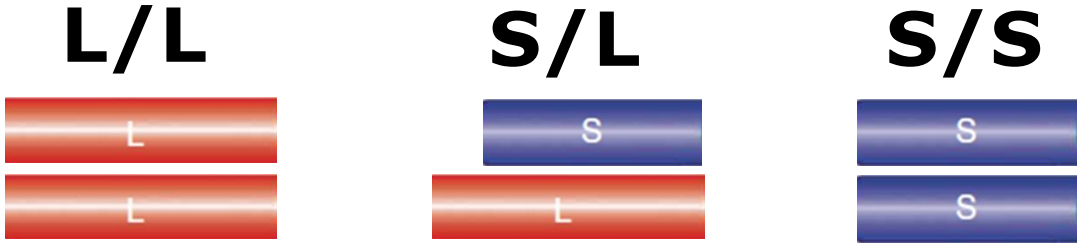


Canli, T., & Lesch, K. P. (2007). Long story short: the serotonin transporter in emotion regulation and social cognition. *Nature Neuroscience*

Serotonin Transporter Polymorphism

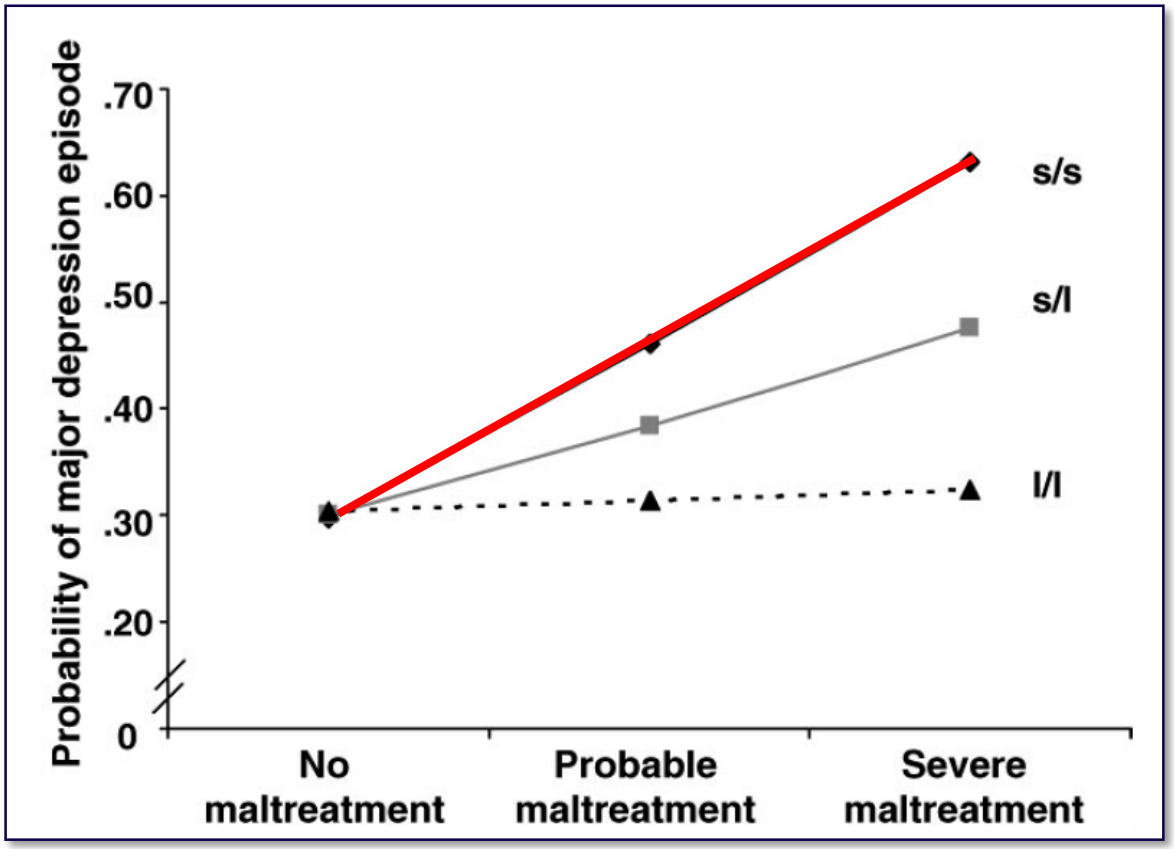






Example: Genetic Factors

- **Serotonin Transporter (5-HTTLPR)**



Caspi, A., Sugden, K., Moffitt, T. E., Taylor, A., Craig, I. W., Harrington, H., et al. (2003). Influence of life stress on depression: moderation by a polymorphism in the 5-HTT gene. *Science*, 301(5631), 386-389.

From Diathesis-Stress to Differential Susceptibility

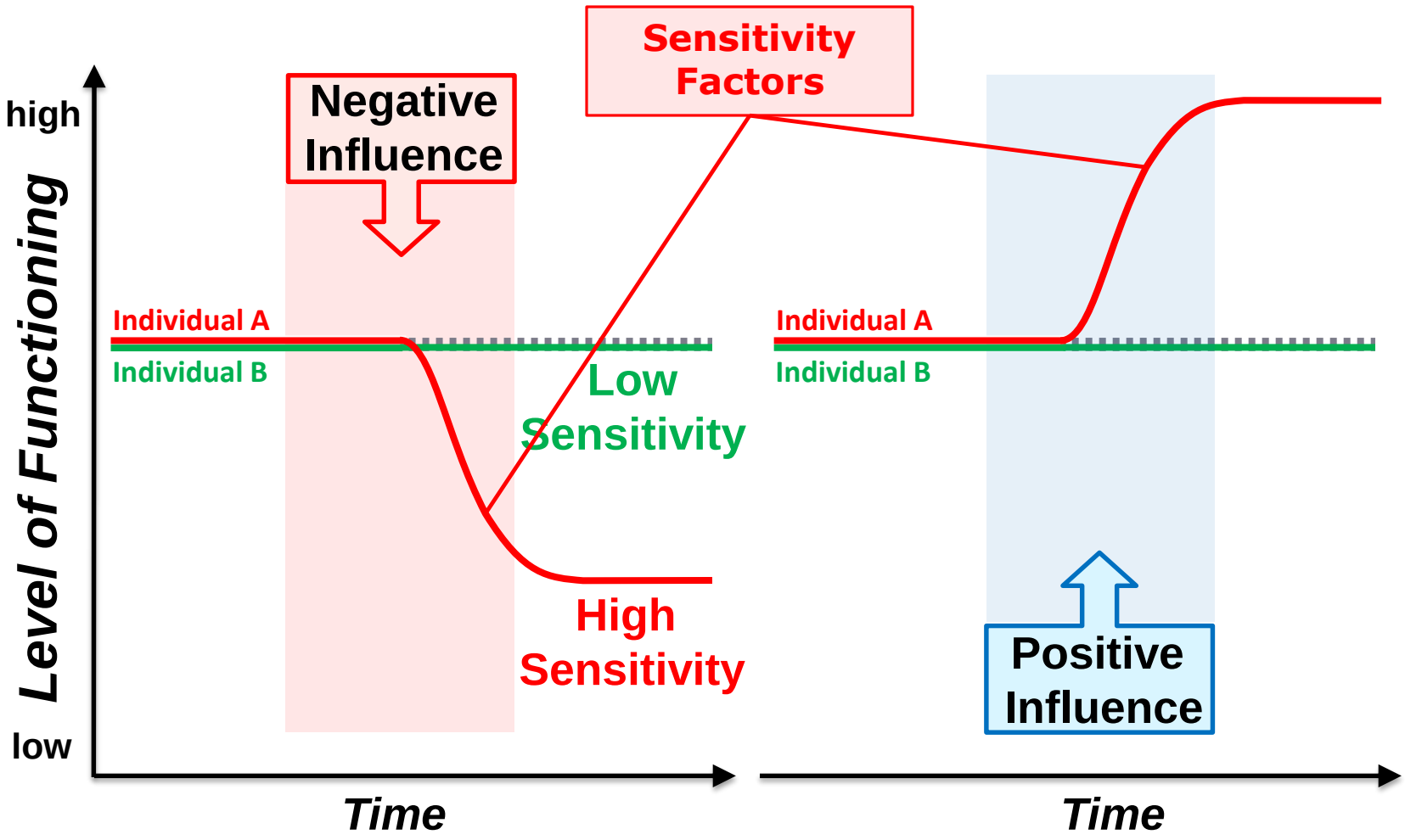
Differential Susceptibility

- Jay Belsky (1997;2005); Belsky & Pluess (2009; 2013)
  - Related to Biological Sensitivity to Context (Boyce & Ellis, 2005)
- Based on evolutionary theory

1. **People differ in their degree of environmental sensitivity**
2. **Some are generally more and some generally less susceptible**
3. **To effects of both *negative* and *positive* environmental experiences**

Belsky, J. & Pluess, M. (2009). Beyond Diathesis-Stress: Differential Susceptibility to Environmental Influences. *Psychological Bulletin, 135*(6), 885-908.

Differential Susceptibility



Belsky, J. & Pluess, M. (2009). Beyond Diathesis-Stress: Differential Susceptibility to Environmental Influences. *Psychological Bulletin, 135*(6), 885-908.

Sensitivity Factors

- Extensive review of empirical studies revealed associations between heightened environmental sensitivity and three categories of individual characteristics:

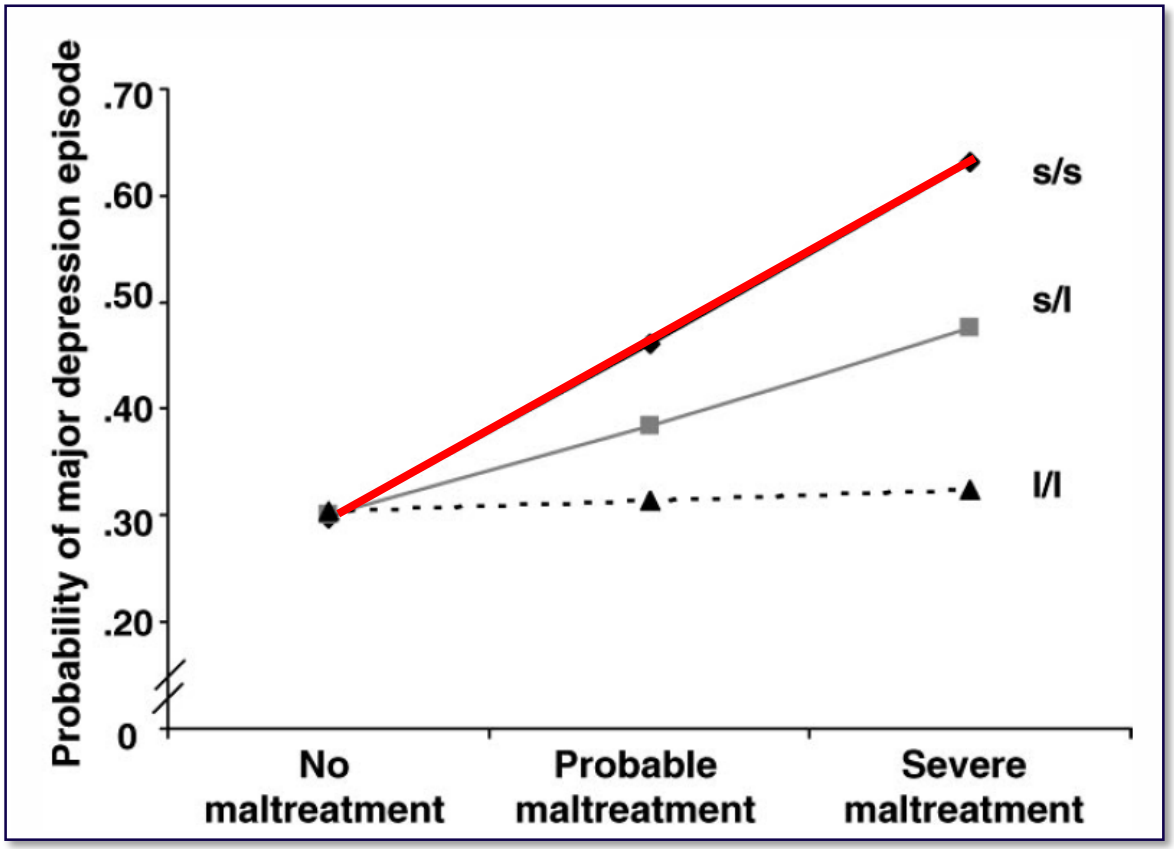
1. **Psychological Factors**
   - *e.g., infant temperament*
2. **Physiological Factors**
   - *e.g., cortisol reactivity*
     - ➢ See Boyce & Ellis (2005) Biological Sensitivity to Context
3. **Genetic Factors**
   - *e.g., serotonin transporter polymorphism*

Belsky, J. & Pluess, M. (2009). Beyond Diathesis-Stress: Differential Susceptibility to Environmental Influences. *Psychological Bulletin, 135*(6), 885-908.

Empirical Evidence for Differential Susceptibility

Empirical Evidence

- **Serotonin Transporter (5-HTTLPR)**



Caspi, A., Sugden, K., Moffitt, T. E., Taylor, A., Craig, I. W., Harrington, H., et al. (2003). Influence of life stress on depression: moderation by a polymorphism in the 5-HTT gene. *Science*, 301(5631), 386-389.

Empirical Evidence

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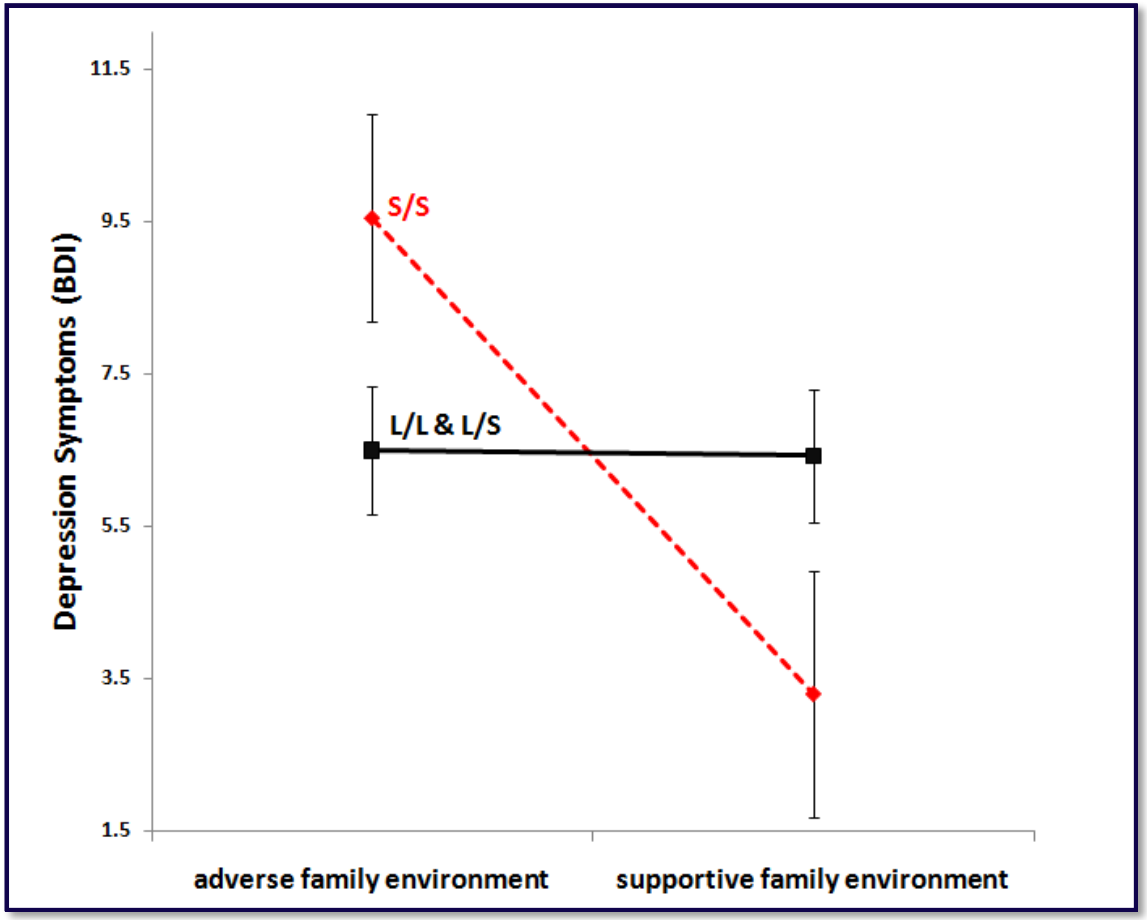
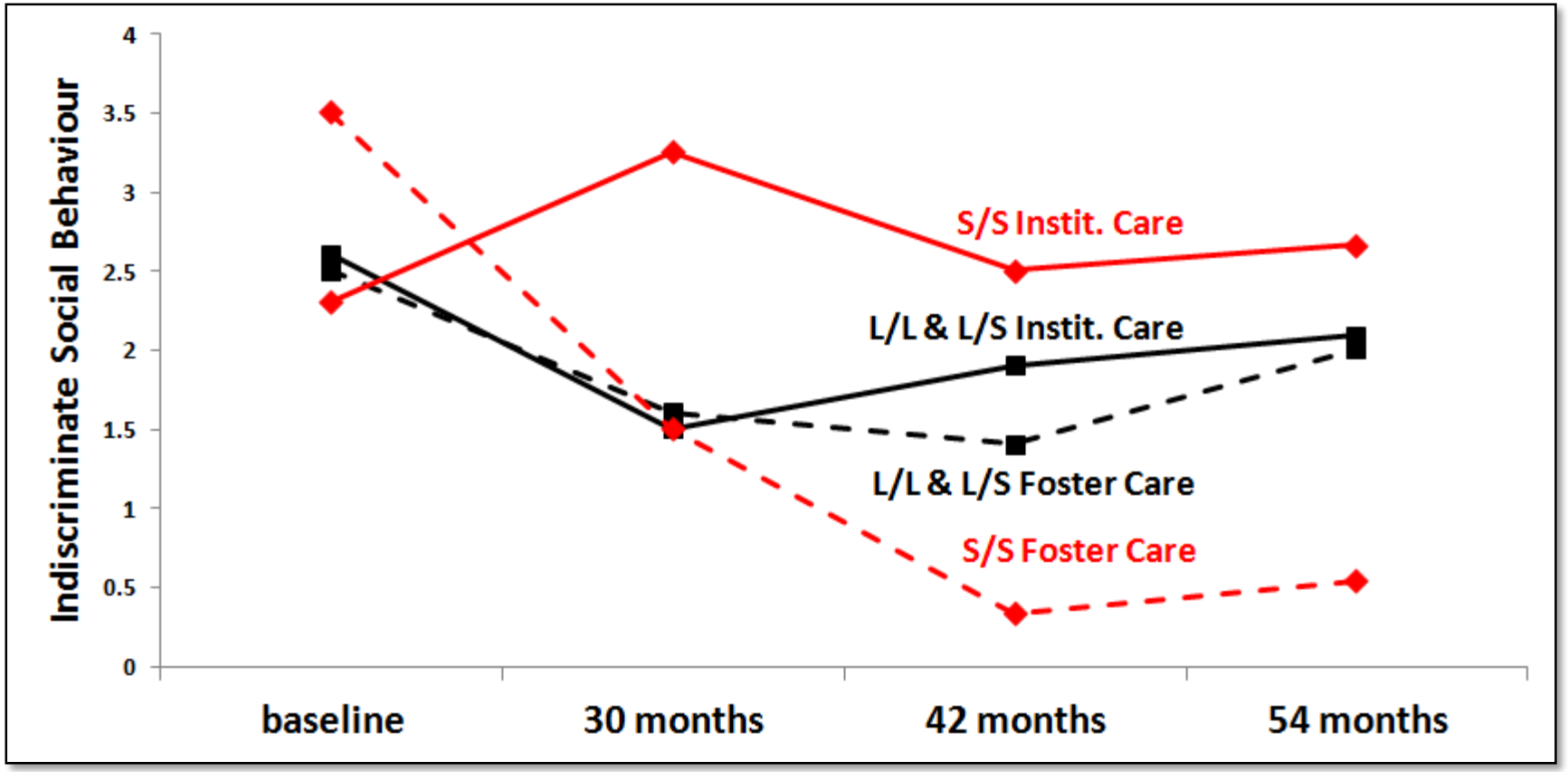


(Figure 1, redrawn)

Taylor, S. E. et al. (2006). Early family environment, current adversity, the serotonin transporter promoter polymorphism, and depressive symptomatology. *Biological Psychiatry*, 60(7), 671-676.

Empirical Evidence

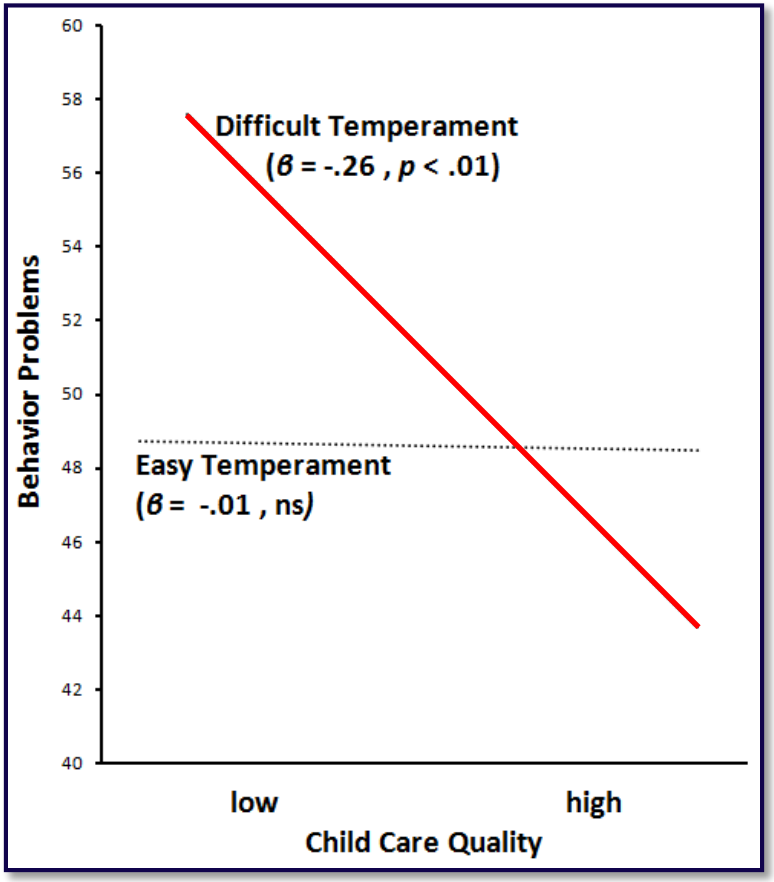
- **Serotonin Transporter (5-HTTLPR)**



Drury, S. S., Gleason, M. M., Theall, K. P., Smyke, A. T., Nelson, C. A., Fox, N. A., & Zeanah, C. H. (2012). Genetic sensitivity to the caregiving context: The influence of 5httlpr and BDNF val66met on indiscriminate social behavior. *Physiology and Behavior, 106*(5), 728-735.

Empirical Evidence

- **Difficult Temperament in Infancy**



Pluess, M., & Belsky, J. (2009). Differential Susceptibility to Rearing Experience: The Case of Childcare. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 50(4), 396-404.

From Differential Susceptibility to Vantage Sensitivity

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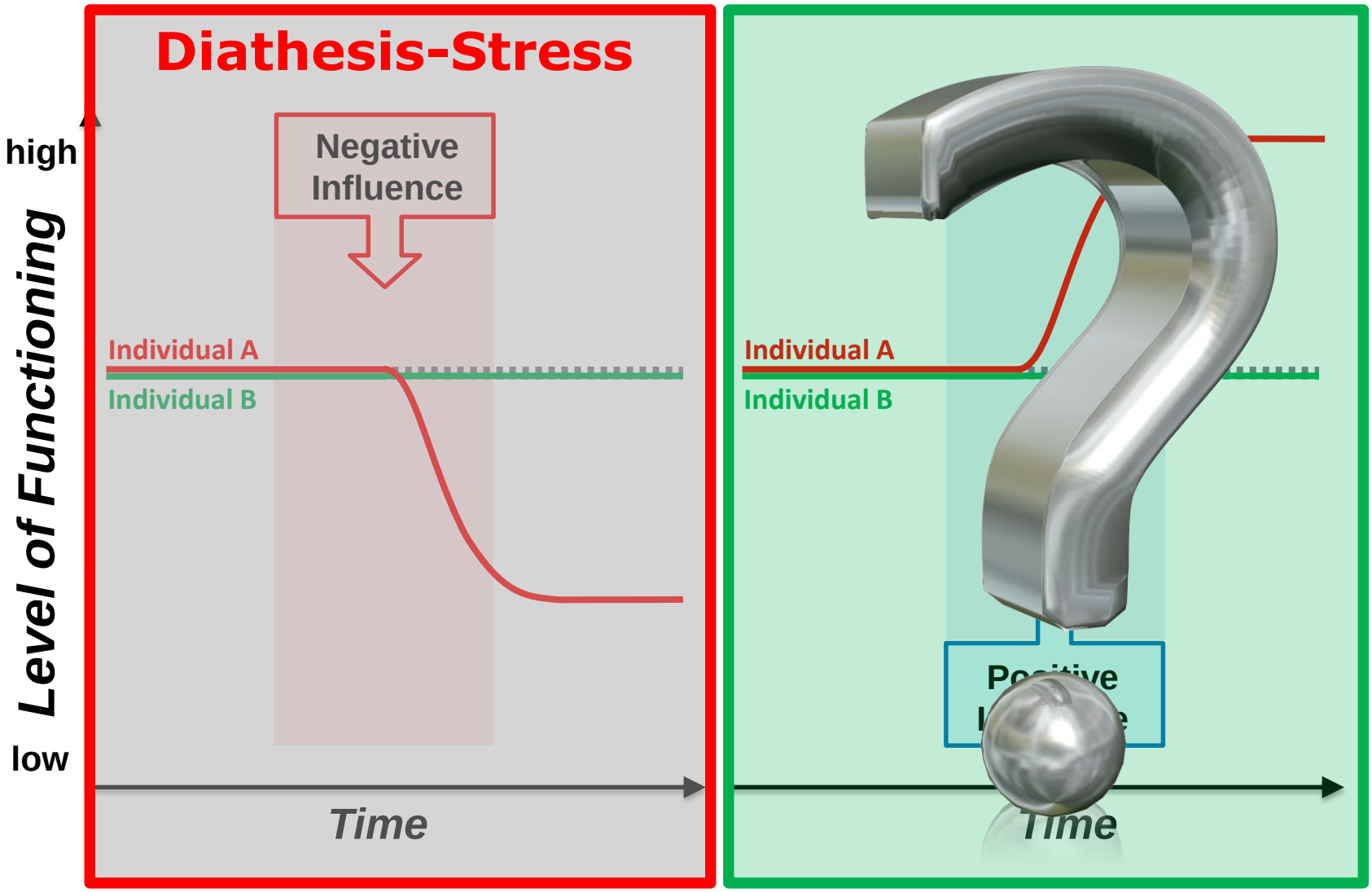
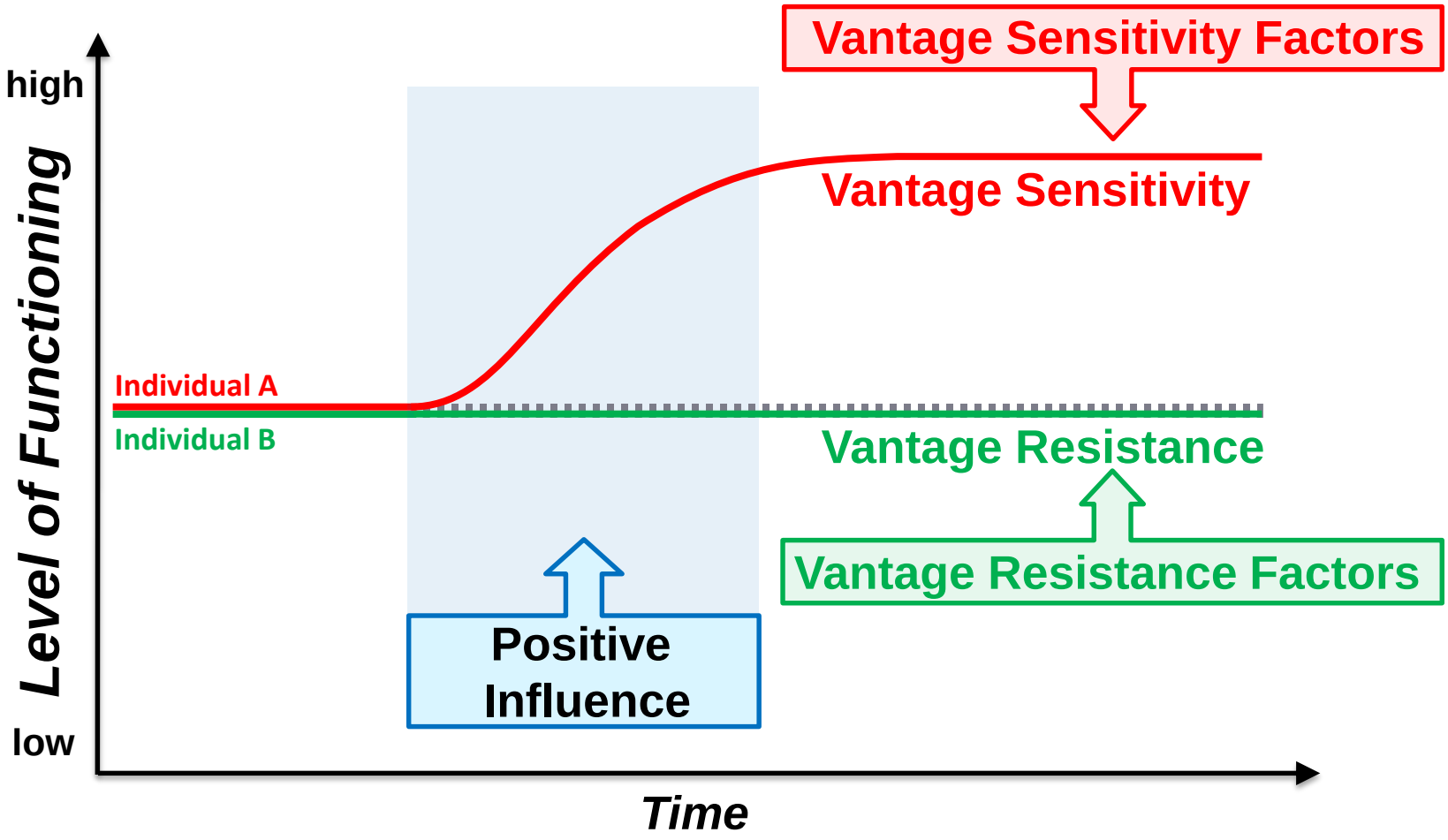
Two Sides to Differential Susceptibility



Vantage Sensitivity

- short for advantage
- a position, condition, or opportunity that is likely to provide superiority or an advantage
  The American Heritage Dictionary of the English Language, 2000

Vantage Sensitivity

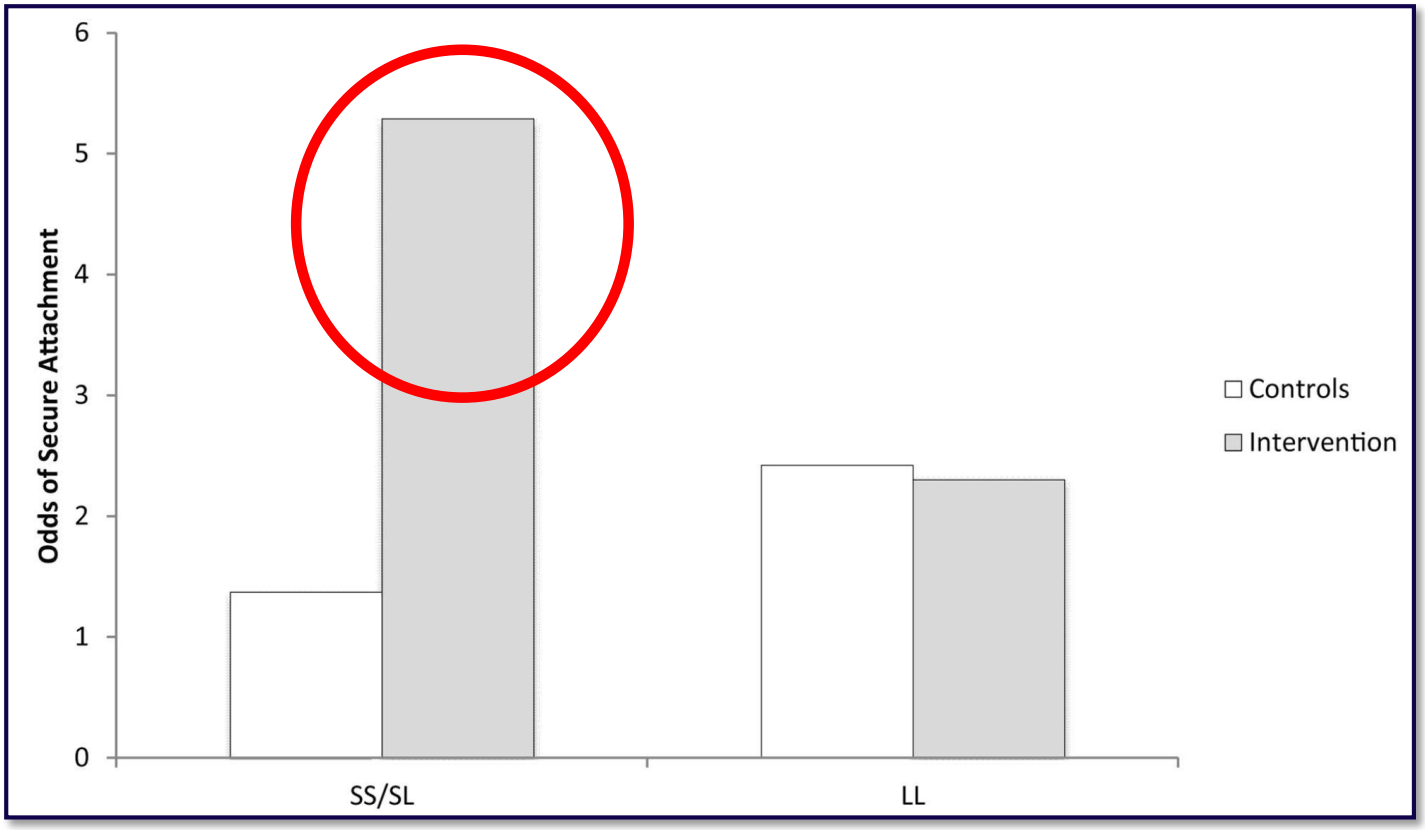


Pluess, M., & Belsky, J. (2013). Vantage Sensitivity: Individual Differences in Response to Positive Experiences. *Psychological Bulletin, 139*(4), 901-916. doi: 10.1037/a0030196

Empirical Evidence for Vantage Sensitivity

Empirical Evidence

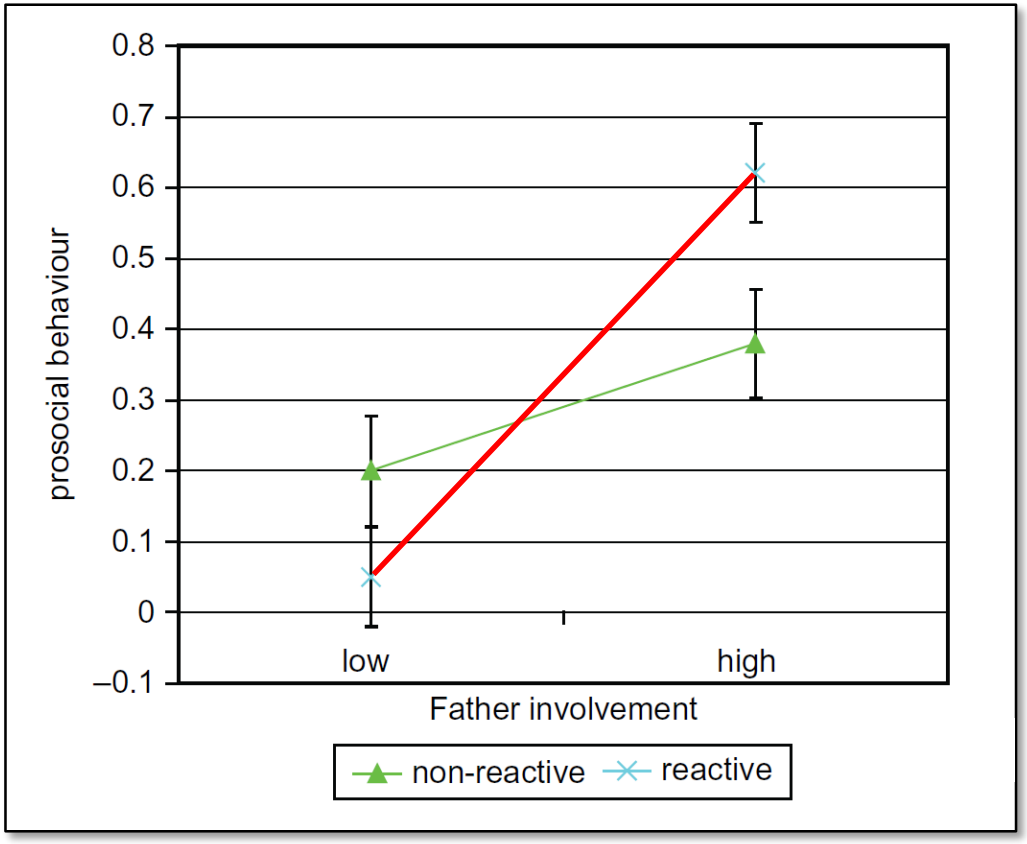
- **Serotonin Transporter (5-HTTLPR)**



Morgan, B., Kumsta, R., Fearon, P., Moser, D., Skeen, S., Cooper, P., ... & Tomlinson, M. (2017). Serotonin transporter gene (SLC6A4) polymorphism and susceptibility to a home-visiting maternal-infant attachment intervention delivered by community health workers in South Africa: Reanalysis of a randomized controlled trial. *PLoS medicine*, 14(2), e1002237.

Empirical Evidence

- **Infant Temperament**

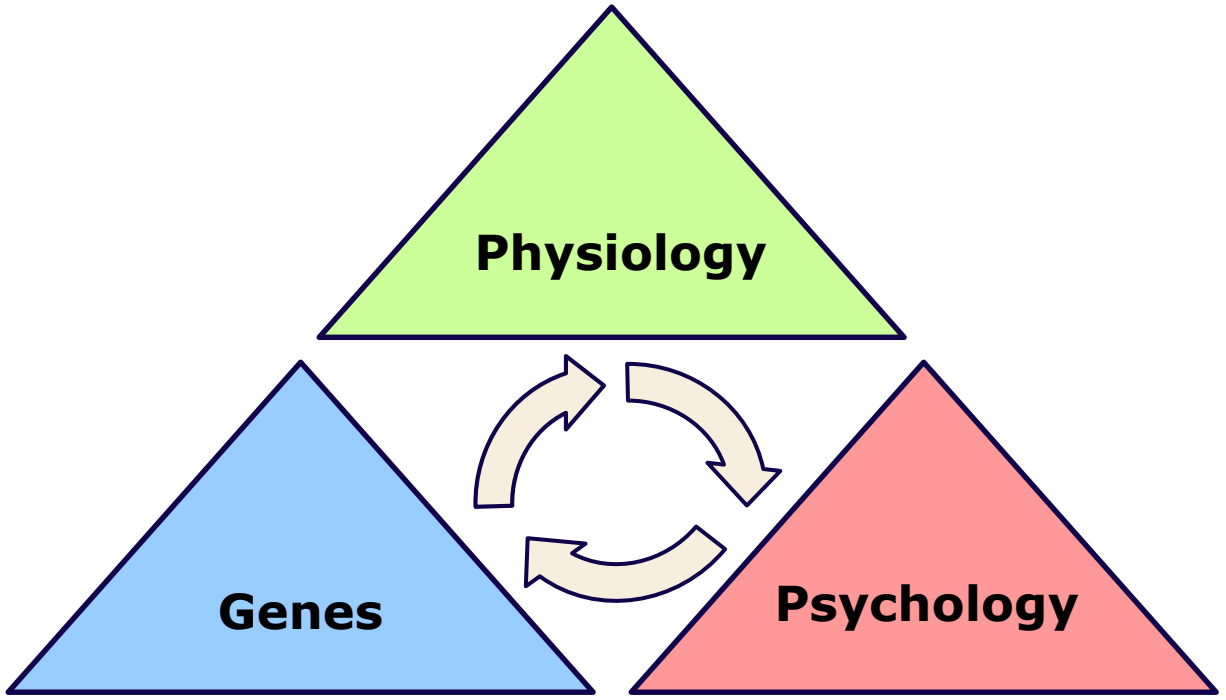


Ramchandani, P. G., van IJzendoorn, M. H., & Bakermans-Kranenburg, M. J. (2010). Differential susceptibility to fathers' care and involvement: The moderating effect of infant reactivity. *Family Science*, 1(2), 93-101

Mechanisms of Environmental Sensitivity

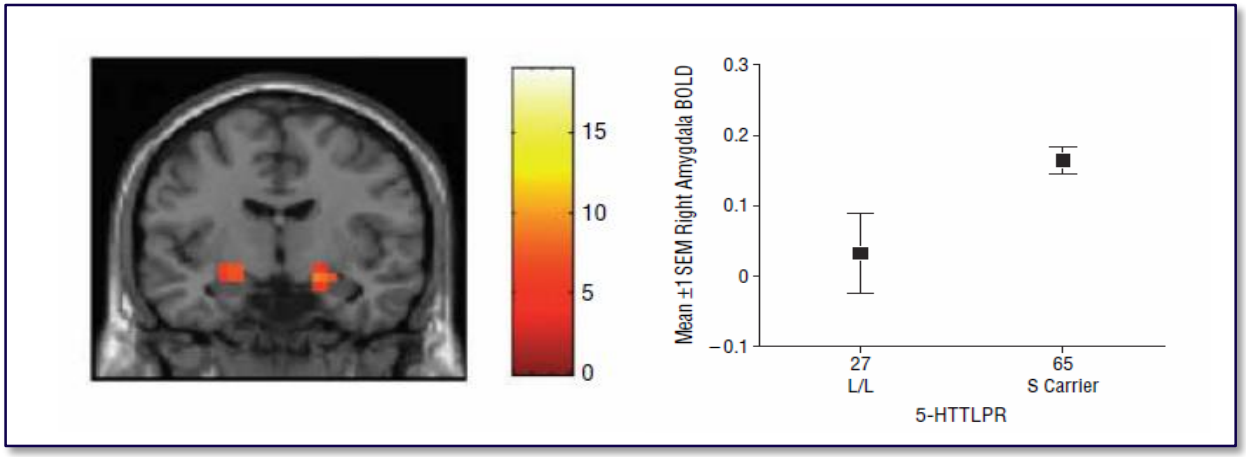
Mechanisms of Environmental Sensitivity

- **The „Neurosensitivity" Hypothesis**
  - Some individuals have a more sensitive central nervous system on which experiences register more easily and more deeply (Aron, 1996; Belsky, 2005; Belsky & Pluess, 2009)



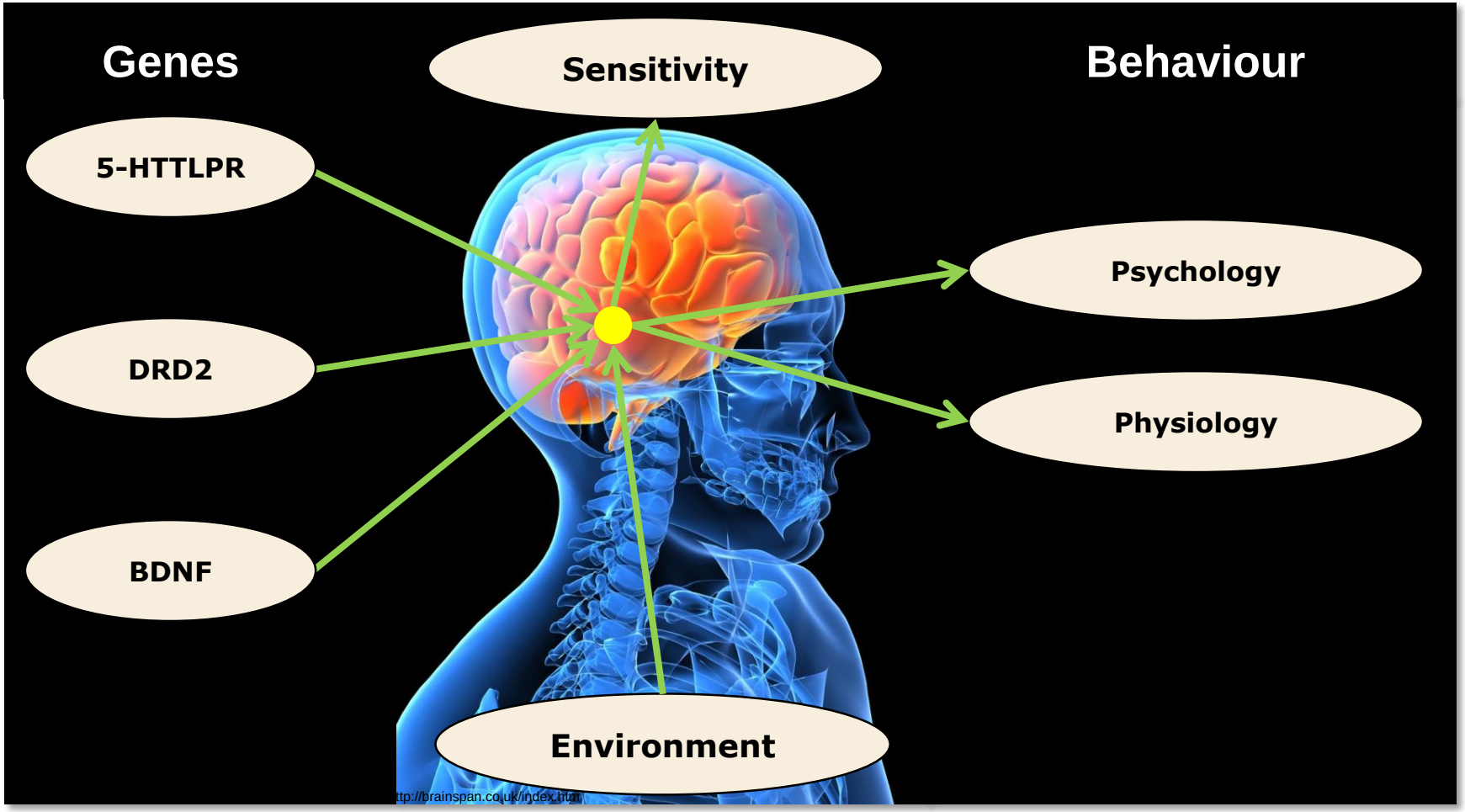
Amygdala

- **Genes and Amygdala Reactivity**
  - Amygdala is part of the limbic system with primary role in the processing and memory of emotional reactions
  - Sensitivity genes are related to amygdala reactivity:
    - **5-HTTLPR** *short allele*
    - **MAOA** *low activity allele*
    - **COMT** *met allele*



Hariri, A. R., E. M. Drabant, K. E. Munoz, B. S. Kolachana, V. S. Mattay, M. F. Egan, et al. A susceptibility gene for affective disorders and the response of the human amygdala. Archives of General Psychiatry 2005; 62(2), 146-152.

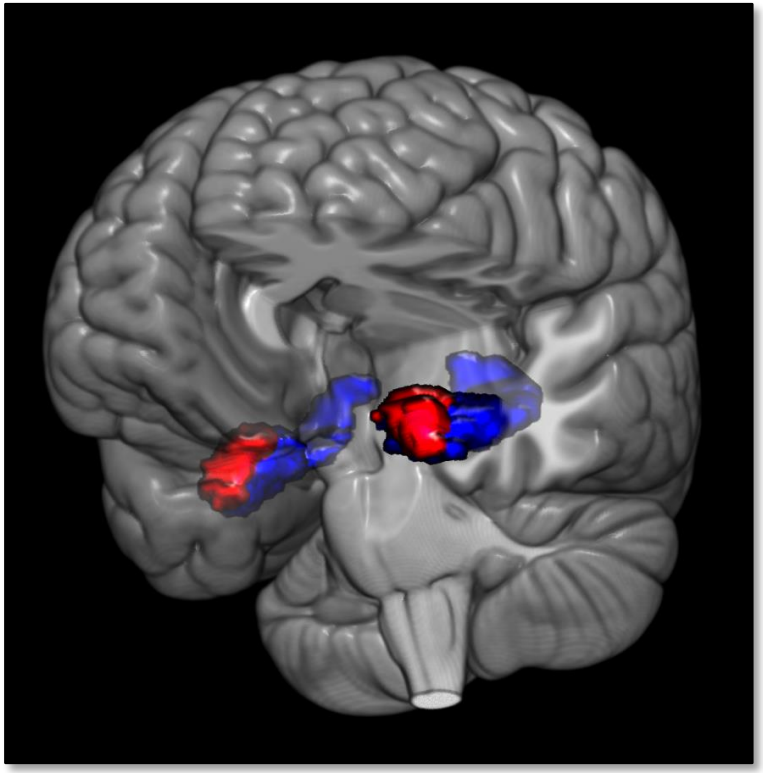
The Neurosensitivity Hypothesis

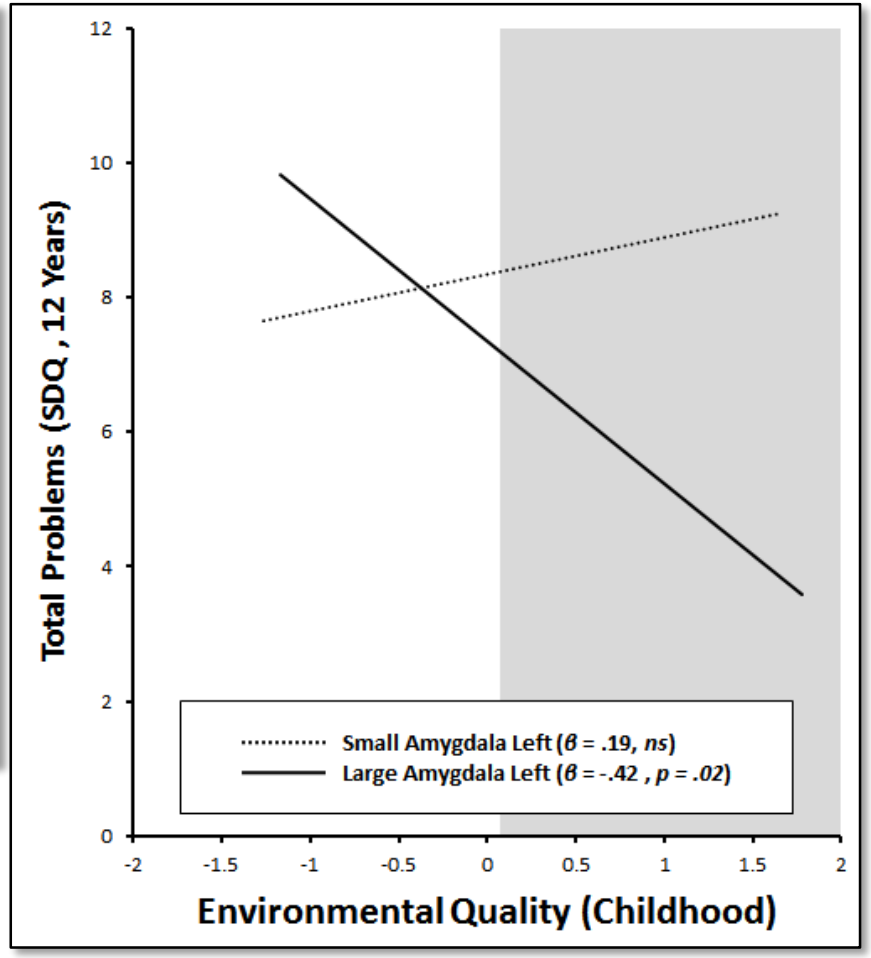


Pluess, M., Stevens, S., & Belsky, J. (2013). Differential Susceptibility: Developmental and Evolutionary Mechanisms of Gene-Environment Interactions. In M. Legerstee, D. W. Haley & M. H. Bornstein (Eds.), *The Infant Mind: Origins of the Social Brain*. New York: Guilford.

Empirical Evidence

- **Amygdala Volume**





Pluess, M., De Brito, S. A., Jones, A., Plomin, R., McCrory, E., & Viding, E. (in preparation). Differential Susceptibility to the Early Environment as a Function of Individual Differences in Brain Structure.

Phenotype of Environmental Sensitivity

Phenotype of Environmental Sensitivity

- **Sensory Processing Sensitivity**
  - Elaine Aron (1996)

- **Common personality trait:**
  - more aware of subtleties in his/her surroundings
  - processing experiences more deeply
  - is more easily overwhelmed when in a highly stimulating environment
- **Facets of SPS:**
  - Behavioural Inhibition
  - Sensory Sensitivity
  - Depth of Cognitive Processing
  - Emotional/Physiological Reactivity

Aron, E. N., Aron, A., & Jagiellowicz, J. (2012). Sensory processing sensitivity: a review in the light of the evolution of biological responsivity. *Personality and Social Psychology Review,* 16(3), 262-282.

High Sensitive Personality Scale

- Original scale with 27 items (Aron & Aron, 1997)
  - Brief versions for adults and children (Pluess et al., 2017)

INSTRUCTIONS: Answer each question according to the way you personally feel, using the following scale:

1	2	3	4	5	6	7
Not at All			Moderately			Extremely

1. I notice when small things have changed in my environment
2. Loud noises make me feel uncomfortable
3. I love nice smells
4. I get nervous when I have to do a lot in little time
5. Some music can make me really happy
6. I am annoyed when people try to get me to do too many things at once
7. I don't like watching TV programs that have a lot of violence in them
8. I find it unpleasant to have a lot going on at once
9. I don't like it when things change in my life
10. I love nice tastes
11. I don't like loud noises
12. When someone observes me, I get nervous. This makes me perform worse than normal

Pluess, M., Assary, E., Lionetti, F., Lester, K. J., Krapohl, E., Aron, E., & Aron, A. (2017). Environmental Sensitivity in Children: Development of the Highly Sensitive Child Scale and Identification of Sensitivity Groups. *Developmental Psychology.*

Heritability of Environmental Sensitivity

- **Born to be Sensitive?** (Assary et al., in preparation)

	A	C	E
HSC	.47 (.30,.53)	.00 (.00,.13)	.53 (.47,.59)
EOE	.42 (.23,.48)	.01 (.00,.14)	.58 (.52,.65)
AES	.36 (.25,.42)	.00 (.00,.07)	.64 (.58,.71)
LST	.41 (.27,.47)	.00 (.00,.00)	.59 (.53,.65)

47%
explained by heritable factors

53%
explained by environmental factors

Sensitivity Groups

Dandelions

- Less sensitive
- Majority (80%)

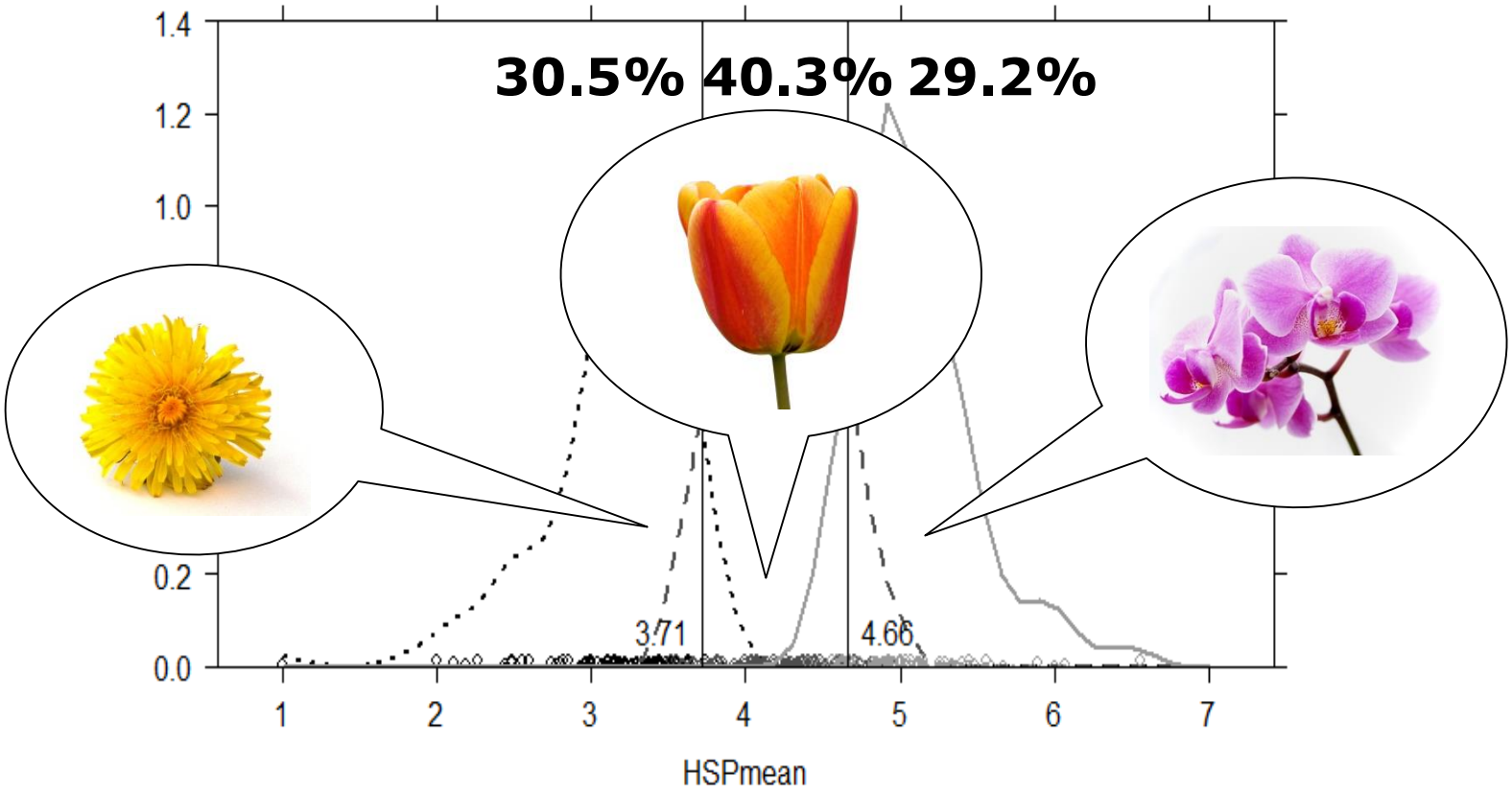
Orchids

- Highly sensitive
- Minority (20%)

Boyce, W. T., & Ellis, B. J. (2005). Biological sensitivity to context: I. An evolutionary-developmental theory of the origins and functions of stress reactivity. *Development and Psychopathology,* 17(2), 271-301.

Sensitivity Groups

- **Evidence for different sensitivity groups?**
  - Latent Class Analysis (N = 901 undergraduate students)

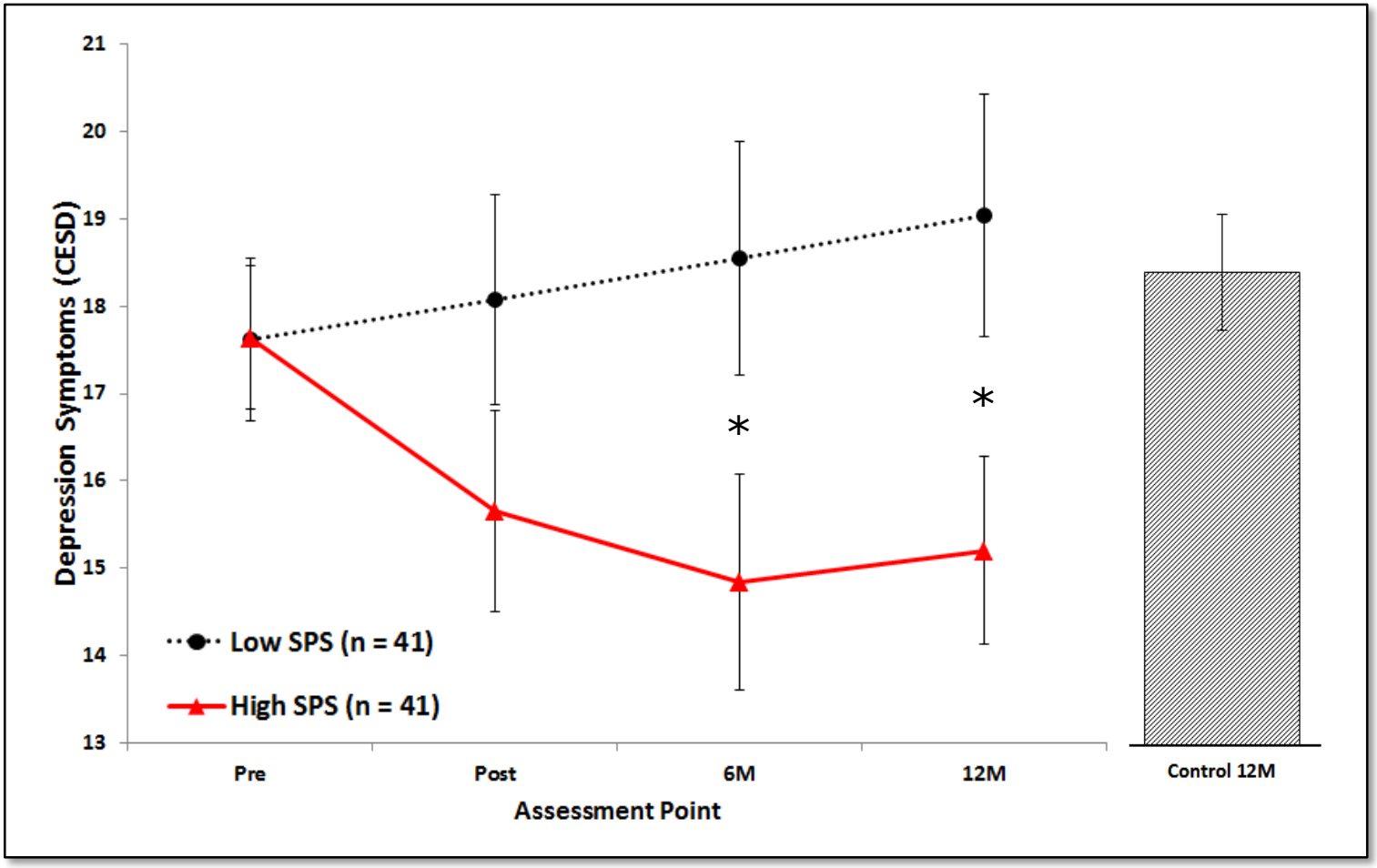


Lionetti, F., Aron, A., Aron, E., Burns, G. L., Jagiellowicz, J. & Pluess, M. (2018). Dandelions, Tulips, and Orchids: Evidence for the Existence of Low, Medium, and High Sensitive Individuals in the General Population. *Translational Psychiatry.*

Does High Sensitivity Moderate Environmental Effects?

HSC and Response to Intervention

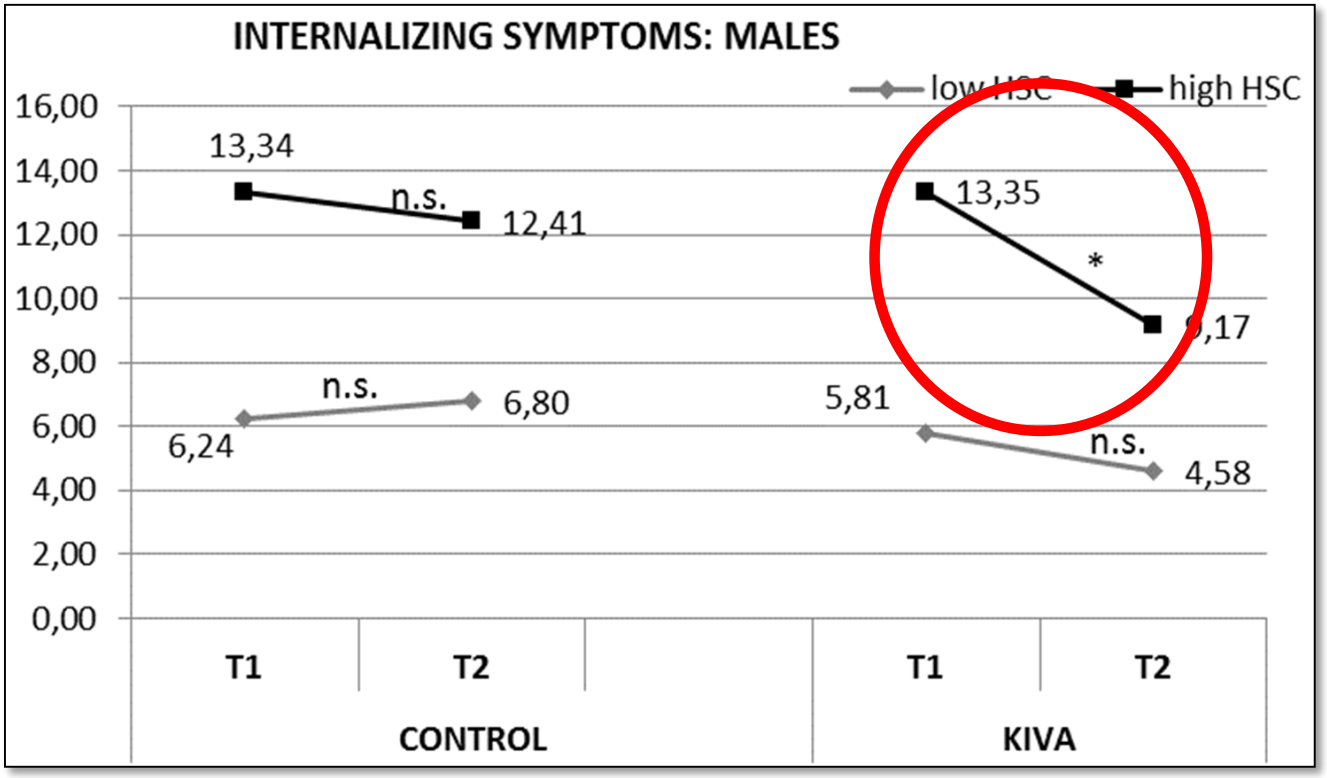
- **Resilience Intervention**



Pluess, M., & Boniwell, I. (2015). Sensory-Processing Sensitivity predicts treatment response to a school-based depression prevention program: Evidence of Vantage Sensitivity. *Personality and Individual Differences, 82*(0), 40-45.

HSC and Response to Intervention

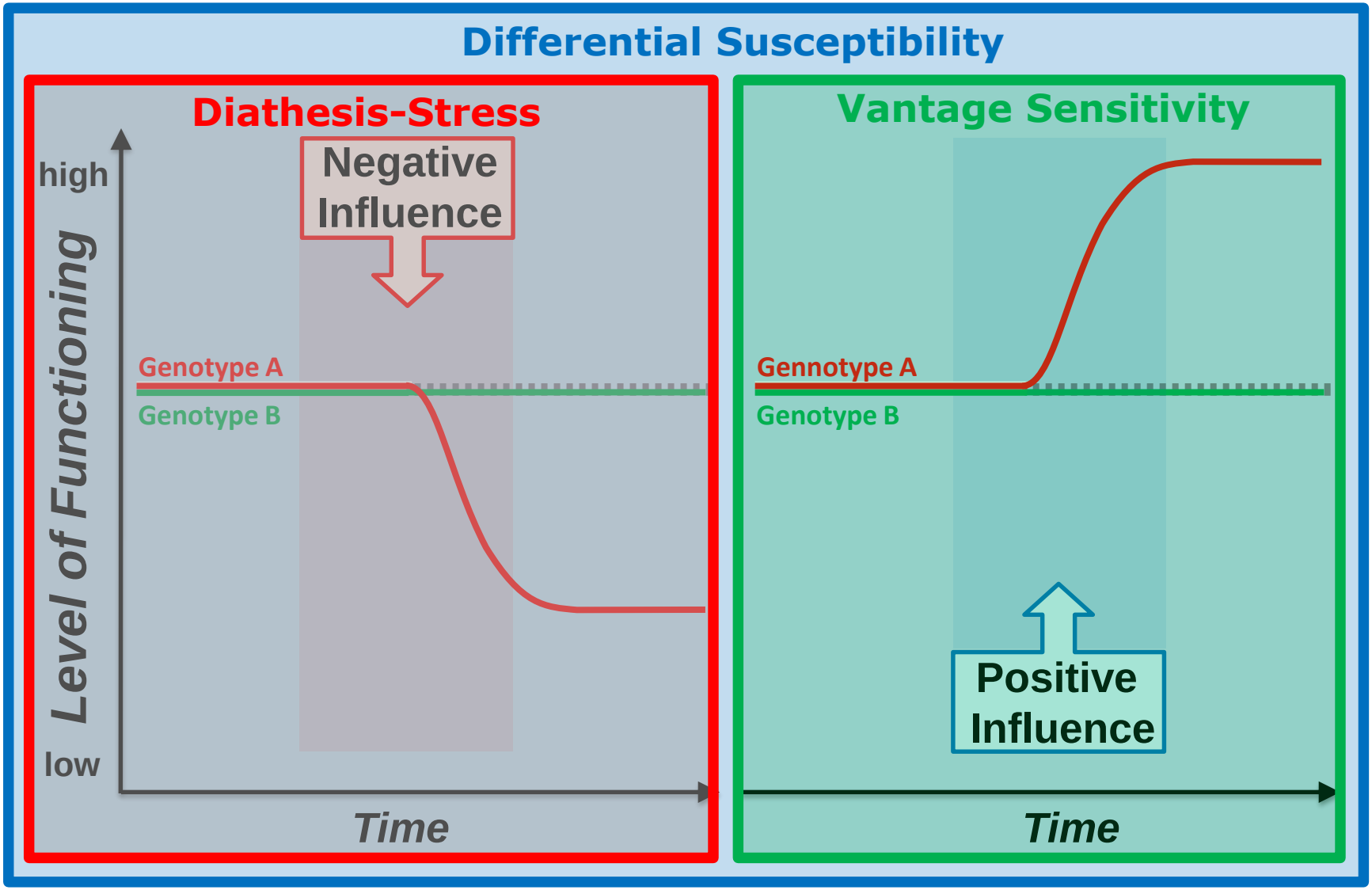
- **Anti-Bullying Intervention (Kiva)**
  - N = 931 (control = 461; treatment = 460)
  - Significant interaction: group X time X HSC X gender



Nocentini, A., Menesini, E., & Pluess, M. (in revision). Environmental Sensitivity Predicts Treatment Response to Anti-Bullying Intervention: Evidence of Vantage Sensitivity.

Sensitivity Types

Patterns of Environmental Sensitivity



Pluess, M. (2015). Individual Differences in Environmental Sensitivity. *Child Development Perspectives.*

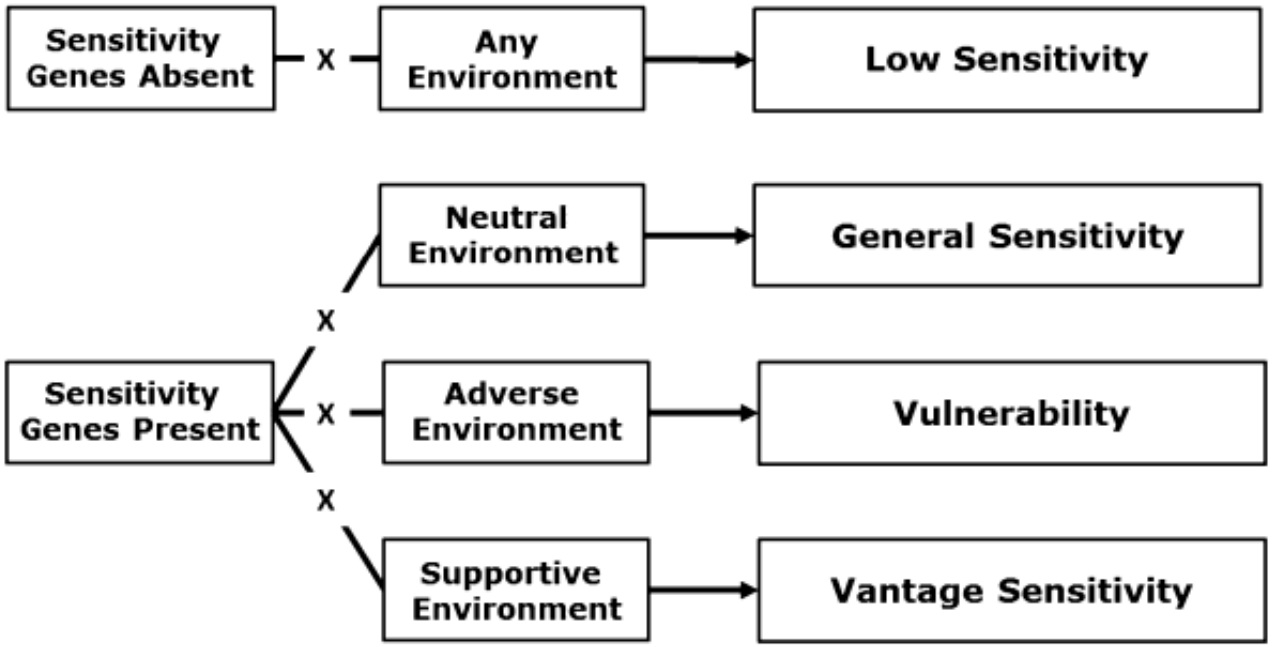
Sensitivity Types

- **Empirical evidence for Vulnerability, Differential Susceptibility and Vantage Sensitivity**
  - Are there four types of individuals?

1. **Generally low sensitive**→ low susceptibility to both negative and positive influences
2. **Generally high sensitive**→ high susceptibility to both negative and positive influences
3. **Vulnerable** → high sensitivity to exclusively negative influences
4. **Vantage Sensitive** → high sensitivity to exclusively positive influences

Sensitivity Types

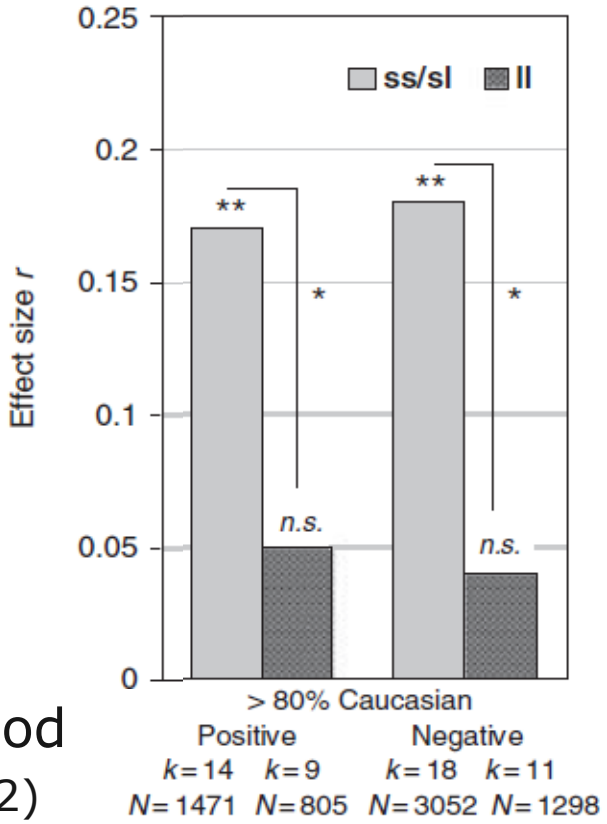
- **Empirical evidence for Vulnerability, Differential Susceptibility and Vantage Sensitivity**
  - Are there four types of individuals?



Pluess, M. (2015). Individual Differences in Environmental Sensitivity. *Child Development Perspectives.*

Development of Sensitivity Types

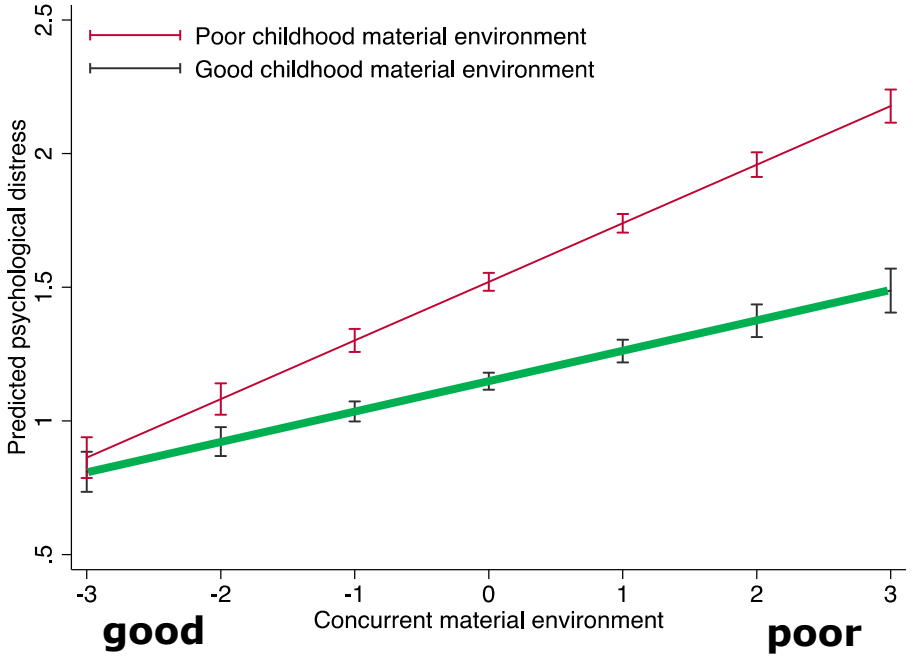
- Environmental Sensitivity has a significant genetic component
  - Several hundred GxE studies provide evidence that candidate genes are associated with Environmental Sensitivity
- **However...**
  - Meta-analysis suggests that 5-HTTLPR moderates effects of early but not late adversity (Karg et al., 2011)
  - Findings extend to positive childhood experiences (van IJzendoorn et al., 2012)



→ **Importance to consider developmental aspects**

Development of Sensitivity Types

- **Hypothesis:** Quality of early environment predicts sensitivity to later environmental quality in individuals that carry sensitivity genes
- **Study**:
  - Data: NCDS
    - N = 7,075-13,927
  - Environmental Quality:
    - Social class
    - Employment
    - Financial problems
    - Owning house
  - Outcome: Malaise
  - Assessments
    - 7, 11, 16 years
    - 23, 33, 42, 50 years

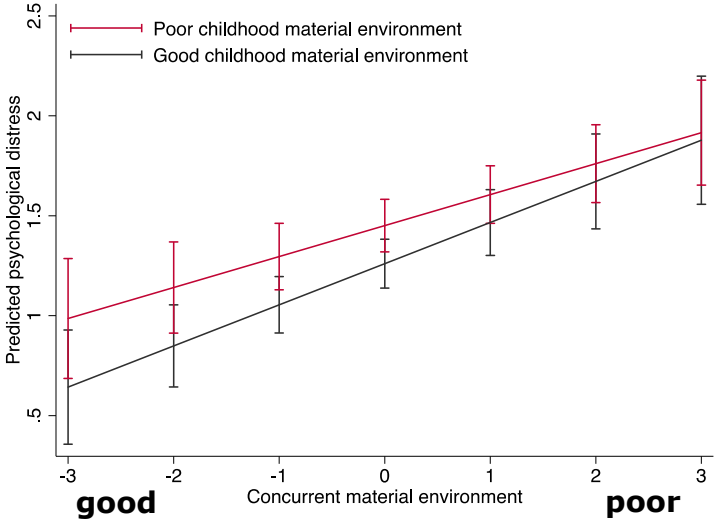


Keers, R., & Pluess, M. (2017). Childhood quality influences genetic sensitivity to environmental influences across adulthood: A life-course Gene × Environment interaction study. *Development and Psychopathology,* 29(5), 1921-1933.

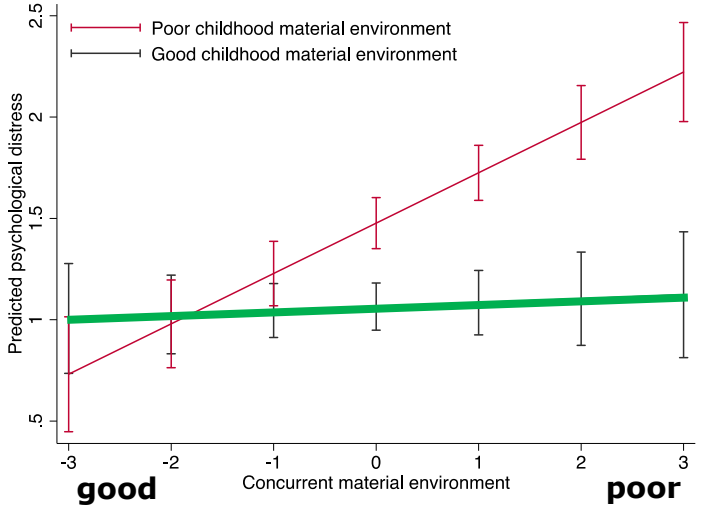
Development of Sensitivity Types

- **Genetic Moderation**
  - Polygenic candidate gene score based on nine polymorphisms previously associated with sensitivity:
    - **5-HTTLPR, BDNF, HTR2A, NR3C2, COMT, NGF, OPRM1, DRD2, FKBP5**
  - Significant ExExG interaction ($p<.001$)

Less genetically sensitive



More genetically sensitive



Keers, R., & Pluess, M. (2017). Childhood quality influences genetic sensitivity to environmental influences across adulthood: A life-course Gene × Environment interaction study. *Development and Psychopathology*, 29(5), 1921-1933.

Implications

Implications

- Given that individuals differ in their degree of Environmental Sensitivity:
  - Some individuals will be ***less*** affected by environmental influences:
    - More resilient to adverse experiences
    - Less responsive to positive experiences
  - Some individuals will be ***more*** affected by environmental influences:
    - More vulnerable to adverse experiences
    - More responsive to positive experiences

→ **Adverse experiences will not harm all individuals to the same degree!**

→ **Supportive experiences will not benefit all individuals to the same degree!**

Conclusion

Conclusion

→ People differ in their Environmental Sensitivity with some being **more affected by negative and/or positive** environmental influences

→ As a function of **genetic, physiological and psychological** factors

→ Suggesting a more **sensitive central nervous system** as a mechanism of heightened Environmental Sensitivity

→ Substantial **variability in response to environmental influences** should be expected (norm rather than exception)!

Thank you for your attention!

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