Nature and Nurture: Genetic and Parental Contributions to Social and Emotional Traits

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Acknowledgements

- Darcia Narvaez and other conference organizers
- My wonderful collaborators and students
  - The funding providers:
    - NSF CAREER Grant BCS-1151905
    - Fetzer Institute
- You! 😊
A little bit about me: Sarina Saturn

- The scientist formerly known as **Sarina Rodrigues**
- 1993: Entered neuroendocrinology research at OHSU
- 2003: PhD in Neuroscience at NYU: **Joseph LeDoux**
- 2005: Postdoctoral fellow at Stanford: **Robert Sapolsky**
- 2007: Postdoctoral scholar at UC Berkeley: **Dacher Keltner**
- 2009: Assistant Professor at Oregon State University
Emotions
Fear and the Stress Response

- Raw, primal, and amazingly strong
- Hardwired universal survival mechanism
- Similar rudimentary neurobiological architecture across species
Release of stress hormones

- PVN
- Pituitary
- Adrenal gland
- Kidney
- Cortex
- Medulla
- Glucocorticoids
- Epinephrine and norepinephrine

- Increase in cardiovascular tone
- Increase in blood pressure
- Mobilization of stored energy to muscle
- Transient enhancement of immunity
- Inhibition of costly, long-term processes such as growth and reproduction

Rodrigues, LeDoux, & Sapolsky (2009)
Annual Review of Neuroscience
Rodrigues, LeDoux, & Sapolsky (2009)
Annual Review of Neuroscience
Stress and the Brain

Vyas et al. (2002)
Journal of Neuroscience

Izquierdo et al. (2006)
Journal of Neuroscience

Rodrigues, LeDoux, & Sapolsky (2009)
Annual Review of Neuroscience
Stress and the Body

### Brain and Nerves
- Headaches
- Feelings of despair
- Lack of energy
- Sadness
- Nervousness
- Anger
- Irritability
- Increased or decreased eating
- Trouble concentrating
- Memory problems
- Trouble sleeping
- Mental health problems (such as panic attacks, anxiety disorders, and depression)

### Skin
- Acne
- Other skin problems

### Muscles and Joints
- Muscle aches and tension (especially in the neck, shoulders, and back)
- Increased risk of reduced bone density

### Heart
- Faster heartbeat
- Rise in blood pressure
- Increased risk of high cholesterol and heart attack

### Stomach
- Nausea
- Stomach pain
- Heartburn
- Weight gain

### Pancreas
- Increased risk of diabetes

### Intestines
- Diarrhea
- Constipation
- Other digestive problems

### Reproductive System
- For women: irregular or more painful periods
- For men: impotence, lower sperm production, reduced sexual desire

### Immune System
- Lowered ability to fight or recover from illness
Fighting stress with prosocial behaviors: actions that benefit others

- Raw, primal, and amazingly strong
- Hardwired universal survival mechanism
- Similar rudimentary neurobiological architecture across species

Keltner, Kogan, Piff, & Saturn (2014) Annual Review of Psychology
Oxytocin and Prosociality

• Oxytocin supports affiliative behavior in a variety of species
  ▪ pair-bond formation
  ▪ parental care
  ▪ bio-behavioral synchrony
Oxytocin has potent physiological anti-stress effects:

- modulates stress hormone levels
- inhibits cardiovascular responses to stress
- lowers amygdala responses to emotional stimuli
Oxytocin and Prosocial Behavior

- In humans, intra-nasal administration of oxytocin increases:
  - generosity
  - trust
  - eye gaze
  - ability to infer the affective mental state of others

- Natural oxytocin levels relate to:
  - parent-child bonding behaviors
  - feelings of romantic love and trust
  - empathy and subsequent generosity towards strangers
What causes individual differences in social and emotional profiles?

- **GENETIC PREDISPOSITION**
  - Genetic variations of our neurochemical systems can have a profound impact on neurochemistry
The Prosocial Nervous System

Keltner, Kogan, Piff, & Saturn (2014)  
Annual Review of Psychology
Polymorphisms
“many forms”
This world would be VERY boring if we all looked, acted, and felt the same!
Neurochemical polymorphisms

• **Sero**tonin system
  - social sensitivity and emotional reactivity

• **Dopamine system**
  - reward-related behaviors
Oxytocin Receptor

- Distributed throughout the body and the brain:
  - heart
  - hypothalamus, amygdala
  - medullary structures regulating vagal control of the heart
  - regions of the spinal cord that regulate the autonomic nervous system, especially the parasympathetic branch
rs53576

- Single-nucleotide polymorphism (SNP)
- Genotypes: AA, AG, or GG
How is a polymorphism (rs53576) of the oxytocin receptor related to stress reactivity?

N=192 undergraduates
59% female
Stress Reactivity: Physiological

- Startle paradigm: white noise bursts presented through headphones
- Average heart rate during a fear-potentiated startle anticipation task (vs. baseline)
Stress Reactivity: Startle Anticipation Heart Rate

Rodrigues et al. (2009)
Proceedings of the National Academy of Sciences
Stress Reactivity Scale

We used items that measure negative-emotion reactivity in stressful situations, emergencies, and crises, rather than baseline negative affect. This unidimensional scale measures a general factor of stress reactivity.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pearson Correlation</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resilience</td>
<td>-0.52**</td>
<td>Sinclair &amp; Watson, 2004</td>
</tr>
<tr>
<td>Rumination</td>
<td>0.52**</td>
<td>Trapnell &amp; Campbell, 1999</td>
</tr>
<tr>
<td>Perceived stress</td>
<td>0.59**</td>
<td>Cohen et al., 1983</td>
</tr>
<tr>
<td>Emotion Reappraisal</td>
<td>-0.28**</td>
<td>Gross &amp; John, 2003</td>
</tr>
<tr>
<td>Attentional Control</td>
<td>-0.46**</td>
<td>Derryberry &amp; Reed, 2002</td>
</tr>
</tbody>
</table>

with Oliver John @ UC Berkeley
Stress Reactivity: Dispositional

Rodrigues et al. (2009)
Proceedings of the National Academy of Sciences
How does the same genetic variation influence prosociality?
Davis: Interpersonal Reactivity Index (IRI)

A well-validated self-report scale that reflects the core facets of other-oriented empathic behavior
Dimensions (subscales) of the IRI

**EMPATHIC CONCERN**

- I often have tender, concerned feelings for people less fortunate than me.
Dimensions (subscales) of the IRI

PERSPECTIVE TAKING

- I sometimes try to understand my friends better by imagining how things would look from their perspective.
Reading the Mind in the Eyes

- Simon Baron-Cohen
- Performance enhanced in non-clinical populations after oxytocin administration (Domes et al., 2007)
- Performance negatively associated with autism
jealous

panicked

arrogant

hateful
grateful

flirtatious

hostile

disappointed
Reading the Mind in the Eyes

Empathic accuracy

Percentage correct

<table>
<thead>
<tr>
<th></th>
<th>male</th>
<th>female</th>
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<tbody>
<tr>
<td>AA/AG</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>GG</td>
<td>85</td>
<td>80</td>
</tr>
</tbody>
</table>

Rodrigues et al. (2009)
Proceedings of the National Academy of Sciences
Listening Prosocially

- Strangers viewed 20-sec video clips of someone listening to their romantic partner talk about a time of suffering
- Evaluated nonverbal prosocial cues
  - Eye contact
  - Leaning
  - Nodding
  - Smiles
  - Arm posture

Kogan et al. (2011)
Proceedings of the National Academy of Sciences (PNAS)
Video: Listening Prosocially
GGs rated more prosocial by strangers (>AAs/AGs)

Kogan et al. (2011)
Proceedings of the National Academy of Sciences (PNAS)
Others have found that this same oxytocin receptor polymorphism relates to:

- Differential structure and function of emotional brain regions
- Maternal sensitivity
- Lower risk for autism spectrum disorders
- .....more! 😊

Tost et al., 2010; Bakermans-Kranenburg & van IJzendoorn, 2008; Tops et al., 2011; Norman et al., 2012; Wu et al., 2005; Wertmer, et al., 2009
“14 Inevitable Scientific Breakthroughs the World Will Regret”
We are not slaves to our genes
Implications

• Genetic variability in the neurochemical systems may contribute to individual differences in complex human social and emotional behaviors
Implications
Implications

• It is important to understand that everyone has unique obstacles to achieving inner-peace and prosociality.
What causes individual differences in social and emotional profiles?

- **ENVIRONMENT**
  - Parents*
  - Friends
  - Peers
  - Teachers
  - Culture
  - Society
  - Experiences
Parental Bonding Instrument
Parker, Tupling, & Brown (1979)

• Retrospective measure of fundamental parenting styles for the first 16 years of life
• Completed separately for mothers and fathers
• Perceptions stable over time

- Affection
- Soothing
- Understanding
Parental Bonding Instrument (PBI)

Previous studies have shown that PBI relates to:

• ↑ self-confidence
• ↑ self-esteem
• ↓ cortisol levels following stress
• ↑ activation in neural centers for maternal care
• ↓ introversion
• ↓ depression
• ↓ emotional instability
• ↓ aggression
• ↓ loneliness

See Avagianou & Zafiropoulou (2008); Kim et al. (2010); Wiseman et al. (2006); Luecken (2000)
PBI results in our sample

Parental Bonding: Mother

Parental Bonding: Father

↑ positive correlation (*p>0.05, **p>0.005)

↓ negative correlation (*p>0.05, **p>0.005)

trending (p>0.06)

N=152 undergraduates
58% female
“I consider myself to be a very affectionate person.”

Floyd, 2002

r = .169*

r = .191*
“Many people I know are quite affectionate with me.”
# Affection and Prosociality

<table>
<thead>
<tr>
<th></th>
<th>TAS-G (Given Affection)</th>
<th>TAS-R (Received Affection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEO-PI-R: Altruism</td>
<td>0.33</td>
<td>0.48</td>
</tr>
<tr>
<td>Empathy Quotient</td>
<td>0.48</td>
<td>0.53</td>
</tr>
<tr>
<td>DPES-Compassion</td>
<td>0.35</td>
<td>0.28</td>
</tr>
<tr>
<td>DPES-Love</td>
<td>0.34</td>
<td>0.37</td>
</tr>
</tbody>
</table>

*Note: N=91, p<0.001*

<table>
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<th>TAS-G (Given Affection)</th>
<th>TAS-R (Received Affection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likelihood that the participant helped</td>
<td>0.35**</td>
<td>0.03</td>
</tr>
<tr>
<td>Number of items picked up</td>
<td>0.33*</td>
<td>-0.03</td>
</tr>
</tbody>
</table>

*Note: N=49, *p<0.05, **p<0.01*
Romantic Affection↑
Light, Grewen, & Amico (2005)

- hold hands
- sit close or lie down close together
- warm touches

- Related to oxytocin levels

$r = .154$

$r = .196^*$
Gratitude ↑
McCullough, Emmons, & Tsang, 2002

“I have so much in life to be thankful for.”

- **Positive emotions**
  - Optimism
  - Hope
- **Prosocial traits**
  - Empathetic affect
  - Perspective taking
  - Forgiveness
- **Big 5 traits**
  - Agreeableness
  - Extraversion
  - Emotional stability

$r = .278^{**}$

$r = .358^{**}$
Altruism ↑
NEO Five-Factor Inventory

“I go out of my way to help others if I can.”

r=.184*
“Most people are trustworthy.”

Yamagishi & Yamagishi (1994)

$r = .174^*$
Love ↑

Disposition Positive Emotion Scales (Shiota, Keltner, & John, 2006)

“I love many people.”

r=.245**
“When I need suggestions on how to deal with a personal problem, I know someone I can turn to.”

Interpersonal Support ↑

Cohen & Hoberman, 1983

$r=.405^{**}$

$r=.235^{**}$
Self-Compassion ↑

Neff

- Self-Kindness vs. Self-Judgment
- Common Humanity vs. Isolation
- Mindfulness vs. Over-identification

$r = .255^*$

$r = .39^*$

$r = .33^{**}$

<table>
<thead>
<tr>
<th>Trait</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trust</td>
<td>.30^{***}</td>
</tr>
<tr>
<td>Gratitude</td>
<td>.29^{**}</td>
</tr>
<tr>
<td>Altruism</td>
<td>.28^*</td>
</tr>
<tr>
<td>Love</td>
<td>.38^{**}</td>
</tr>
<tr>
<td>Social Support</td>
<td>.38^{***}</td>
</tr>
</tbody>
</table>
Affiliative Humor Style

*Humor Styles Questionnaire (Martin et al., 2003)*

- style of humor used to enhance one’s relationships with others in a benevolent, positive manner
- ↑ self-esteem
- ↓ depression
- ↓ emotional instability

\[ r = 0.405^{**} \]

\[ r = 0.235^{**} \]
Happiness ↑
Lyubomirsky

“In general, I consider myself:
1 - not a very person
2
3
4
5
6
7 - a very happy person.”

r=.231**

r=.189*
Satisfaction with Life ↑

Diener

“The conditions of my life are excellent.”

- Affective-emotional
- Cognitive-judgmental

r = .273**
Sleep quality ↑
*Pittsburgh Sleep Quality Index*

Health↑
*SF-36 general health subscale*

\[ r = 0.194^* \]

\[ r = 0.276^{**} \]
Stress Reactivity

$r = -0.201*$
Subjective SES↑

Alder

Social Class↑

$\rho = 0.193^{*}$

$\rho = 0.256^{**}$

$\rho = 0.178^{*}$
What causes individual differences in social and emotional profiles?

- **MORAL EXEMPLARS**
  - *Prosocial role models*
MORAL ELEVATION

*Moral elevation,* or *elevation,* is a specific emotional state triggered by witnessing displays of a profound display of virtue.

Elicitors of elevation are actions of others that are perceived as having moral beauty and great integrity.

These include moments of unexpected benevolence, kindheartedness, altruistic deeds, and displays of gratitude among strangers.
Moral Elevation

People are often profoundly moved by the virtue (moral excellence), yet neuroscience and psychology have little to say about the ‘other-praising’ family of emotions.
Moral Elevation

- Schnall, Roper, & Fessler (2010)
  - Found altruism to increase after elevation induction
  - Degree of altruism correlated with experiential self-reports of wanting to help others, feeling moved, warmth in chest, etc.
Moral Elevation

• Silvers & Haidt, 2008
  o Studied nursing mothers with infant children
  o After elevation induction (amusement as a control):
    o Mothers experienced more milk letdown
    o More likely to hug their children
  o Authors speculated that oxytocin, a hormone and neurotransmitter, may be involved

• *We set out to characterize the biology underlying elevation*...
The Vagus Nerve

- The social engagement system is intimately related to stress reactivity and oxytocin.
- The parasympathetic nervous system calms down the heart via the vagus nerve.
The Vagus Nerve

- One of the greatest mind-body connections
- The “love nerve”
  - connected to oxytocin system and caretaking
- Eyes, neck, heart, digestive organs

- Low “vagal tone” relates to:
  - Heart disease, obesity, diabetes
  - Psychiatric disorders

- High “vagal tone” associated with:
  - increased positive emotion
  - appearing more trustworthy to strangers
  - better social support networks
  - more prosocial children
Elevation

The following video clip was taken from an episode of Oprah about people who have been inspired by others.
Elevation induction

Neutral baseline

Baseline

Emotion induction

Elevation (music teacher)

Amusement (talking animals)
Amusement
Elevation boosts vagal tone (RSA) parasympathetic activity
Elevation increases heart rate and skin conductance sympathetic activity.
Dual Activation of the ANS

- During some situations that involve both arousal and social sensitivity, dual activation of the SNS and PNS may occur.
  - Such situations include:
    - caring for infants (Kenkel et al., 2013)
    - crying (Trimble, 2012)
    - sexual activity (Carter, 1992)
Medial Prefrontal Cortex

- Medial prefrontal cortex (mPFC) is relevant to both regulation of the autonomic nervous system, social cognitive processing, and emotion regulation.
- Previous work has illustrated that vagus nerve activity is influenced by prefrontal cortex (PFC) activity.

(Amodio & Frith, 2006; Thayer et al., 2012)
Functional Near-Infrared Spectroscopy (fNIR)

Figure 2 Absorption factors of 3 main chromophores in tissue

Fig. 1. fNIR sensor with 4 light sources and 10 detectors (left, top) and 16 optode (channel) measurement locations registered on sensor (left, middle) and on brain surface image (right). fNIR sensor positioned on participants' head (left, bottom) and the fNIR Device model 1000 (bottom, middle). Brain surface image is from University of Washington, Digital Anatomist Project.
Elevation decreases mPFC activity
dampening of self(ego)-
awareness and/or social-
evaluative threat?

• mPFC deactivation correlates with:
  ▪ inspiration
  ▪ admiration
  ▪ hope
  ▪ sympathy/compassion
  ▪ desire to help others
mPFC Activity

• mPFC activity decreased in elevation
  ▪ No change in amusement
• mPFC deactivation significantly related to subjective feelings during elevation and higher vagus activity
• may relate to alterations in:
  ▪ ego (self) awareness
  ▪ social evaluations
  ▪ judgment of others
  ▪ moral judgments
  ▪ time travel
<table>
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<th>TAS-G (Given Affection)</th>
<th>TAS-R (Received Affection)</th>
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<tbody>
<tr>
<td><strong>Sympathy/Compassion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>-0.14</td>
<td>0.50</td>
</tr>
<tr>
<td>p</td>
<td>0.33</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td><strong>Optimistic about humanity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>0.14</td>
<td>0.36</td>
</tr>
<tr>
<td>p</td>
<td>0.34</td>
<td>0.01**</td>
</tr>
<tr>
<td><strong>Wanted to help others</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>0.10</td>
<td>0.29</td>
</tr>
<tr>
<td>p</td>
<td>0.51</td>
<td>0.04*</td>
</tr>
<tr>
<td><strong>More open and loving toward people in general</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>0.01</td>
<td>0.34</td>
</tr>
<tr>
<td>p</td>
<td>0.95</td>
<td>0.02*</td>
</tr>
<tr>
<td><strong>Warmth</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>0.24</td>
<td>0.35</td>
</tr>
<tr>
<td>p</td>
<td>0.10</td>
<td>0.01**</td>
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<tr>
<td><strong>Admiration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>0.17</td>
<td>0.45</td>
</tr>
<tr>
<td>p</td>
<td>0.23</td>
<td>0.001***</td>
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<tr>
<td><strong>Hope</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>0.02</td>
<td>0.44</td>
</tr>
<tr>
<td>p</td>
<td>0.92</td>
<td>0.001***</td>
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<td><strong>Uplifted</strong></td>
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<td></td>
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<tr>
<td>r</td>
<td>0.04</td>
<td>0.54</td>
</tr>
<tr>
<td>p</td>
<td>0.78</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td><strong>Awe</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>-0.09</td>
<td>0.31</td>
</tr>
<tr>
<td>p</td>
<td>0.54</td>
<td>0.03*</td>
</tr>
<tr>
<td><strong>Warm or expansive feelings in chest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>0.21</td>
<td>0.46</td>
</tr>
<tr>
<td>p</td>
<td>0.14</td>
<td>0.001***</td>
</tr>
</tbody>
</table>

*Note: N=49, *p<0.05, **p<0.01, ***p<0.001*
Up Next:

- Measure oxytocin release due to elevation induction in nursing mothers
- See how this relates to prosocial behaviors in the mother and child later in life
Magic tricks for prosociality?!?
How can become more prosocial?

- build social bonds with loved ones and strangers
- witness and perform compassion and altruistic acts
Cultivate prosociality

• Being prosocial is amazingly beneficial to both your body and your brain.

• Therefore, being good to others is also good for you!
Nature and Nurture: 
Genetic and Parental Contributions to Social and Emotional Traits

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Acknowledgements

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- The funding providers: NSF CAREER Grant BCS-1151905
- Darcia Narvaez and other conference organizers
- You! 😊