

Precision Learning Center
UCSF brainLENS UCSF Dyslexia Center
CHC - Sand Hill School | 05.03.2017

Cognitive & Socio-Emotional Resilience in Dyslexia

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SUPPORTERS

TONNEY & POTTER FAMILY | RASKOB | NSF1540954 SL-CN (Gazzaley/Uncapher, UCSF)

UNIVERSITY OF CALIFORNIA CENTER OF THE FUTURE
 R01HD078351 (Hoeft, UCSF)
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 R01MH104438 (Nordahl, UC Davis/MIND)
 R01MH103371 (Amaral, UC Davis/MIND)

Why is each child so different? How can we ensure success in each child?

Kaito (6)
"STORY MAN"
"3D MAN"

Empathic
Spiderman - Halloween

Taiga (8)
"INFORMATION SEEKER"

Analysis
Red/White blood cell
Halloween

Visuo-spatial | specimen box

Jack Horner, a paleontologist from Jurassic Park/World

NOW
 Technical Advisor of Jurassic Park
 (= Dr. Alan Grant)
 MacArthur Genius Award ('86)
 Romer-Simpson Medal ('13)

THEN
 Severely dyslexic
 Graduated high school with D---
 Failed college 7 times
 Never graduated
 GPA 0.06
 (Honorary doctorate, '06)

Jack Horner, a paleontologist from Jurassic Park/World

Importance of resilience

Importance of environment & community

Importance of looking at an individual as a whole
(including literacy but also other cognitive and socio-emotional aspects)

Outline

- BACKGROUND
 - Dyslexia costly in many dimensions
 - Importance of an integrative approach
- TODAY'S FOCUS
 - The resilience framework of dyslexia
 - Cognitive resilience
 - Socio-Emotional resilience
- CONCLUSION, OTHER WORK (e.g. English Learners)

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

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Neuroscience of Dyslexia

Xia, Hancock, Hoeft. Language & Linguistic Compass. 2017.

Regions & circuits dysfunctional in dyslexia (function, structure, temporal dynamics, neurochemicals, relation with risk genes, etc)

- Even when compared to reading-matched "normal" readers: *Hoeft et al. J Neurosci '06; PNAS '07*
- Regardless of writing system (Chinese): *Xia et al. Neuropsychologia '16; Rueckl et al. PNAS '15*
- At-risk pre-readers (with family history): *Black et al. NeuroImage '12; Hosseini et al. NeuroImage '13; Vandermosten, Hoeft, Norton. Curr Opin Beh Sci. '16*
- Regardless of identification criteria: *Tanaka et al. Psychol Sci '11*
- In "normal" readers with high IQ (Gifted Dyslexics, 2e kids): *Hancock et al. TINE '17*

Articular (Frontal) Phonological (Temporo-Parietal)

Orthographic (Occipito-Temporal)

Compensatory frontal articular & right hemisphere networks: *Hoeft et al. PNAS '07; PNAS '11; Hancock Richlan, Hoeft. Neurosci Beh Rev '16*

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Reading Circuits: Domain General + Specific Circuits

Black, Xia, Hoeft. Language & Linguistic Compass

- Orthography
- Phonology
- Semantics
- Sentence / Syntax
- Vocabulary
- Attention
- Executive Function

Major Reading Systems

ACC: anterior cingulate cortex; AG: angular gyrus; DLDFPC: dorsolateral prefrontal cortex including superior/middle/dorsal inferior frontal gyri; IFGtri: anterior/mid-triangular gyrus (visual word form area, VWFA); IFGop: inferior frontal gyrus orbital, triangular, opercularis; PPC: posterior parietal cortex; PreCG: precentral gyrus; a/pSMG: anterior/posterior-supramarginal gyrus; p5/MTG: posterior superior/middle temporal gyrus.

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

Cost of Dyslexia

RISK GENES → Risks (PHONOLOGICAL, ORTHOGRAPHIC) → Dyslexia → POOR OUTCOME: Reading Comprehension, Educational Attainment, Psychosocial Adjustment

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Cost of Dyslexia is High

Developing dyslexia	up to 50% with family history, (4 times higher)
Cost to individual	>£100k less earning (\$150k)
Cost to (UK) society	>£1bn/year (\$1.5bn)
High School drop out	2.5x
Prison population	32-46% (note low IQ and not SLD!)
Anxiety disorder	2.0x (5.0x severe test anxiety)
Depression	2.0x
Substance abuse	2.7x
ADHD	4.5x

Snowling et al. Psychol Bull 2016; Pennington & Lefly. Child Develop 2001; Cosden JLD 2001; Wilson et al. JLD 2009; Foresight Mental Capital and Wellbeing Project. 2008 ; DuPaul et al. JLD 2012

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

Cost of Dyslexia is High

Matthew Effect in Reading

READING PERFORMANCE vs GRADE

With Foundation Skills

Without Foundation Skills

Snowling et al. Psychol Bull 2016; Pennington & Lefly. Child Develop 2001; Cosden JLD 2001; Wilson et al. JLD 2009; Foresight Mental Capital and Wellbeing Project. 2008 ; DuPaul et al. JLD 2012

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Latest Thinking on the Factors that Contribute to Dyslexia: Multiple Factors Impact Dyslexia

Cumulative Risk & Protection Model of Dyslexia

Multiple deficit model: Pennington, Cognition '06, Pennington et al, J Abnorm Psychol '12
 Diathesis-stress model: Rosenthal ed. "The Genain Quadruplets" '64
 Liability threshold model: Gottesman & Shields. PNAS '67

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Importance of an Integrative Approach to Maximizing Children's Learning Potential

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

TODAY'S TOPIC: Cognitive and Socio-Emotional Resilience in Dyslexia

Weaknesses vs. Relative strengths
 Risk vs. Protective factors
 Vulnerability vs. Resilience

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

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Resilience

The ability to adapt to stressors in the environment (adversity) by "bending" but not "breaking"
 (Karatsoreos & McEwen F1000Prime Reports 2013)

Socio-emotional resilience Cognitive resilience

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

Resilience Framework of Dyslexia: Promoting Resilience & Optimizing Dyslexia Outcome

Haft, Myers, Hoeft. Curr Opin Beh Sci 2016

INTERNAL

- Growth mindset
- Hopeful thinking
- Sense of coherence
- Locus of control
- Self determination

FAMILY

- Family cohesion
- Maternal affect
- Strong parental attachment
- Parental support & understanding of RD

PEER/SCHOOL

- Peer relationships
- Mentorship by teachers
- Teacher support
- Small class-size

- Oral language skills
- Motor skills
- Task-focused behavior
- Executive functions
- Interpersonal relationships
- Morphological awareness
- Vocabulary
- Verbal reasoning
- Executive functions
- Grammar

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

The Neuroscience of Dyslexia – Traditional View Focus on Weaknesses, Risks & Vulnerability

RELATIVE WEAKNESSES

- phonological processing
- (visual/selective) attention
- cognitive implicit procedural learning short-term memory
- information processing

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

The Neuroscience of Dyslexia – Traditional View Focus on Weaknesses, Risks & Vulnerability

POOR READERS & DYSLEXIA.
Reduced efficiency in brain networks related to speech & visual aspects of reading.
Shaywitz et al. NEJM '98; Hoeft et al. J Neurosci '06. Hoeft et al. PNAS '07

Temporo-Parietal (TP) Phonological processing
Occipito-Temporal (OT) Orthographic processing

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

The Neuroscience of Dyslexia – Emerging View Focus Also on Strengths, Protective Factors & Resilience

RELATIVE STRENGTHS

- visuo-spatial Holistic, 3d
- cognitive explicit memory comprehension
- IQ, reasoning, oral language ...
- character traits, socio-emotional

RELATIVE WEAKNESSES

- phonological processing
- (visual/selective) attention
- cognitive implicit procedural learning short-term memory
- information processing

Grit, Resilience, Mindset, Empathy

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

The Neuroscience of Dyslexia – Emerging View Focus Also on Strengths, Protective Factors & Resilience

PROTECTIVE FACTORS & RESILIENCE
Which brain systems???
What mechanism???

Temporo-Parietal (TP) Phonological processing
Occipito-Temporal (OT) Orthographic processing

Coincidence. Bryden MP. *Laterality* '87
Compensatory. Lansdell HJ. *Comp Physio Psychol* '69, Levy J. *Nature* '69
Causal. Kosslyn SM. *Psychol Rev* '87, Cai et al. *PNAS* '13.
Evolutionary advantage Geschwind N. *Annals of Dyslexia* '84

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Resilience Framework of Dyslexia: COGNITIVE RESILIENCE

Haft, Myers, Hoeft. Curr Opin Beh Sci 2016

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    graph TD
      Risks --> LessSevere[Less Severe Dyslexia]
      LessSevere --> PositiveOutcome[Positive Outcome]
      CognitiveProtective[Cognitive Protective Factors] --> LessSevere
      CognitiveProtective --> PositiveOutcome
  
```

Risks

- Oral language skills
- Motor skills
- Task-focused behavior
- Executive functions
- Interpersonal relationships

Cognitive Protective Factors

- Morphological awareness
- Vocabulary
- Verbal reasoning
- Executive functions
- Grammar

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COGNITIVE RESILIENCE
Resilient Dyslexics

Patael et al. under review

RESILIENT READERS: Those with good comprehension despite poor decoding.

Those with decoding difficulties rely more on contextual information to be able to read successfully.

INTERACTIVE COMPENSATORY MODEL OF DYSLLEXIA
(Stanovich, 1980)

Implications for intervention.

Created by Blair Brice, MEd in 2013. <http://www.illnessandlearning.org>

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

COGNITIVE RESILIENCE
Brain Mechanism?

Patael et al. under review

Expected pattern related to:

RESILIENCE	High	Low	Low
COMPREHENSION	High	High	High
DECODING	Low	High	High
	POOR READERS	RESILIENT READERS	TYPICAL READERS

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

COGNITIVE RESILIENCE
Left Dorsolateral Prefrontal Cortex (DLPFC)

Patael et al. under review

Resilient > Poor readers
Resilient > Typical readers

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

COGNITIVE RESILIENCE
Not just dyslexics but anyone can have it.

Patael et al. under review

10-16yo children with & without poor decoding

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

COGNITIVE RESILIENCE
Chicken or egg? Show signs BEFORE reading failure.

Patael et al. under review

Prereading kids' left DLPFC predicts future 'resilience'

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COGNITIVE RESILIENCE
Role of DLPFC Network?

Patael et al. under review

Related to learning, attention, & cognitive flexibility

Fronto-parietal network

1000 Functional Connectome. Neurosynth.org

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COGNITIVE RESILIENCE

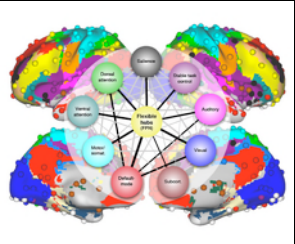
Fronto-parietal network "flexible learning hub".

Patael et al. under review

Dynamically changes how it connects to other key networks based on current goals.

Critical for learning new skills and building mental rules.

Allows immediate & flexible transfer of skills.



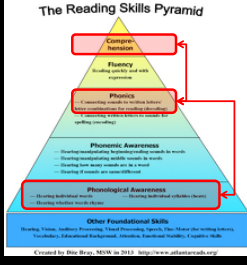
Cole et al. Nat Neuroscience '13

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

COGNITIVE RESILIENCE: Summary

Patael et al. under rev; Hoeft et al. PNAS '07 & PNAS '11; Hancock Richlan Hoeft. Neurosci Beh Rev '16

- Prefrontal & fronto-parietal network
- Cognitive flexibility, learning network
- Related studies also point to prefrontal mechanisms
- May suggest importance of promoting activities to enhance cognitive flexibility & self-regulation early



Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

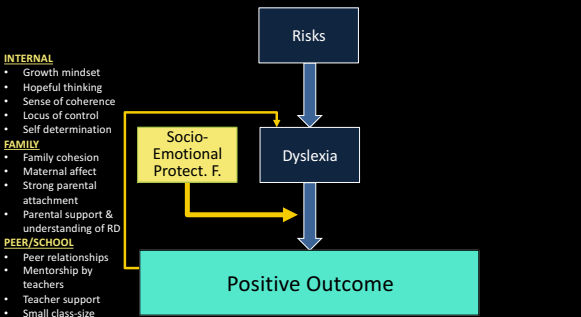
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Resilience Model of LD: SOCIO-EMOTIONAL RESILIENCE

Haft, Myers, Hoeft. Curr Opin Beh Sci 2016



Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

SOCIO-EMOTIONAL RESILIENCE

Character traits critical for success

Grit (self discipline), more predictive than IQ (2x) & above and beyond achievement itself (Duckworth & Seligman, Psychol Sci '05)

Academic-performance variable	Study 2 (N = 164)	
	2x Self-discipline	IQ
First-marking-period GPA	.66***	.34***
Final GPA	.67***	.32***
Spring achievement test	.43***	.36***
Selection to high school	.56***	.26**
School absences	-.20**	-.07
Homework hours	.35***	-.09
Television hours	-.33***	-.06
Time of day homework is begun	-.26**	.18*

Note. GPA = grade point average. *p < .05. **p < .01. ***p < .001.

Variable	B	SE B	β
Study 1			
First-marking-period GPA	0.96	0.04	.82***
Self-discipline	0.95	0.39	.10*
Study 2			
IQ	0.01	0.01	.01
First-marking-period GPA	0.04	0.04	.09***
Self-discipline	0.76	0.33	.08*

*p < .05. **p < .01. ***p < .001.

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

SOCIO-EMOTIONAL RESILIENCE

Brain mechanisms of Grit vs. Growth Mindset

Myers et al. SCAN 2016

Multiple targets – Multiple routes to enhance learning

GROWTH MIND-SET:
Belief that ability is effort based

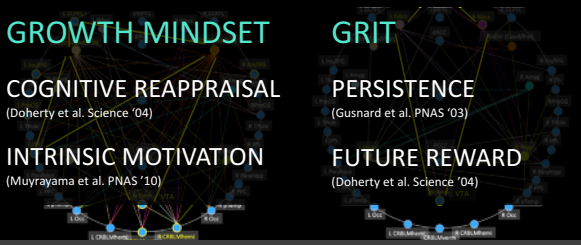
GRIT:
Perseverance toward a long term goal

GROWTH MINDSET
COGNITIVE REAPPRAISAL
(Doherty et al. Science '04)

GRIT
PERSISTENCE
(Gusnard et al. PNAS '03)

INTRINSIC MOTIVATION
(Muyrayama et al. PNAS '10)

FUTURE REWARD
(Doherty et al. Science '04)




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SOCIO-EMOTIONAL RESILIENCE

Stereotype Threat puts Individuals At Risk for Learning

“Stereotype threat is being at risk of confirming, as self-characteristic, a negative stereotype about one’s group.” –Steele and Aronson (1995)


“White men can’t jump.” “African Americans are not smart.” “Women are not good at math.”

reducingstereotypethreat.org, *Whistling vivaldi* by Claude Steele

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

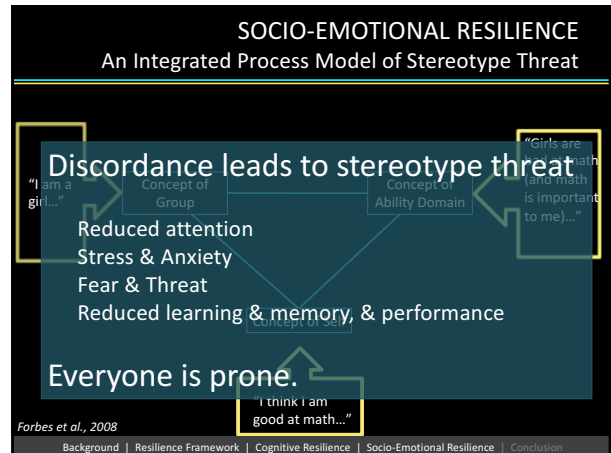
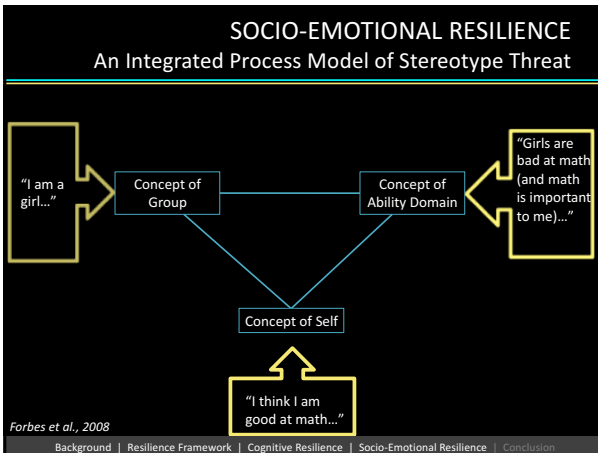
SOCIO-EMOTIONAL RESILIENCE

Stereotype threat MAY exist in LDs

Why might individuals with learning disabilities (including dyslexics, but also ADHD etc) experience stereotype threat?

- Group identification - low achievement
- Aware of stereotype (Kelly and Norwich, 2004; Rashkind et al., 2006)
- Negative academic self-concept (Zelevke, 2004)
- Low self-esteem, negative affect, anxiety, and depression when faced with performance-avoidance goals (the desire to perform less poorly than others) (Sideridis, 2007; Aquino, 2011)

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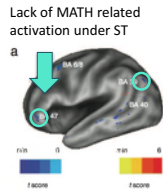
SOCIO-EMOTIONAL RESILIENCE

Brain mechanism of stereotype threat?

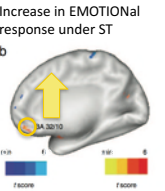
Women & under-performance in math Lack of improvement in math performance over time under ST (interaction: $p < .005$)

Krendl et al. Psychol Sci 2008

Lack of MATH related activation under ST



Increase in EMOTIONAL response under ST



Stereotype threat impacts key cognitive networks and emotion-related networks negatively

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

SOCIO-EMOTIONAL RESILIENCE

Building Resilience Against Stereotype Threat

- Reframing the task (e.g. Quinn & Spencer, 2001)
- De-emphasizing threatened social identities (e.g. Stricker and Ward, 2004)
- Role models (e.g. Blanton et al., 2000)
- External attributions for difficulty (e.g. Good et al, 2003)
- Self-affirmations (e.g. Schimel et al., 2004)
- Growth mindset (e.g. Aronson et al., 2002)

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SOCIO-EMOTIONAL RESILIENCE
Strength-based approach may build resilience

Ken Pugh
von Károlyi et al., '01; '03; Diehl ... Hoeft ... Pugh. *NeuroImage* '14

Visuo-spatial processing show yin-yang relationship with reading

BEHAVIOR **BRAIN**

reading

$r = -0.42$
 $p < 0.05$

visuo-spatial

dyslexics non-dyslexics

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

SOCIO-EMOTIONAL RESILIENCE
Mentoring may build resilience

IMPROVEMENT IN:

- SELF ESTEEM (12%)
- GRIT (value) (8-36%)
- GROWTH MINDSET (14%)
- LD IDENTITY (comfort, bond, importance) (24-52%)
- READING SELF-CONCEPT (19%)
- etc...

Scores

■ Fall ■ Spring

Response to failure 26.7% *** $P < 0.0001$

Depression

Self Esteem 12.5% ~* $P = 0.05$

Display more positive emotions and effort-based strategies in the face of failure. $N = 48$

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SOCIO-EMOTIONAL RESILIENCE
Mentoring may build resilience

Self-Esteem (Fall to Spring % increase)

$R^2 = 0.13$ ($r = 0.36$)
 $P = 0.025$

Mentee-Rated Mentorship Quality (1-low to 3-high) $N = 39$

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SOCIO-EMOTIONAL RESILIENCE: Positive Impact on Learning-Related Brain Regions

Haft, Black. *Under prep*

Self-Awareness

Self-Concept

Self-Esteem

Mindset

Medial/Lateral Prefrontal Cortex (m/IPFC): information processing

Dorsal Anterior Cingulate Cortex (dACC): reward-based decision making; error monitoring

Hypothalamus, Pituitary Gland: regulation & production of hormones (e.g. cortisol)

Amygdala, Hippocampus: fear, emotions, and fear learning

Social Support

Positive Emotion

Coping

Regulates hormones. Reduces stress.

Regulates emotional response to threat.

Modulates salience of information.

Influences neuroendocrine responses to stress.

Influences adaptive responses to errors.

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

SOCIO-EMOTIONAL RESILIENCE: Summary

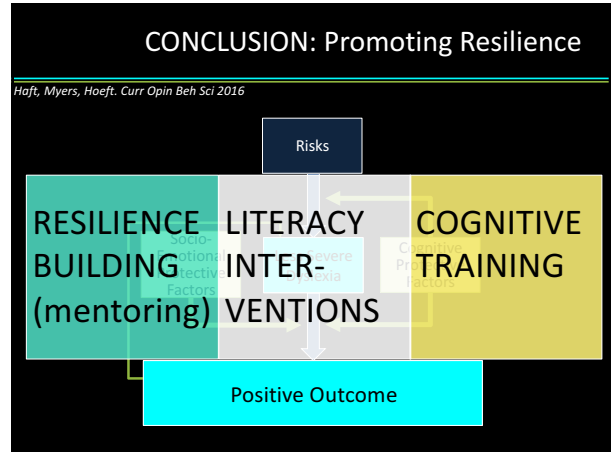
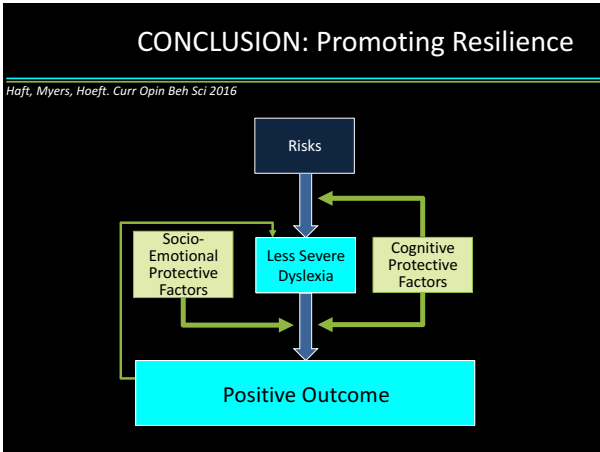
- Socio-emotional character traits impact learning related brain mechanisms.
- Large individual differences. Understanding these differences are important (Learner Positional System [LPS]). Opportunity for personalized learning.
- Stereotype threat may exist that impede on learning but can be minimized in the classroom.
- Potential for taking a strength-based approach.
- Mentoring potentially builds resilience.

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

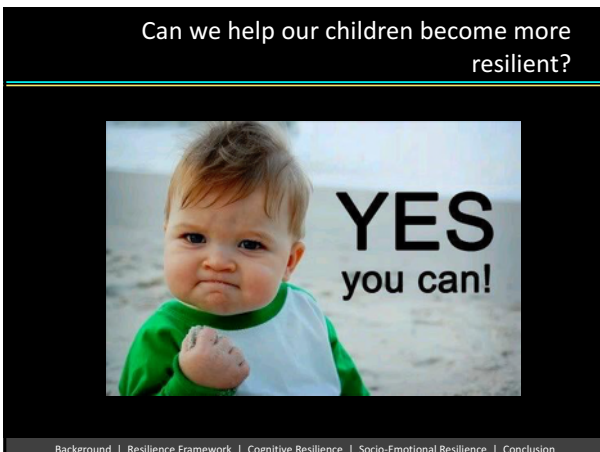
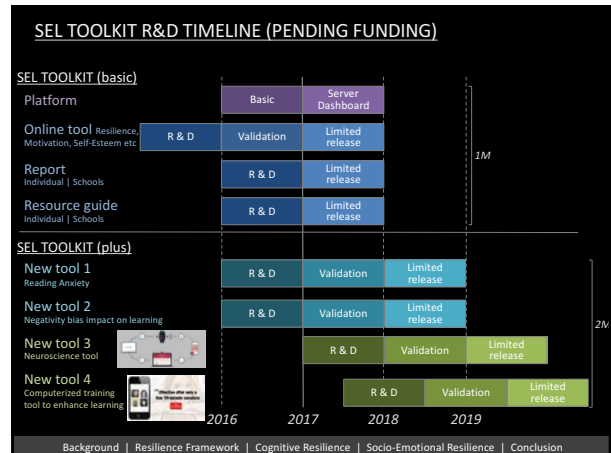
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- ### CONCLUSION: Building Resilience
- Scaffold for positive reframing > Cognitive reappraisal, Sense of control, Cognitive control & self-regulation > Growth mindset, Motivation, Grit
 - Strength based approach > Confidence, Optimism, Motivation
 - Social support, role model, mentoring > Connection to community
 - Reduce stereotype threat > Optimize learning environment & enhanced performance
 - Stress inoculation (exposure to tolerable levels of stress & challenges)
- Charney. Nat Rev Neurosci 2009; Ken Ginsberg <http://www.fosteringresilience.com/7cs.php>*
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(OTHER) WORK @ UCSC brainLENS

UCSC Center for Educational Neuroscience

Early identification & prevention

Mechanisms of dyslexia, reading & learning

Protective factors Building resilience

Community

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

UCSF brain LENS UC MERCED UC DAVIS Cal UCLA Stanford
 Fumiko Hoeft MD PhD, Executive Director

Precision Learning Center
 university of california
 berkeley + davis
 Irvine + los angeles
 merced + san francisco
 stanford
 PrecisionLearningCenter.org

WANTED!
 Part-time licensed clinical psychologist
 Community partners
 Philanthropic partners

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Mission and Goals

WHO WE ARE A new and cross-disciplinary 'Precision Ed-Health' center across the (6) UC campuses with expertise in (bilingual) education, sp-ed, cog psych, neuroscience, medicine, & policy.

Precision Medicine is an emerging data-driven approach for disease treatment and prevention that takes into account individual variability in environment, lifestyle and genes for each person. (2015)

Precision Ed-Health is an data-driven approach to prevent the spiral effect of poor educational attainment to health disparity taking into account variability in each child by looking at large amounts of data from the environment, psychological, cognitive, neuroscience, biomedical information.

MISSION. Tackle issues associated with education and health disparity with a particular emphasis on underrepresented populations.

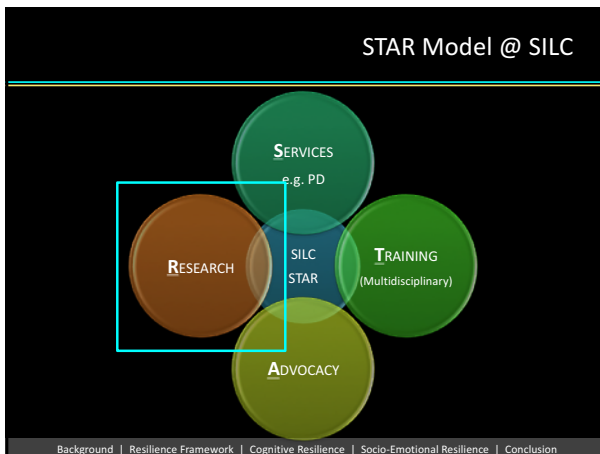
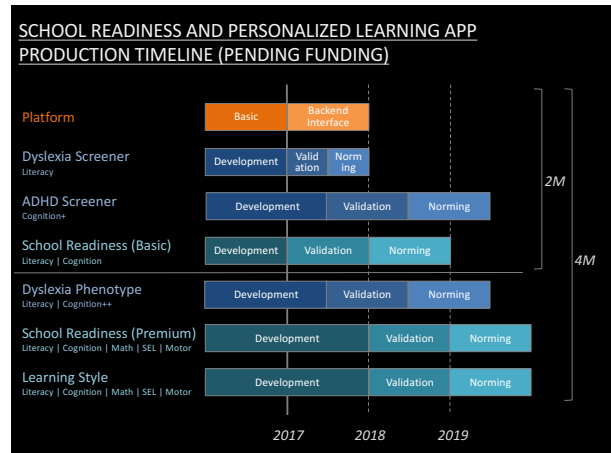
LONG-TERM GOAL. To provide the best educational and health outcomes for ALL CHILDREN regardless of their background.

SHORT TERM GOAL. Early identification and intervention of children at risk for learning challenges, especially in English learners.

Background | Resilience Framework | Cognitive Resilience | Socio-Emotional Resilience | Conclusion

School Readiness & Personalized Learning App. Modules

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BACKGROUND: Education & Health Disparity in English Learners (ELs)

Category	Value
Proportion of ELs in Public School	US (1 in 10) = 9.3%, CA (1 in 4) = 22.3%
Distribution of ELs within the US	1 in 3 in CA = 33.3%, 2 in 3 in Other States = 66.7%
Native Languages spoken in US!	Spanish EL = 70.0%, Other EL = 30.0%

VICIOUS CYCLE OF INEQUALITY

Low English Proficiency → Difficult to Predict Learning Challenges → Poor Educational Attainment → Low Income → Poor Health → Low English Proficiency

ELs are 200% more likely to live in poverty

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Translational Research Program

1. IDENTIFY BEST WAY TO PREDICT FUTURE LEARNING CHALLENGES EARLY AND ACCURATELY. (Learner Positional System [LPS])

3. EVALUATE HEALTH OUTCOME. Obesity, Immune function, Telomerase, etc...

2. INDIVIDUALIZE INSTRUCTION/INTERVENTION. Computerized training programs, e.g. mAZi, GraphoGame

4. EVALUATE IMPACT OF ENVIRONMENT. e.g. toxin

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Science of Learning Collaborative Network (SL-CN)
UCSF - Stanford - UC Berkeley

UC Berkeley

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Thank you...

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Thank you...

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