Affirmative Action and Human Capital Investment: Evidence from a Randomized Field Experiment

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Areas of Interest:
Family structure; Field experiments in schools; Healthy eating; Habit formation; Parental time investments
Do affirmative action policies affect student effort?

• Bowen and Bok (1998), Arcidiacono (2005), Howell (2010) all estimate impact of AA ban on college minority admissions.
  • These studies use current test scores of black and white students.

• If affirmative action increases effort among minority students, then consequences of removing AA will be larger than predicted.

• We test the impact of AA on student effort using a field experiment in which we randomly assign AA.
  • We use a quota policy: a set of prizes just for the disadvantaged group.
  • Experiment includes adjacent grades taking the same test (AMC 8).
  • Sample: 992 5th-8th grade students from several schools in Utah County.
  • All students took a pre-test. They received a sheet with the score and prize structure.
  • Neutral condition: two grades competing for same prizes; Quota: Separate prizes.
  • We provide a website where students can practice two weeks leading up to test.
The quota doubles student effort in using our website.

Much smaller but still slightly positive coefficient for the advantaged group.

The quota improves student performance by 0.62 points (about 25% of a standard deviation).

Performance declines a bit for the advantaged group.

Next Steps:
Chicago experiment
NSF grant
Education Research in the Life Sciences

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Areas of Interest:
The development and transferability of scientific reasoning skills; appropriate assessment techniques; effective strategies for constructivist teaching in the STEM classroom; strategies to enhance STEM retention
Do you want to take the same scientific approach to your teaching as you do with your research? I can help.

Examples

• Are students more motivated to learn if they handle authentic materials in lab?
  

• Do scientific reasoning abilities predict retention in STEM majors?
  
  Jensen, J. L., Neeley, S., Hatch, J. B., & Piorczynski, T. (In press). Learning scientific reasoning skills may be the key to retention in science, technology, engineering, and mathematics. *Journal of College Student Retention*.

• Can access to personal genomics tools influence students’ learning experiences in genetics?
  
Examples

• Is a ‘flipped’ classroom going to improve what I am already doing?


• Does it matter if my exams consist of low-level recall or high-level problem solving?


• Does it matter how long my exams are?


• If I use collaborative groups, does it matter how I group students?

Thinking about trying something new in the classroom? Want to know if it worked?

• Come to me with an idea and I can help you form a testable hypothesis grounded in educational theory

• Contact me before you make the change so we can
  • Collect control data
  • Obtain IRB approval
  • Perfect experimental design
  • Get funding??

• Be willing to write

• That’s it! Easy as pie. 😊
Designing the **Building Expertise in STEM Application (BEST App)**

Brainstorming to define the scientific reasoning and process skills inherent to your discipline

Defining SPARS in STEM disciplines

Recruiting teaching majors for a development team

Assigning the BEST App to your students pre/post

Involving the pre-service teachers in the process

Assigning the BEST App to your students pre/post

Testing the BEST App in your classroom

Assigning the BEST App to your students pre/post

Involving the pre-service teachers in the process

Assigning the BEST App to your students pre/post

Testing the BEST App in your classroom
Helper T cell role in Immunity to Infection

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Areas of Interest:
Immunology; Host-pathogen interactions; Molecular Biology; Mechanisms of T Cell Activation and Memory Cell Formation; High Affinity T cell Receptors
I am an Immunologist using molecular, biochemical, and cellular techniques to understand T cell activation and improve the immune response to infection.
Central role of helper T cells in immunity to infection
T cell activation controlled on numerous levels

1) **T cell receptor:** T cell function dependent upon affinity of TCR-peptide MHC

2) **Cell signaling:** Signaling cascade regulates the T cell response to antigen

3) **Co-receptors:** Co-receptors have a critical role in T cell inhibition and activation
① Examining memory cell generation to infection
② Engineering soluble high affinity T cell receptors
③ Measuring T cell activation with calcium influx
Two TCR transgenic mice specific for Listeria

- **LLO118**
  - LLO190-205/I-A^b_{Va2, Vb2}
  - Ly5.1
  - TCRs differ by 15 amino acids (10 in the CDR3\(\beta\))
  - CD4^+ cells

- **LLO56**
  - LLO190-205/I-A^b_{Va2, Vb2}
  - Thy1.1
  - CD4^+ cells

**TCRtg mice**
Key finding: LLO118 better in primary response and LLO56 better in secondary response

- How can helper T cell memory formation be improved?
- What role does cell death have on memory cell generation?
- How does TCR affinity affect recognition of infectious agents?
- What is the role of CD5 in T cell function?

Protein engineering using yeast display

**Why use yeast display?**
1) Generate therapeutic and diagnostic reagents.
2) Increase biological understanding of T cell activation.
3) Stabilized TCRs are amenable to affinity and structural studies.
Engineering high affinity T cell receptors

- How is T cell activation altered when TCR affinity is increased?
- Can high affinity TCRs be used as immunoregulatory therapeutics?

Calcium ions are involved in numerous cellular events: Fertilization, Transcription, Lymphocyte activation, Muscle contraction, and Cell death. The diagram illustrates the role of calcium ions in various cellular processes, including the activation of NFAT and Calcineurin, and the movement of calcium ions between different compartments such as the endoplasmic reticulum (ER) and the nucleus.
Measuring T cell activation with calcium influx

- How is calcium influx and T cell activation altered in memory cells and high affinity T cells?
Conserved pathways involved in regulating central metabolism

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Areas of Interest:

Regulation of metabolism in response to the availability of nutrients and other factors affecting growth, the study of PAS kinase, control of NAD and NADP levels within the cell
Total US Government Spending for United States

- Welfare: 5%
- Defense: 14%
- Education: 13%
- Pensions: 18%
- Health Care: 24%
- Other spending: 9%
- Interest: 5%
- General government: 3%
- Transportation: 5%
- Protection: 4%
Cellular Resource Allocation

- **Glucose**
  - **Enzymes:**
    - Glucose-6-P
    - Pyruvate
    - TCA
    - Respiration

- **Energy (ATP)**
  - **Enzymes:** Reducing Power (NADPH)

- **Storage: (GLYCOGEN/FATS)**

- **Building Blocks: (amino acids/nucleotides/vitamins)**

- **Pentose Phosphate Pathway**
Nutrient sensing protein kinases regulate cellular processes through phosphorylation.
Sensory Protein Kinases Regulate Metabolism

**Glucose**

- **PAS**
  - **Glucose-6-P**
  - **Pyruvate**
  - **TCA**
  - **Respiration**
  - **Energy** (ATP)

**Building Blocks**

- **Storage** (glycogen/fats)
- **Reducing Power** (NADPH)

**Energy Pathways**

- **Pentose Phosphate Pathway**

**Building Blocks**

- **Amino acids/nucleotides/vitamins**

**KEYS**

- **AMPK**
- **mTOR**

**Regulation**

- Sensory Protein Kinases regulate metabolism.
A model for PAS kinase activation and function

- kinase
- PAS
- downstream targets
- P
- liver TAG
- adiposity
- respiration
- insulin sensitivity

Questions:

- ?

Diagram:

1. PAS
2. Kinase
3. P
4. Downstream targets
5. Liver TAG
6. Adiposity
7. Respiration
8. Insulin sensitivity

Question:

- ?
107 Psk1 binding partners identified by Y2H and copurification

70% of the Y2H hits are known to interact with at least one hit from copurification
Interplay Between PAS Kinase and TORC1, Through the Phosphorylation of Pbp1

Growth & Proliferation

Pbp1

TorC1

ENERGY (Respiratory Carbon Sources)

Snf1 (AMPK) Sip2

Gal83

PAS kinase P

Pbp1

P

Stress granule sequestration

Growth & Proliferation
Cbf1 activates respiration and is inhibited by PAS kinase

*P < 0.05 for condition vs WT
#P < 0.05 for psk vs cbf1 and cbf1psk

DeMille et al., 2014
SNF1 Phosphorylates PAS kinase in Response to Respiratory Carbon Sources

**Inactive**

**Active**

SNF1 Phosphorylates PAS kinase in Response to Respiratory Carbon Sources

- Snf1 (AMPK)
- Sip2

**Energy**

(Respiratory Carbon Sources)

**Kinase**

**PAS**

**Downstream targets**

- Ugp1
- Cbf1
- Pbp1

↑ lipids??

↑ structural carb.

↓ respiration

↓ storage

(glycogen/fat)

↓ growth/

proliferation
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NIH1R15GM100376-01
Molecular Pathways of β-cell Function and Proliferation

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Areas of Interest:
Delineating the molecular pathways that increase β-cell proliferation; enhance glucose stimulated insulin secretion; protection against β-cell death; effects of maternal environment, aging and nutrients on functional β-cell mass
Molecular pathways of β-cell function and proliferation

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Type 1 and Type 2 Diabetes are increasing worldwide

347 Million people world wide are diabetic
Islet transplantation—potential cure for diabetes

Major obstacle to greater use of islet transplantation is the availability of beta-cells

More $\beta$-cells are needed

Discovery and manipulation of $\beta$-cell proliferation pathways
Tessem Lab - Metabolic Regulation of β-cells

• Identify **molecular accelerators and brakes** of beta cell replication

• Understand how these factors regulate **functional beta cell mass**

• Develop **small molecule activators** of beta cell proliferation pathways

• Apply findings to **two-state models of beta cell function** (obese vs. lean, young vs. aged, male vs. female)

• Discover unique regulators of **integrative metabolism**
What is functional $\beta$-cell mass?

$$FM_\beta = F_{SR} \left(1 + \Delta M_P - \Delta M_D\right)$$

$FM_\beta$ = functional $\beta$-cell mass  
$F_{SR}$ = secretion rate factor  
$\Delta M_P$ = change in mass due to proliferation  
$\Delta M_D$ = change in mass due to cell death
Our experimental methodology

Adenoviral gene transfer, shRNA knockdown, pharmacological modulators, nutritional factors

Changes in proliferation, glucose stimulated insulin secretion, protection against apoptosis

Expression analysis and molecular, biochemical, histological techniques are used to define pathways
Tools that we have for collaborations

• Wistar rat colony (access to young and aged animals)

• Knock out mice
  – Full body knock out: Nr4a1 and Nr4a3
  – Floxed: Nr4a1
  – RIP-CRE-ERTM-β-cell specific

• Adenovirus-over 100 adenovirus for gene overexpression and knockdown

• Islet isolation from rat and mice-have you wondered what your gene of interest does in the β-cell? Let us help you find out

• Other techniques: RT-PCR, Histology, shRNA, lentivirus, β-cell lines, feeding studies, etc.
GENE REGULATORY NETWORKS IN THE DEVELOPING HEART

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Areas of Interest:
understanding how genes are regulated during heart formation;
bioinformatics and bench biology to study how gene expression is controlled during this process
GENE REGULATORY NETWORKS IN THE DEVELOPING HEART
HEART LOOPING AND AVC FORMATION

Human

Ventricle

Atrium

21 days

28 days

50 days

Zebrfish

Ventricle

Atrium

30 hours

48 hours

72 hours
GENE REGULATORY NETWORK

Program = DNA sequence of regulatory regions

Input 1 = Epigenetic marks
Input 2 = Transcription Factors
Input 3 = Signaling Pathway

Regulate other genes
Cell structure/shape
Cell function

Output
GENE REGULATORY NETWORK

Output
Program = DNA sequence of regulatory regions
Input 1 = Epigenetic marks
Input 2 = Transcription Factors
Input 3 = Signaling Pathway

Regulate other genes
Cell structure/shape
Cell function

Time-course & Genetic Mapping
RNA-seq & ChIP-seq
Currently Developing
COLLABORATIONS

Conducting and analyzing RNA-seq and ChIP-seq experiments
Improving our tools for mapping mutations (bioinformatics, statistics)
Performing mutagenesis screens in zebrafish
Programming a web interface for a zebrafish monitoring system