Intelligence: Is it the epidemiologists’ elusive fundamental cause of social class inequalities in health?

Linda S. Gottfredson
University of Delaware
APA 2003
Toronto, Canada
“Wealth Secures Health”

Psychologists’ research is probing why the more money you have, the better health you enjoy.

(APA Monitor, 2001)
The Issue

- Yes, pervasive SES differences in health
- But “poverty paradigm” has failed
- There’s a more “fundamental cause”
- Intelligence ($g$) may be that cause
  - Predicts better than SES measures
  - Explains better than SES theories
Yes, SES-Health Gradients Are Pervasive

- Higher social class (education, occupation, income) associated with:
  - Lower morbidity
  - Lower mortality
  - Better health behaviors
  - More health knowledge
Example (odds ratios): Same for all sex/race (B/W) groups

<table>
<thead>
<tr>
<th>Diseases</th>
<th>Cum. probability of onset by age 63 for persons aged 51 without the disease</th>
<th>Years of Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes, Chronic obstructive pulmonary disease</td>
<td></td>
<td>2.0 1.0 0.5</td>
</tr>
<tr>
<td>Stroke, heart, hypertension</td>
<td></td>
<td>1.5 1.0 0.7</td>
</tr>
<tr>
<td>Cancer</td>
<td></td>
<td>0.7 1.0 1.4</td>
</tr>
</tbody>
</table>

Red = prevalence rates higher for black M and F
But “Poverty Paradigm” Has Failed

Health epidemiologists point to two puzzles and a paradox.
Puzzle 1: Effect Too General

- Virtually all major diseases/causes of death
- All demographic groups
- All nations
- All decades

Gradients do not trace variation/change
Puzzle 1: Effect Too General

- Virtually all major diseases/causes of death
- All demographic groups
- All nations

Moreover, gradients are found:

- Regardless of the disease’s treatability
- Even when health care free
- Even when treatments identical
Puzzle 2: Effect Too Linear

- Health is *increasingly* better at higher SES levels, even beyond point where resources are more than sufficient
- “Finely graded”
Paradox: SES-Health Gaps Grow When They Should Shrink

- When health care made *more* widely available
- When health information made *more* widely available

All gain, but higher SES people gain more
Contributing Behaviors

When care is free:

- Lower social classes seek:
  - Less information
  - Less preventive care
  - More—but less appropriate—curative care

- And perform worse:
  - Know, understand less
  - Less healthy behavior (e.g., smoking)
  - Adhere less to treatment regimens
Epidemiologists’ Suspect a “Fundamental Cause” At Work

SES-health gradients are so “remarkably” general that there must be some equally general “fundamental cause,” “higher order variable,” or “transportable” resource that maintains the SES-health relation in a “dynamic system in which risk factors, knowledge of risk factors, treatments, and patterns of disease are changing.”

(Link & Phelan, 1995)
Their Candidates

- Cannot be material resources
- Perhaps psychic mediators of SES?
  - Social support, connectedness, anxiety, stress
  - Sense of control, mastery, esteem, stigma
  - Capacities in coping, resistance, problem-solving
- Perhaps inequality itself (relative deprivation)?
- But not IQ!!
Intelligence Might Be That "Fundamental Cause." Why?

First clue:
- Effects of intelligence ($g$) in other life arenas mimic the puzzles and paradox for SES in health
  - Highly general, context-insensitive
  - Linear
  - Variance in performance increases as mean rises
Intelligence Might Be That “Fundamental Cause.” Why?

Second clue:

- SES-health gradients steeper when SES scale is a better surrogate for IQ

<table>
<thead>
<tr>
<th>Variable</th>
<th>Rank</th>
<th>r with IQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>income</td>
<td>+</td>
<td>.3-.4</td>
</tr>
<tr>
<td>occupation</td>
<td>++</td>
<td>.4-.5</td>
</tr>
<tr>
<td>education</td>
<td>+++</td>
<td>.5-.6</td>
</tr>
</tbody>
</table>
## SES Differences in IQ (WAIS)

<table>
<thead>
<tr>
<th>Education (Yrs)</th>
<th>IQ</th>
<th>%</th>
<th>Occupation</th>
<th>IQ</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>16+</td>
<td>115</td>
<td>84</td>
<td>Prof/technical</td>
<td>111</td>
<td>76</td>
</tr>
<tr>
<td>13-15</td>
<td>107</td>
<td>68</td>
<td>Man/cler_sales</td>
<td>104</td>
<td>61</td>
</tr>
<tr>
<td>12 (diploma)</td>
<td>100</td>
<td>50</td>
<td>Skilled</td>
<td>99</td>
<td>48</td>
</tr>
<tr>
<td>9-11</td>
<td>96</td>
<td>39</td>
<td>Semi-skilled</td>
<td>93</td>
<td>32</td>
</tr>
<tr>
<td>8</td>
<td>91</td>
<td>27</td>
<td>Unskilled</td>
<td>89</td>
<td>24</td>
</tr>
<tr>
<td>0-7</td>
<td>82</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2 SD  1.5 SD
IQ Predicts Health Better Than SES

Large, prospective IQ-SES-health studies

- Scotland (IQ at age 11)
  - Longevity
  - Heart disease, lung cancer mortality
  - Smoking cessation

- Australia (IQ at Army induction)
  - All-cause mortality
  - Motor vehicle deaths
  - Suicide
Example: Motor Vehicle Deaths

- IQ is best predictor
- Predicts net of 56 other variables
- “People with lower IQ may have a poorer ability to assess risks and, consequently, may take more risks in their driving.”

<table>
<thead>
<tr>
<th>Australian veterans followed to age 40</th>
<th>Death rate per 10,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQ: above 115</td>
<td>51.3</td>
</tr>
<tr>
<td>100-115</td>
<td>51.5</td>
</tr>
<tr>
<td>85-100</td>
<td>92.2 2x</td>
</tr>
<tr>
<td>80- 85</td>
<td>146.7 3x</td>
</tr>
</tbody>
</table>
IQ Provides Better Explanatory Mechanisms Than SES

- Poverty paradigm has failed
- No viable social class psyche theory yet
- But the SES-health data fit well into the $g$ theory of competence in everyday life

Mental, not material, resources the key?
Preview of Explanation: Health Is a “Job”

1. IQ/$g$ is a general learning, reasoning ability
2. This ability is the best predictor of job performance, especially in complex jobs
3. Health self-care is a life-long, increasingly complex career
4. Health self-care is at least as important as medical care
1. IQ/$g$ Is a Highly General & Highly Practical Ability

- All mental tests measure mostly the same ability: $g$
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- All mental tests measure mostly the same ability: $g$
1. IQ/$g$ Is a Highly General & Highly Practical Ability

- All mental tests measure mostly the same ability: $g$
- IQ/$g$ reflects generic content-free thinking skills: learn quickly and from experience, reason, think abstractly, spot and solve problems, etc.

The ability to process complex information efficiently and accurately.
Sample IQ Items

<table>
<thead>
<tr>
<th></th>
<th>Easy</th>
<th>Moderate</th>
<th>Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill in the next two numbers</td>
<td>3, 5, 7, 9, __, __</td>
<td>3, 5, 6, 8, 9, __, __</td>
<td>10, 9, 8, 9, 8, 7, __, __</td>
</tr>
<tr>
<td>Name one similarity</td>
<td>orange—banana (93%)</td>
<td>table-chair (55%)</td>
<td>fly-tree (18%)</td>
</tr>
<tr>
<td>Define the word</td>
<td>breakfast</td>
<td>reluctant</td>
<td>encumber</td>
</tr>
</tbody>
</table>

Complexity is the active ingredient: More complex tasks are more “g loaded”

% = % of 16-65 year-olds getting at least partial credit for answer, WAIS, 1955
Example of Mental Manipulation

- Digits Subtests: Forward vs. Backward
- Latter is twice as $g$ loaded ($\approx .2$ vs. .4)
1. IQ/$g$ Is a Highly General & Highly Practical Ability

- All mental tests measure mostly the same ability: $g$
- IQ/$g$ reflects generic content-free thinking skills: learn quickly and from experience, reason, think abstractly, spot and solve problems, etc.
- Everyday tasks require the same generic learning, reasoning, and problem-solving skills
### Example: Functional Literacy (NALS)

<table>
<thead>
<tr>
<th>NALS Level</th>
<th>% pop. (white)</th>
<th>Simulated Everyday Tasks</th>
</tr>
</thead>
</table>
| 5          | 4%             | - Use calculator to determine cost of carpet for a room  
|            |                | - Use table of information to compare 2 credit cards       |
| 4          | 21%            | - Use eligibility pamphlet to calculate SSI benefits       
|            |                | - Explain difference between 2 types of employee benefits |
| 3          | 36%            | - Calculate miles per gallon from mileage record chart     
|            |                | - Write brief letter explaining error on credit card bill  |
| 2          | 25%            | - Determine difference in price between 2 show tickets    
|            |                | - Locate intersection on street map                       |
| 1          | 14%            | - Total bank deposit entry                                
|            |                | - Locate expiration date on driver’s license               |

(NALS) National Adult Literacy Survey
## Functional Literacy (NALS)

<table>
<thead>
<tr>
<th>NALS Level</th>
<th>% pop. (white)</th>
<th>Simulated activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4%</td>
<td>Use calculator to...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use table of info.</td>
</tr>
<tr>
<td>4</td>
<td>25%</td>
<td>Use eligibility pan...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Explain difference.</td>
</tr>
<tr>
<td>3</td>
<td>36%</td>
<td>Calculate miles per...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Write brief letter.</td>
</tr>
<tr>
<td>2</td>
<td>25%</td>
<td>Determine difference.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Locate intersection.</td>
</tr>
<tr>
<td>1</td>
<td>14%</td>
<td>Total bank deposit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Locate expiration.</td>
</tr>
</tbody>
</table>

**Difficulty based on “process complexity”**

- **level of inference**
- **abstractness of info**
- **distracting information**
You are a marketing manager for a small manufacturing firm. This graph shows your company's sales over the last three years. Given the seasonal pattern shown on the graph, predict the sales for Spring 1985 (in thousands) by putting an “x” on the graph.

Simple inference
Little distracting information
**NALS Level 4—Sample Item**

On Saturday afternoon, if you miss the 2:35 bus leaving Hancock and Buena Ventura going to Flintridge and Academy, how long will you have to wait for the next bus?

<table>
<thead>
<tr>
<th>ROUTE 5</th>
<th>VISTA GRANDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>This bus line operates Monday through Saturday providing &quot;local service to most neighborhoods in the northeast section. Buses run thirty minutes apart during the morning and afternoon rush hours Monday through Friday. Buses run one hour apart at all other times of day and Saturday.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>OUTBOUND</strong></th>
<th><strong>INBOUND</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>from Terminal</strong></td>
<td><strong>to Terminal</strong></td>
</tr>
<tr>
<td>Leave Downtown Terminal</td>
<td>Leave Downtown Terminal</td>
</tr>
<tr>
<td>Leave Hancock and Buena Ventura</td>
<td>Leave Hancock and Buena Ventura</td>
</tr>
<tr>
<td>Leave Rustic Hills</td>
<td>Leave Rustic Hills</td>
</tr>
<tr>
<td>Leave North Carriage</td>
<td>Leave North Carriage</td>
</tr>
<tr>
<td>Leave One Blanche</td>
<td>Leave One Blanche</td>
</tr>
<tr>
<td>Leave Flintridge and Academy</td>
<td>Leave Flintridge and Academy</td>
</tr>
<tr>
<td>Leave North Carriage and One Blanche</td>
<td>Leave North Carriage and One Blanche</td>
</tr>
<tr>
<td><strong>Arrive Downtown Terminal</strong></td>
<td><strong>Arrive Downtown Terminal</strong></td>
</tr>
<tr>
<td>Leave Hancock and Buena Ventura</td>
<td>Leave Hancock and Buena Ventura</td>
</tr>
<tr>
<td>Leave Rustic Hills</td>
<td>Leave Rustic Hills</td>
</tr>
<tr>
<td>Leave North Carriage</td>
<td>Leave North Carriage</td>
</tr>
<tr>
<td>Leave One Blanche</td>
<td>Leave One Blanche</td>
</tr>
<tr>
<td>Leave Flintridge and Academy</td>
<td>Leave Flintridge and Academy</td>
</tr>
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<td>Leave North Carriage and One Blanche</td>
<td>Leave North Carriage and One Blanche</td>
</tr>
</tbody>
</table>

**More elements to match**

**More inferences**

**More distracting information**
IQ/Literacy Relate in Same Way to Same Life Outcomes

- **General:**
  - High: Education level
  - Moderately high: Occupation level
  - Moderate: Income, adult poverty, welfare use
  - Low: Not employed

- **Linear**

NALS literacy and IQ are “functionally equivalent” (among the native-born).
2. IQ/$g$ Is the Best Predictor of Job Performance

**Meta-analyses show that:**
- $g$ predicts performance to some extent in all jobs
- it is best single predictor overall
- it has average (corrected) validity of .4-.5
- its validity is higher in more complex jobs
- its validity does not fade among experience

**Why so predictive?**
Jobs Differ Most in Their Learning/Reasoning Demands

<table>
<thead>
<tr>
<th>Reasoning &amp; Judgment Factor (Arvey)</th>
<th>$r$ with factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learn and recall relevant information</td>
<td>.75</td>
</tr>
<tr>
<td>Reason and make judgments</td>
<td>.71</td>
</tr>
<tr>
<td>Deal with unexpected situations</td>
<td>.69</td>
</tr>
<tr>
<td>Identify problem situations quickly</td>
<td>.69</td>
</tr>
<tr>
<td>React swiftly when unexpected problems occur</td>
<td>.67</td>
</tr>
<tr>
<td>Apply common sense to solve problems</td>
<td></td>
</tr>
<tr>
<td>Learn new procedures quickly</td>
<td>.66</td>
</tr>
<tr>
<td>Be alert &amp; quick to understand things</td>
<td></td>
</tr>
</tbody>
</table>

$g$: A general ability to learn, reason, and solve problems.
Jobs Therefore Differ in Their Demands for $g$ ($g$ Loadedness)

<table>
<thead>
<tr>
<th>Occupation</th>
<th>IQs: Middle 50% (Applicants)</th>
<th>%ile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attorney, Engineer</td>
<td>108-128</td>
<td>70-97</td>
</tr>
<tr>
<td>Teacher, Programmer</td>
<td>100-120</td>
<td>50-90</td>
</tr>
<tr>
<td>Secretary, Lab tech</td>
<td>96-116</td>
<td>40-85</td>
</tr>
<tr>
<td>Meter reader, Teller</td>
<td>91-110</td>
<td>27-75</td>
</tr>
<tr>
<td>Welder, Security guard</td>
<td>85-105</td>
<td>15-63</td>
</tr>
<tr>
<td>Packer, Custodian</td>
<td>80-100</td>
<td>10-50</td>
</tr>
</tbody>
</table>

Criterion validity (Corrected) 
- $g = 0.80$
- $g = 0.20$
More \( g \)-Loaded Jobs Are More Complex

<table>
<thead>
<tr>
<th>Complex</th>
<th>( r )</th>
<th>Self-direction</th>
<th>Reason</th>
<th>Update knowledge</th>
<th>Analyze</th>
<th>Lack of structure</th>
<th>Criticality of position</th>
<th>Combine information</th>
<th>Advise</th>
<th>Write</th>
<th>Plan</th>
<th>Negotiate, Persuade</th>
<th>Coordinate</th>
<th>Instruct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple</td>
<td>-0.73</td>
<td>Transcribe</td>
<td>Recognize</td>
<td>Repetitive</td>
<td>Physical exertion</td>
<td>Supervision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teller</td>
<td>-0.56</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attorney</td>
<td>-0.49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Patient?
3. Health Self-Care is a Complex Job

- Top 4 killers today (developed world)
  - Cancer
  - Heart disease
  - Stroke
  - Injuries

- Keys to good health
  - Prevention
  - Controlling damage
Life Requires “Defensive Driving” to Prevent Accidents

Highly cognitive process

- Recognize hazards
- Prevent incidents starting
- Halt progress of incidents
- Limit damage during incidents
- Recover and redesign

Same process as with chronic illness.
Non-Work Accidental Death Rates Higher in Lower Classes

- Suffocation (infants) 1.3
- Choking on food (infants & elderly) 1.5
- Drowning (young males) 2.0
- Motor vehicle (young males) 2.4
- Fires/burns (children & elderly) 2.5
- Lightning (young males) 3.4
- Firearms (young males) 4.4
- Natural disasters (all ages, sexes) 5.0
- Exposure/neglect (infants & elderly) 7.4
Accidents and Chronic Diseases Are Like Complex Jobs

Recall these job analysis results

<table>
<thead>
<tr>
<th>Complex jobs require you to:</th>
<th>( r ) with complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Learn and recall relevant information</td>
<td>0.75</td>
</tr>
<tr>
<td>- Reason and make judgments</td>
<td>0.71</td>
</tr>
<tr>
<td>- Deal with unexpected situations</td>
<td>0.69</td>
</tr>
<tr>
<td>- Identify problem situations quickly</td>
<td>0.69</td>
</tr>
<tr>
<td>- React swiftly when unexpected problems occur</td>
<td>0.67</td>
</tr>
<tr>
<td>- Apply common sense to solve problems</td>
<td>0.66</td>
</tr>
<tr>
<td>- Learn new procedures quickly</td>
<td>0.66</td>
</tr>
<tr>
<td>- Be alert &amp; quick to understand things</td>
<td>0.55</td>
</tr>
</tbody>
</table>
Chronic Illnesses: Cognitively Demanding, Long-Term Careers

- Chronic illnesses are “slow-acting, long-term killers that can be treated but not cured”
  - Develop slowly, hard to detect
  - Damage process slow, invisible
  - Lengthy treatment requiring continued need “to learn,” “reason,” and “solve problems”
  - No immediate consequences of back-sliding
Chronic Illnesses Require Foresight & Prevention

- Keep informed
- Live healthy lifestyle
- Get preventive checkups
- Detect signs and symptoms
- Seek timely, appropriate medical attention

All are less frequent in lower social classes
State launches plan to stop rising rate of killer disease

About 15,000 in Del. don’t know they’re diabetic

Delaware health officials released a plan Tuesday they hope will help stop the rising rate of diabetes in the state by 2010, primarily through better education of adults and children, increased screening and by helping uninsured people treat the disease.

State officials estimate that 45,000 Delaware residents have diabetes, and that 15,000 of them do not know it because they have not been screened or diagnosed. Delaware has the fourth highest diabetes death rate in the nation.

Diabetes is a disease that occurs when the body is not able to use sugar properly. Diabetes can cause adult blindness, kidney failure, heart disease and stroke, and require lower limb amputation. The illness occurs more often in women than men, more often in blacks than whites and more often among people older than 65. Those with a family history of diabetes also are at greater risk, according to health officials.

The state’s plan outlines a variety of strategies to avoid preventable cases of diabetes and help those who have the disease better treat it. Central to the plan is increased awareness through education and outreach in communities, schools and businesses, and expanded screening programs.

The plan’s authors also hope by 2010 to provide coverage for diabetes and treatment for 75 percent of people who have insurance or not enough to cover adequate care. The 54-page document is a follow-up to the “Burden of Diabetes,” a report issued by the state in March documenting the extent of the diabetes problem in Delaware.

Lt. Gov. John Carney said Tuesday that the action plan should help Delaware qualify for $800,000 in federal grants to implement
Chronic Illnesses Require Self-Regulation/Treatment

- Follow treatment regimen
  - Use medications as prescribed
  - Diet, exercise, no smoking, etc.
  - Including for diseases without outward signs (e.g., hypertension)
- Monitor daily signs and symptoms
- Adjust medication and behavior in response to signs
- Have regular check-ups

All are less frequent in lower social classes
Chronic Illnesses Require Self-Regulation to Limit Damage

Urban hospital outpatients: % diabetics *not* knowing that:

<table>
<thead>
<tr>
<th>Signal: Thirsty/tired/weak usually means blood sugar too high</th>
<th>Health literacy level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action: Exercise lowers blood sugar</td>
<td>V-low: 40, Low: 31, OK: 25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signal: Suddenly sweaty/shaky/hungry usually means blood sugar too low</th>
<th>Health literacy level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action: Eat some form of sugar</td>
<td>V-low: 50, Low: 15, OK: 6</td>
</tr>
</tbody>
</table>

| Action: Eat some form of sugar                                          | V-low: 62, Low: 46, OK: 27 |
Even Simplest Tasks Pose Barriers for Some People

Label on a prescription vial:

Acme Pharmacy Dept. 7806 Rt. 4 & Elkton Road
Newark, DE
Phone: (302) 453-2335

Date: 07/05/03
Rx# 19253
LINDA GOTTFREDSON

TAKE 4 CAPSULES BY MOUTH
1 HOUR PRIOR TO DENTAL APPT.

AMOXYCILLIN 500MG CAPSULE By GENEV
Orig.
Date 7/31/02 Refill Y Qty. 4 RPh SSM
Non-compliance with treatment a huge problem

- Often due to a failure to “learn, reason, & problem-solve”
- Leads to higher morbidity
- Leads to higher mortality
- Can create new health problems (e.g., by taking medication incorrectly)
Treatment Regimens
Becoming More Complex

Heart attacks:
- 1960’s—just “good luck”
- Now often includes:
  - regimen of aspirin, β-blocker, angiotensin-converting enzyme inhibitor
  - low-salt and low-cholesterol diet
  - Medicine to control hypertension, diabetes, & hypercholesterolemia
- “A patient’s ability to learn this regimen and follow it correctly will determine a trajectory toward recovery or a downward path to death.”

Higher-g individuals can take better advantage of medical advances like this
4. Health Self-Care Is As Important as Medical Care

“Mortality could be reduced substantially if people at risk would change just five behaviors:

Adherence to medical recommendations (e.g., medication), diet, smoking, lack of exercise, and alcohol and drug use.”

(American Psychological Society, 1996)
4. Health Self-Care Is As Important as Medical Care

“Beginning in childhood and throughout life, each of us makes decisions affecting our health. They are made, for the most part, without regard to, or contact with, the health care system. Yet their cumulative impact has a greater effect on the length and quality of life than all the efforts of medical care combined.”

(Surgeon General Report, 1979)
In Short—

You are your own “primary health care” provider
Conclusion—

- $g$ is only one factor affecting health.
- But it may be the health factor that differs most across social classes.
- Narrowing gaps in **material** access to health care will not equalize health.
- But improving **cognitive** access to health care may help flatten SES-health gradients.
Cognitive Access Can Be Improved Using $g$ Theory

- Reduce unnecessary complexity
  - E.g., simplify labels
- When complexity inherent in task, provide more cognitive support
  - E.g., monitor understanding, adherence

Material resources require mental resources for their safe and effective use
Thank You

Two in-press articles available at:
www.udel.edu/educ/gottfredson/reprints