The Rising Complexity of Everyday Life

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University of Delaware
Newark, Delaware USA

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Karl Franzens University of Graz
Graz, Austria
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Cognitive demands of everyday life
Cognitive demands of everyday life

1. People differ in cognitive ability \((g)\)

2. Life tasks differ in cognitive complexity \((g\text{ loading})\).

3. So what?
Everyday literacy

Name a reading task:

- Very simple for most people
- Very difficult for most people
What about this one?

Label on a prescription vial

**Acme** Pharmacy Dept.  7806       Rt. 4 & Elkton Road

Newark, DE

Date: 07/05/03         Phone: (302) 453-2335

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
Sample literacy items & error rates

TOHFLA test

Patients examine the actual vials or documents

<table>
<thead>
<tr>
<th>% of urban hospital outpatients not knowing:</th>
<th>Health literacy level</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>V-low</td>
</tr>
<tr>
<td>How to take meds 4 times per day</td>
<td>24</td>
</tr>
<tr>
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<td>40</td>
</tr>
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<td>How many pills of a prescription to take</td>
<td>70</td>
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<td>What an informed consent form is saying</td>
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### Sample TOHFLA Items & Error Rates

Patients examine the actual vials or documents

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But how representative?
## Typical literacy items, by difficulty level

**National Adult Literacy Survey (NALS), 1993**

<table>
<thead>
<tr>
<th>NALS difficulty level (&amp; scores)</th>
<th>% US adults peaking at this level</th>
<th>Simulated everyday tasks</th>
</tr>
</thead>
</table>
| 5 (375-500)                      | 3%                              | ▪ Use calculator to determine cost of carpet for a room  
                                             ▪ Use table of information to compare 2 credit cards |
| 4 (325-375)                      | 15%                             | ▪ Use eligibility pamphlet to calculate SSI benefits  
                                             ▪ Explain difference between 2 types of employee benefits |
| 3 (275-325)                      | 31%                             | ▪ Calculate miles per gallon from mileage record chart  
                                             ▪ Write brief letter explaining error on credit card bill |
| 2 (225-275)                      | 28%                             | ▪ Determine difference in price between 2 show tickets  
                                             ▪ Locate intersection on street map |
| 1 (0-225)                        | 23%                             | ▪ Total bank deposit entry  
                                             ▪ Locate expiration date on driver’s license |

**Daily self-maintenance in modern literate societies**
COMPARATIVE REPORT ON HEALTH LITERACY IN EIGHT EU MEMBER STATES

Graph 6: Distribution of the General HL Index for Total

The European Health Literacy Project 2009-2012
Graph 1: Shares of ‘Fairly Difficult’ and ‘Very Difficult’ Answers of Health Care Items for Countries and Total

Items differ by difficulty level

How, why??

On a scale from very easy to very difficult. How easy would you say it is to:

Q1.12...judge if the information about illness in the media is reliable?
Q1.10...judge the advantages and disadvantages of different treatment options?
Q1.11...judge when you may need to get a second opinion from another doctor?
Q1.6...understand the leaflets that come with your medicine?
Q1.2...find information on treatments of illnesses that concern you?
Q1.13...use information the doctor gives you to make decisions about your illness?
Q1.1...find information about symptoms of illnesses that concern you?
Q1.3...find out what to do in case of a medical emergency?
Q1.7...understand what to do in a medical emergency?
Q1.9...judge how information from your doctor applies to you?
Q1.5...understand what your doctor says to you?
Q1.4...find out where to get professional help when you are ill?
Q1.15...call an ambulance in an emergency?
Q1.14...follow the instructions on medication?
Q1.8...understand your doctor’s or pharmacist’s instruction on how to take a prescribed medicine?
Q1.16...follow instructions from your doctor or pharmacist?
What makes some items more difficult?
“Information processing complexity”

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Elements of “process complexity”

- number of features to match
- level of inference
- abstractness of info
- distracting information

Not reading per se, but “problem solving”

“To be, or not to be. That is the question.”

“Information processing complexity”

- Information processing complexity
- NALS difficulty level & scores
- % US adults peaking at this level
- Simulated everyday tasks

To be, or not to be. That is the question.”
Item at NALS Level 1

- 22% of US adults
- 78% of adults do better

Here is a Social Security card. Sign your name on the line that reads “signature.”

- Literal match
- One item
- Little distracting info

* 80% probability of correctly answering items of this difficulty level
Item at NALS Level 2

27% of US adults

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
Item at NALS Level 3

31% of US adults

You need to smooth wood in preparation for sealing and plan to buy garnet sandpaper. What type of sandpaper should you buy?

<table>
<thead>
<tr>
<th>MATERIAL &amp; OPERATION</th>
<th>PRODUCTION²</th>
<th>GARNET</th>
<th>WETORDRY²</th>
<th>FRE-CUT²</th>
<th>EMERY</th>
</tr>
</thead>
<tbody>
<tr>
<td>WOOD</td>
<td>EC</td>
<td>C</td>
<td>M</td>
<td>F</td>
<td>EF</td>
</tr>
<tr>
<td>Paint Removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy Stock Removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate Stock Removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparation for Sealing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After Sealer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Coats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After Final Coat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>METAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rust and Paint Removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Stock Removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparation for Priming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finishing and Polishing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After Primer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Coats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After Final Coat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLASTIC &amp; FIBERGLASS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Stock Removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finishing &amp; Scraping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SAFETY INFORMATION:
- Wear approved safety goggles when sanding.
- Use particle/dust mask or other means to prevent inhalation of sanding dust.
- When using power tools, follow manufacturer's recommended procedures and safety instructions.

Reduced from original copy
Item at NALS Level 4

80%

17% of US adults

3%

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?

Or,

- More elements to match
- More inferences
- More distracting information

Solved
Item at NALS Level 5

97%

3% of US adults

Using the information in the table, write a brief paragraph summarizing the extent to which parents and teachers agreed or disagreed on the statements about issues pertaining to parental involvement at their school.

- Search through complex displays
- Multiple distractors
- Make high-level text-based inferences
- Use specialized knowledge

Parents and Teachers Evaluate Parental Involvement at Their School

<table>
<thead>
<tr>
<th>Do you agree or disagree that . . .?</th>
<th>Level of School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Our school does a good job of encouraging parental involvement in sports, arts, and other nonsubject areas</td>
<td></td>
</tr>
<tr>
<td>Parents</td>
<td>77</td>
</tr>
<tr>
<td>Teachers</td>
<td>77</td>
</tr>
<tr>
<td>Our school does a good job of encouraging parental involvement in educational areas</td>
<td></td>
</tr>
<tr>
<td>Parents</td>
<td>73</td>
</tr>
<tr>
<td>Teachers</td>
<td>80</td>
</tr>
<tr>
<td>Our school only contacts parents when there is a problem with their child</td>
<td></td>
</tr>
<tr>
<td>Parents</td>
<td>55</td>
</tr>
<tr>
<td>Teachers</td>
<td>23</td>
</tr>
<tr>
<td>Our school does not give parents the opportunity for any meaningful roles</td>
<td></td>
</tr>
<tr>
<td>Parents</td>
<td>22</td>
</tr>
<tr>
<td>Teachers</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: The Metropolitan Life Survey of the American Teacher, 1987
Landscape of cognitive risk

Could teach these individual items, but not all such tasks in daily life.
“Literacy” ≈ verbal comprehension ≈ general ability
Sample IQ Items
(individually administered)

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

<table>
<thead>
<tr>
<th>Easy</th>
<th>Moderate</th>
<th>Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fill in the next two numbers</strong></td>
<td>3, 5, 7, 9, __, __</td>
<td>3, 5, 6, 8, 9, __, __</td>
</tr>
<tr>
<td><strong>Name one similarity</strong></td>
<td>orange—banana (93%)</td>
<td>table-chair (55%)</td>
</tr>
<tr>
<td><strong>Define the word</strong></td>
<td>conceal (87%)</td>
<td>reluctant (50%)</td>
</tr>
</tbody>
</table>

\% = \% of 16-65 year-olds getting at least partial credit for answer, WAIS, 1955
Literacy/IQ/g is:

• Ability to avoid cognitive error
• Not content specific

“Shhhh. Zog! ... Here come one now!”
Typical life outcomes along the IQ continuum

<table>
<thead>
<tr>
<th>Life chances: % pop.:</th>
<th>“High Risk”</th>
<th>“Up-Hill Battle”</th>
<th>“Keeping Up”</th>
<th>“Out Ahead”</th>
<th>“Yours to Lose”</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>20%</td>
<td>50%</td>
<td>20%</td>
<td>5%</td>
<td></td>
</tr>
</tbody>
</table>

Training potential:
- Slow, simple, supervised
- Mastery learning, hands-on
- Gathers, infers own information

Career potential:
- Assembler
- Food Service Worker
- Nurse’s Aide
- Clerk, teller
- Police officer
- Machinist, sales
- Manager
- Teacher
- Accountant
- Attorney
- Chemist
- Executive

Military trainability thresholds

Odds of socioeconomic success increase
“Reasoning & Judgment” factor
Job analysis 1 (Arvey, 1986)

<table>
<thead>
<tr>
<th>Job requirements:</th>
<th>Correlation 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>.66</td>
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<tr>
<td>Learn new procedures quickly</td>
<td>.66</td>
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<td>Be alert &amp; quick to understand things</td>
<td>.55</td>
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More results

- Job attributes that correlate highly with job complexity:

<table>
<thead>
<tr>
<th>Cognitive requirements</th>
<th>Working conditions</th>
<th>Task characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compile info</td>
<td>Ambiguity, change</td>
<td>Abstractness of info</td>
</tr>
<tr>
<td>Combine info</td>
<td>Uncertainty, unpredictability</td>
<td>Incomplete info</td>
</tr>
<tr>
<td>Transmit info in writing &amp; orally</td>
<td>Distractions</td>
<td>Amount of irrelevant info</td>
</tr>
<tr>
<td>Learn &amp; recall relevant info</td>
<td>Time pressure</td>
<td>Inferences required</td>
</tr>
<tr>
<td>Reason, analyze</td>
<td>Lack of structure</td>
<td>Unclear means-ends</td>
</tr>
<tr>
<td>Make decisions</td>
<td>No set procedures</td>
<td>Multiple competing tasks</td>
</tr>
<tr>
<td>Evaluate, judge</td>
<td>Little feedback</td>
<td></td>
</tr>
<tr>
<td>Advise, persuade</td>
<td>Lack of supervision</td>
<td></td>
</tr>
<tr>
<td>Plan, schedule, coordinate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Update knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spot problems quickly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>React quickly to unexpected problems</td>
<td></td>
<td></td>
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Like life itself!
Practical value of $g$ level differs by task complexity & life arena

- Standardized academic achievement \( .8 \)
- Job performance—complex jobs
- Years of education \( .6 \)
- Occupational level
- Job performance—middle-level jobs \( .4-.5 \)
- Income \( .3-.4 \)
- Delinquency \( -.25 \)
- Job performance—simple jobs \( .2 \)

But all require some learning & reasoning
Innovation increases complexity

Look! I just invented writing!

Thanks a lot!... You just made everybody else in the world illiterate!
Hazards of innovation

You idiot! You were shaving and using your Palm pilot instead of driving!

If you hadn’t been sending a fax while playing with your GPS system, you moron!
Landscape of cognitive risk

Error rate (%)
at mean score

Literacy level:
Mean score:

% adults peaking in this range:

Cost of cognitive risk

NALS task level (hardest)

Cognitive burden
So what?

Chronic disease

Healthy ageing

Accidental injury
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.
### % of civilian deaths

<table>
<thead>
<tr>
<th></th>
<th>USA (1986)</th>
<th>Ache (&lt;1971)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age:</strong></td>
<td>15-24</td>
<td>25-34</td>
</tr>
<tr>
<td><strong>Illness</strong></td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td><strong>Accident</strong></td>
<td>51</td>
<td>31</td>
</tr>
<tr>
<td><strong>Suicide</strong></td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td><strong>Homicide</strong></td>
<td>14</td>
<td>13</td>
</tr>
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Drowning, Firearms, Vehicles, Lightning, Cut/pierced, Caught/crushed, Falling object, Machines, Snake bite, Drowned, Lightning, Got lost, Jaguar, All preventable using “mind’s eye”
Important for dealing with the unexpected

“Say ... what’s a mountain goat doing way up here in a cloud bank?”
Chronic Illness Requires Foresight & Prevention

- Keep informed
- Live healthy lifestyle
- Get preventive checkups
- Detect signs and symptoms
- Seek timely, appropriate medical attention
- Adhere to treatment
“Health Self-Care Is As Important as Medical Care”

You are your own “primary health care” provider

And it’s becoming a more complex job
State launches plan to stop rising rate of killer disease

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

By SEAN O’SULLIVAN
Staff reporter

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 ailment 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 a greater risk, according to health officials.

The state’s plan outlines a variety of programs, including the establishment of diabetes centers 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 private 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 programs.

Lots of self-instruction
The diabetes patient’s job description

Objective: Keep blood glucose within safe limits

• Learn about diabetes in general (At “entry’)
  – Physiological process
  – Interdependence of diet, exercise, meds
  – Symptoms & corrective action
  – Consequences of poor control

• Apply knowledge to own case (Daily, Hourly)
  – Implement appropriate regimen
  – Continuously monitor physical signs
  – Diagnose problems in timely manner
  – Adjust food, exercise, meds in timely and appropriate manner

• Coordinate with relevant parties (Frequently)
  – Negotiate changes in activities with family, friends, job
  – Enlist/capitalize on social support
  – Communicate status and needs to practitioners

• Update knowledge & adjust regimen (Occasionally)
  – When other chronic conditions or disabilities develop
  – When new treatments are ordered
  – When life circumstances change

• Conditions of work—24/7, no days off, no retirement

Self-management

Training
Patient’s everyday reality

- Meds
- Interpret readings
- Monitor sugar
- Do A if low, Do B if high
- What’s a carb??
- Count carbs
- Proper diet
- Read labels
- Eye exam
- Don’t stress
- Exercise, except when...
- Sick day rules
- Coordinate meds & eating
- Adjust insulin
- Check feet

Call 911 for C, but doctor for D
Good glucose control requires good judgment

- IT IS NOT mechanically following a recipe
- IT IS keeping a complex metabolic system under control in often unpredictable circumstances (like accident prevention process)
  - Coordinate a regimen having multiple interacting elements
  - Adjust parts as needed to maintain good control of system buffeted by many other factors
  - Anticipate lag time between (in)action and system response
  - Monitor advance “hidden” indicators (blood glucose) to prevent system veering badly out of control
  - Decide appropriate type and timing of corrective action if system veering off-track
  - Monitor/control other shocks to system (infection, emotional stress)
  - Coordinate regimen with other daily activities
  - Plan ahead (meals, meds, etc.)
    - For the expected
    - For the unexpected and unpredictable
  - Prioritize conflicting demands on time and behavior
Preventing/managing chronic disease: Also a life-long “job”

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<th>that pile up</th>
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*Job analysis by Arvey (1986)*
The health provider’s reality

My blood sugar is 154 over 90.

I don’t eat sugar any more. Just pasta.

It’s low fat, so it’s healthy.

I skipped lunch so I could have a big dinner.

You mean I have to measure stuff?!

Never tested my sugar because I never figured out my meter.

What’s a carb??

Adjust insulin

Can I still eat donuts?

Patient fails to take control
Attention-diverting labeling
Pros:
- Fewer items
- Single vertical list
- Major headings stand out

Cons:
- Lots of irrelevant info
- Seemingly inconsistent info
Increasing Complexity Favors the Young

Raw mental horsepower (ability to learn and reason) rises into early adulthood, then falls.

Average profile only

Score relative to age mates ("IQ") is stable from adolescence on.
Complexity & Aging

"Okay your father managed to get a mouse. Now how do we use it?"
Literacy levels require different cognitive support

<table>
<thead>
<tr>
<th>NALS difficulty level (&amp; scores)</th>
<th>% US adults peaking at this level</th>
<th>Simulated everyday tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (375-500)</td>
<td>3%</td>
<td>- Use calculator to determine cost of carpet for a room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Use table of information to compare 2 credit cards</td>
</tr>
<tr>
<td>4 (325-375)</td>
<td>15%</td>
<td>- Use eligibility pamphlet to calculate SSI benefits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Explain difference between 2 types of employee</td>
</tr>
<tr>
<td>3 (275-325)</td>
<td>31%</td>
<td>- Calculate miles per gallon from mileage record chart</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Write brief letter explaining error on credit card bill</td>
</tr>
<tr>
<td>2 (225-275)</td>
<td>28%</td>
<td>- Determine difference in price between 2 show tickets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Locate intersection on street map</td>
</tr>
<tr>
<td>1 (0-225)</td>
<td>23%</td>
<td>- Total bank deposit entry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Locate expiration date on driver’s license</td>
</tr>
</tbody>
</table>

Minimal

Moderate

Strong
1. When cognitive budget is small, spend it wisely.

High g loadings are expensive.

2. Focus on critical tasks
3. Teach g-efficiently
4. Supply g support
Thank you.

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