# The Human Side of Transportation Safety: Behavioral Science for Planners and Engineers

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# Research Focus

## Unintentional injury = “accidents”

## Human factors

## Safety

- Injury etiology
- Injury prevention

## Safety topics

- Human perception and injury risk
- Human error modeling
- Nuclear safety
- Risk Appraisal Model

| | <1 | 1-4 | 5-9 | 10-14 | 15-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65+ | All Ages |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Congenital Anomalies 4,061 | Unintentional Injury 1,252 | Unintentional Injury 719 | Unintentional Injury 795 | Unintentional Injury 11,705 | Unintentional Injury 23,019 | Unintentional Injury 29,138 | Malignant Neoplasms 32,451 | Malignant Neoplasms 98,592 | Heart Disease 560,828 | Heart Disease 683,491 |
| 2 | Short Gestation 2,941 | Congenital Anomalies 402 | Malignant Neoplasms 400 | Suicid 487 | Suicid 5,815 | Suicid 7,993 | Heart Disease 11,607 | Heart Disease 29,624 | Heart Disease 76,501 | Malignant Neoplasms 470,997 | Malignant Neoplasms 619,876 |
| 3 | Sids 1,351 | Malignant Neoplasms 278 | Congenital Anomalies 225 | Malignant Neoplasms 446 | Homicid 4,259 | Homicid 4,877 | Malignant Neoplasms 11,583 | Unintentional Injury 25,241 | Unintentional Injury 28,628 | Cerebrovascular 145,402 | Unintentional Injury 197,449 |
| 4 | Unintentional Injury 1,245 | Homicid 288 | Homicid 146 | Homicid 280 | Malignant Neoplasms 1,421 | Malignant Neoplasms 3,659 | Suicid 8,514 | Liver Disease 8,314 | Diabetes Mellitus 15,581 | Chronic Low. Respiratory Disease 126,630 | Cerebrovascular 166,852 |
| 5 | Maternal Pregnancy Comp. 1,193 | Heart Disease 134 | Influenza & Pneumonia 91 | Congenital Anomalies 203 | Heart Disease 831 | Heart Disease 3,511 | Liver Disease 5,008 | Suicid 7,077 | Chronic Low. Respiratory Disease 15,113 | Alzheimer's Disease 114,509 | Chronic Low. Respiratory Disease 145,643 |
| 6 | Bacterial Sepsis 603 | Influenza & Pneumonia 121 | Heart Disease 80 | Heart Disease 100 | Congenital Anomalies 473 | Liver Disease 1,591 | Homicid 4,137 | Diabetes Mellitus 6,543 | Liver Disease 14,261 | Unintentional Injury 75,699 | Alzheimer's Disease 116,022 |
| 7 | Placenta Cord Membranes 594 | Cerebrovascular Septicemia 62 | Chronic Low. Respiratory Disease 57 | Chronic Low. Respiratory Disease 79 | Diabetes Mellitus 250 | Diabetes Mellitus 1,051 | Diabetes Mellitus 2,585 | Cerebrovascular 5,192 | Cerebrovascular 13,222 | Diabetes Mellitus 68,387 | Diabetes Mellitus 94,445 |
| 8 | Respiratory Distress 453 | | Cerebrovascular 49 | Influenza & Pneumonia 69 | Chronic Low. Respiratory Disease 208 | Cerebrovascular 535 | Cerebrovascular 2,086 | Homicid 2,524 | Suicid 7,249 | Nephritis 45,583 | Nephritis 55,081 |
| 9 | Circulatory System Disease 376 | Perinatal Period 60 | Septicemia 36 | Cerebrovascular 59 | Influenza & Pneumonia 179 | Influenza & Pneumonia 493 | Influenza & Pneumonia 1,026 | Chronic Low. Respiratory Disease 2,470 | Nephritis 5,838 | Parkinson's Disease 39,935 | Liver Disease 52,274 |
| 10 | Intrauterine Hypoxia 368 | Covid-19 38 | Benign Neoplasms 25 | Septicemia 37 | Cerebrovascular 162 | Congenital Anomalies 475 | Nephritis 887 | Nephritis 2,337 | Septicemia 5,374 | Influenza & Pneumonia 39,204 | Suicid 48,824 |

## 10 Leading Causes of Injury Deaths by Age Group

2021, Both sexes, All ages, All races

| | <1 | 1-4 | 5-9 | 10-14 | 15-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65+ | All Ages |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Unintentional Suffocation 1,072 | Unintentional Drowning 476 | Unintentional Mv Traffic 381 | Unintentional Mv Traffic 489 | Unintentional Mv Traffic 7,270 | Unintentional Poisoning 23,167 | Unintentional Poisoning 26,070 | Unintentional Poisoning 21,011 | Unintentional Poisoning 18,596 | Unintentional Fall 38,742 | Unintentional Poisoning 102,001 |
| 2 | Homicide Unspecified 138 | Unintentional Mv Traffic 309 | Unintentional Drowning 146 | Suicide Suffocation 316 | Unintentional Poisoning 6,929 | Unintentional Mv Traffic 8,739 | Unintentional Mv Traffic 6,977 | Unintentional Mv Traffic 6,048 | Unintentional Mv Traffic 6,465 | Unintentional Mv Traffic 8,616 | Unintentional Mv Traffic 45,404 |
| 3 | Unintentional Mv Traffic 106 | Unintentional Suffocation 127 | Homicide Firearm 105 | Homicide Firearm 254 | Homicide Firearm 6,207 | Homicide Firearm 6,679 | Homicide Firearm 3,931 | Suicide Firearm 3,717 | Suicide Firearm 3,984 | Suicide Firearm 6,935 | Unintentional Fall 44,686 |
| 4 | Homicide Other Spec., Classifiable 53 | Unintentional Hot Object Or Substance 101 | Unintentional Fire/Flame 95 | Suicide Firearm 235 | Suicide Firearm 3,590 | Suicide Firearm 4,221 | Suicide Firearm 3,644 | Homicide Firearm 2,024 | Unintentional Fall 3,278 | Unintentional Poisoning 6,078 | Suicide Firearm 26,328 |
| 5 | Undetermined Suffocation 43 | Homicide Unspecified 99 | Unintentional Suffocation 37 | Unintentional Drowning 98 | Suicide Suffocation 1,848 | Suicide Suffocation 3,100 | Suicide Suffocation 2,688 | Suicide Suffocation 1,972 | Suicide Suffocation 1,540 | Unintentional Unspecified 4,917 | Homicide Firearm 20,958 |
| 6 | Unintentional Drowning 38 | Homicide Firearm 72 | Unintentional Other Land Transport 34 | Unintentional Poisoning 67 | Suicide Poisoning 557 | Undetermined Poisoning 862 | Undetermined Poisoning 970 | Unintentional Fall 1,333 | Suicide Poisoning 1,109 | Unintentional Suffocation 4,022 | Suicide Suffocation 12,431 |
| 7 | Homicide Poisoning 32 | Unintentional Pedestrian, Other 63 | Homicide Unspecified 30 | Unintentional Other Land Transport 57 | Unintentional Drowning 475 | Suicide Poisoning 767 | Suicide Poisoning 880 | Suicide Poisoning 1,094 | Homicide Firearm 1,096 | Adverse Effects 3,990 | Unintentional Suffocation 7,182 |
| 8 | Unintentional Poisoning 27 | Undetermined Poisoning 53 | Unintentional Firearm 25 | Unintentional Fire/Flame 55 | Undetermined Poisoning 256 | Unintentional Drowning 605 | Unintentional Fall 714 | Undetermined Poisoning 842 | Adverse Effects 1,079 | Unintentional Hot Object Or Substance 1,673 | Unintentional Unspecified 6,392 |
| 9 | Undetermined Unspecified 21 | Unintentional Firearm 51 | Unintentional Natural/ Environment 19** | Unintentional Suffocation 36 | Homicide Cut/Pierce 235 | Homicide Cut/Pierce 469 | Unintentional Drowning 642 | Unintentional Drowning 511 | Unintentional Suffocation 889 | Unintentional Natural/ Environment 1,304 | Adverse Effects 6,051 |
| 10 | Unintentional Natural/ Environment & Homicide Poisoning 19** | Homicide Other Spec., Classifiable 44 | Unintentional Fall 18** | Suicide Poisoning 32 | Suicide Fall 223 | Unintentional Fall 404 | Homicide Cut/Pierce 412 | Adverse Effects 474 | Undetermined Poisoning 705 | Suicide Poisoning 1,128 | Suicide Poisoning 5,568 |

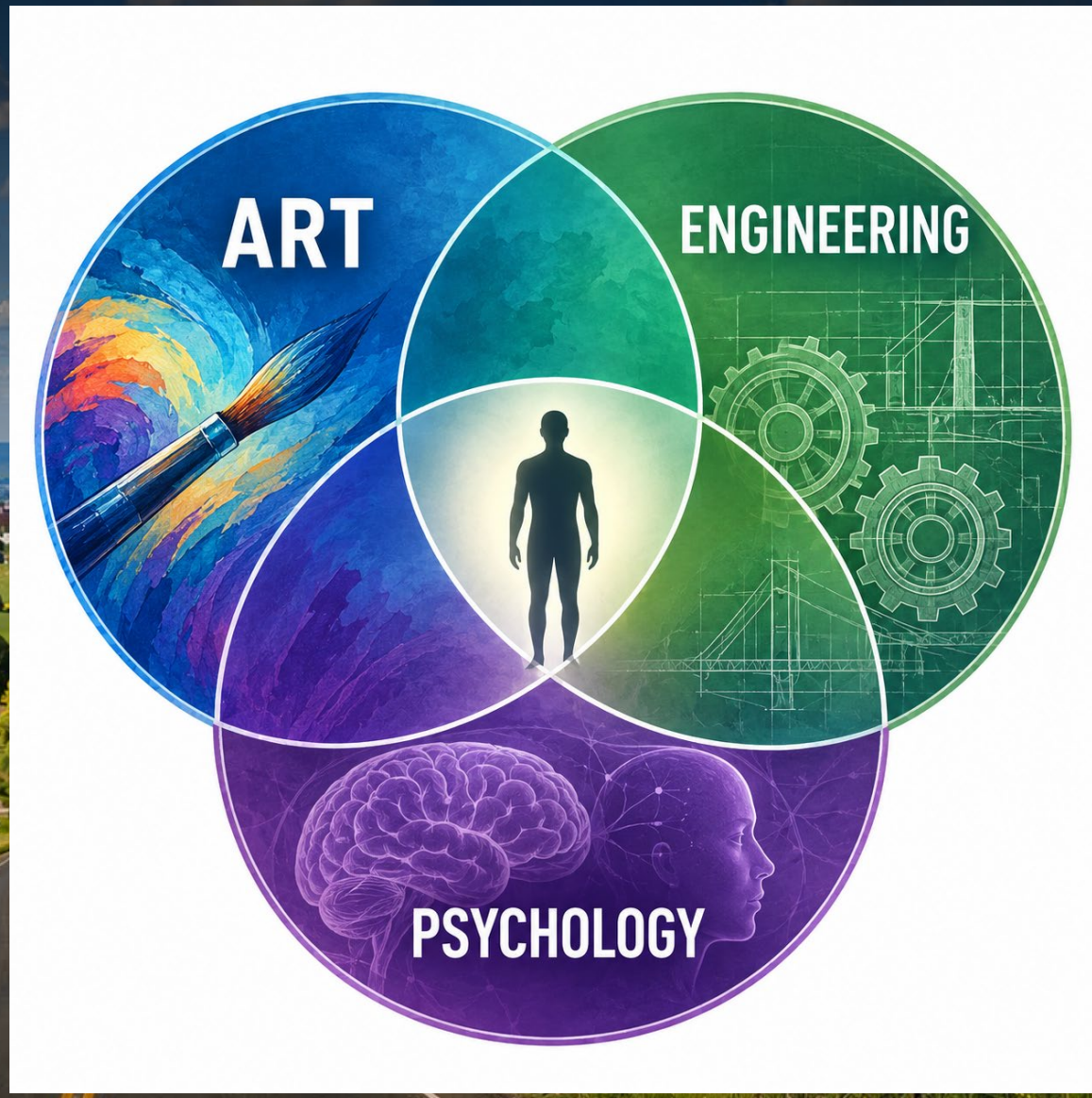
# OBJECTIVES:

Examine how principles from psychology and human factors can strengthen transportation safety initiatives

Explore how behavioral science can inform decision making, improve system design, and advance methods for reducing fatalities and serious injuries

# How does psychology do this?

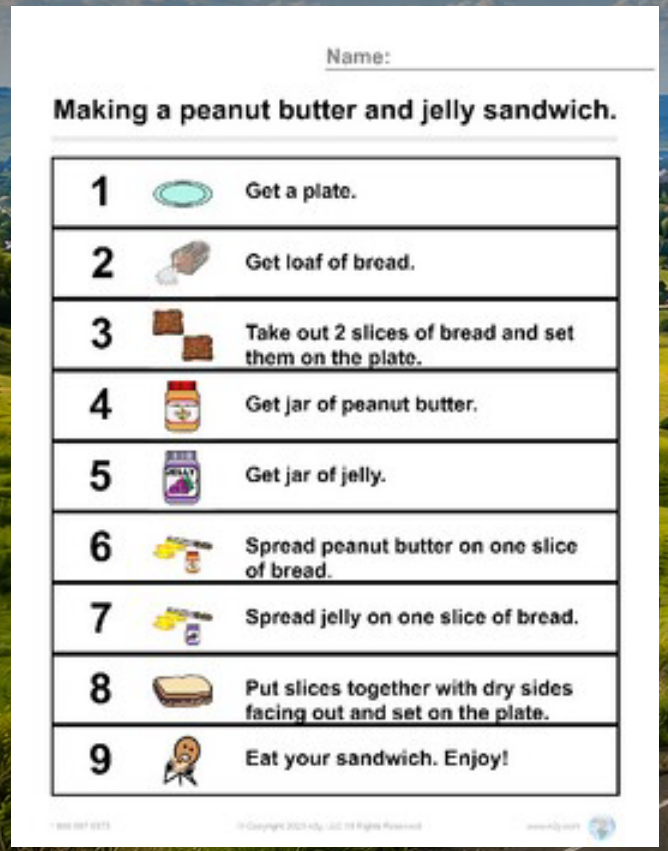
**Human Factors**



# Important areas in Human Factors

- Human-centered design to:
  - Enhance user experience
  - Increase safety
  - Reduce human error
  - Prevent fatigue, dissatisfaction, or injury
- Overall to support the human user while they perform a given task

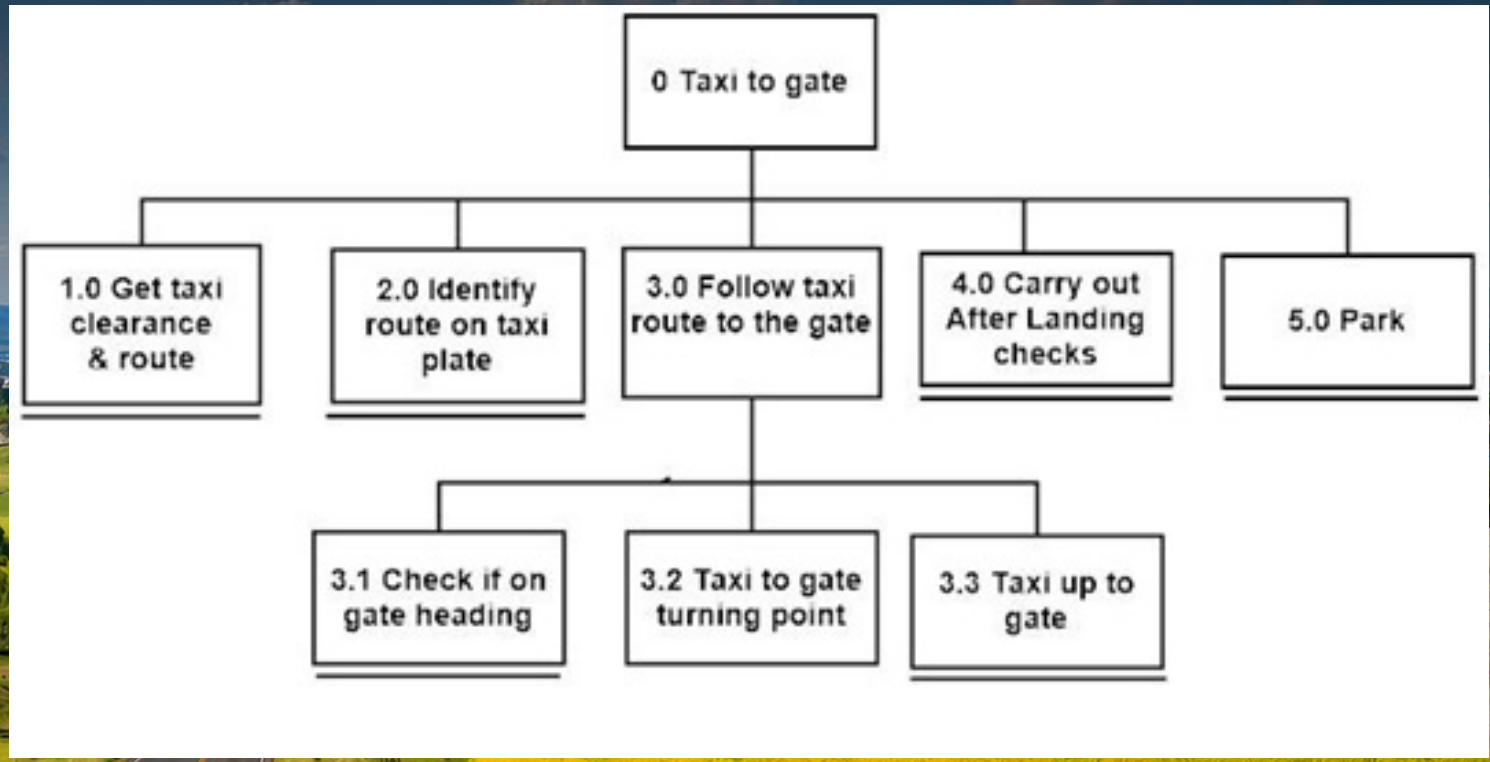
# Task Analysis



Name:

Making a peanut butter and jelly sandwich.

| | | |
|---|---|---|
| 1 | | Get a plate. |
| 2 | | Get loaf of bread. |
| 3 | | Take out 2 slices of bread and set them on the plate. |
| 4 | | Get jar of peanut butter. |
| 5 | | Get jar of jelly. |
| 6 | | Spread peanut butter on one slice of bread. |
| 7 | | Spread jelly on one slice of bread. |
| 8 | | Put slices together with dry sides facing out and set on the plate. |
| 9 | | Eat your sandwich. Enjoy! |




Psychology in Transportation

# Why Psychology Belongs in Transportation

- Psychology as another source of evidence—not a replacement for engineering
- Engineering changes roads.
- Psychology explains the people using those roads.

# Where does psychology fit?

# Links with Human Factors Psychology

- People
- Roads
- Vehicles
- Speed
- Post-crash care


Road Users

# Conceptualizing Road Users

Human factors perspective:

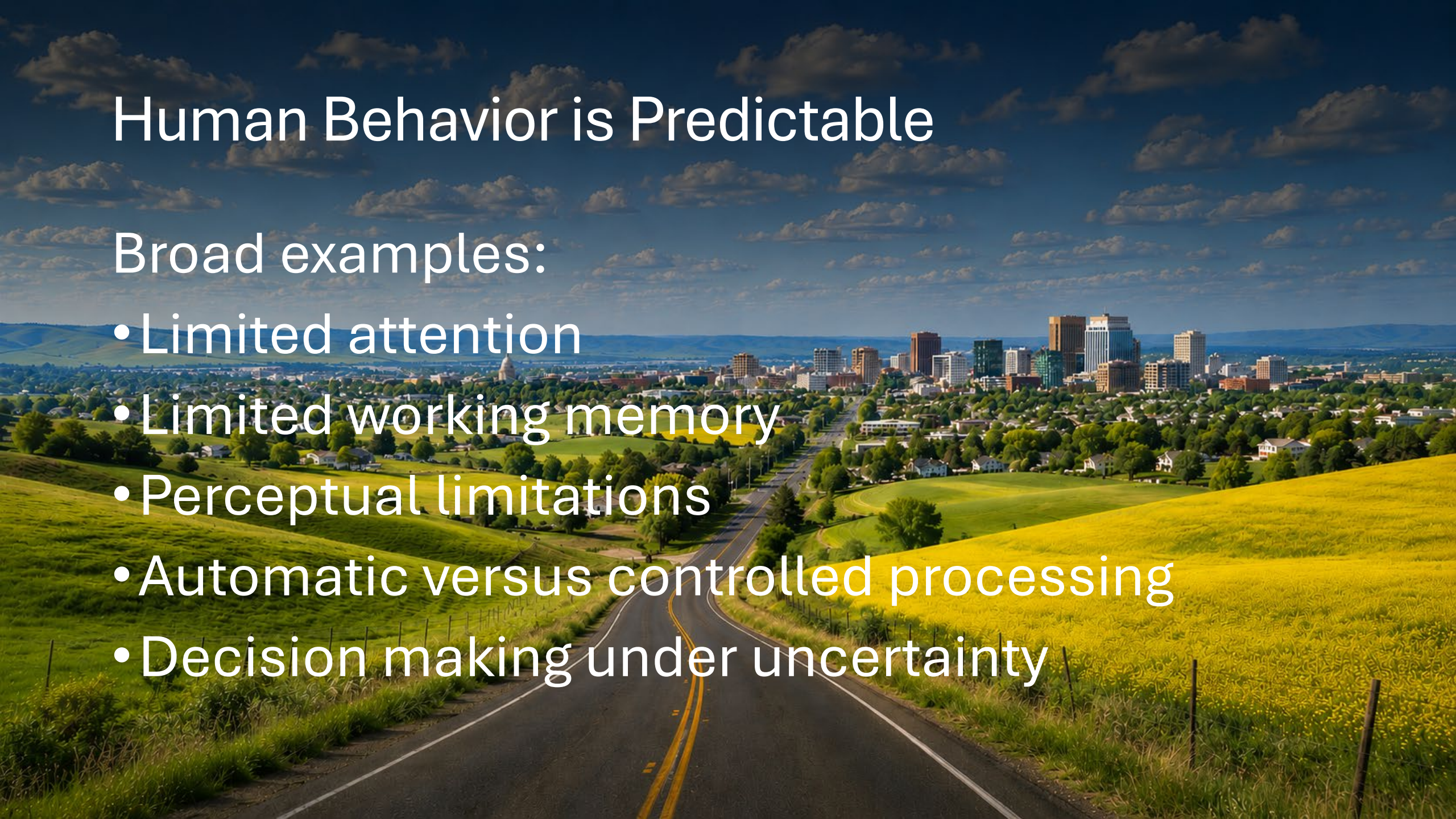
- Who is the user?
- What are their characteristics?
- Are there primary and secondary users?
- How do we design for the user?

Key point:

- On roadways, multiple users are completing similar tasks within the same space

# Road User Tasks

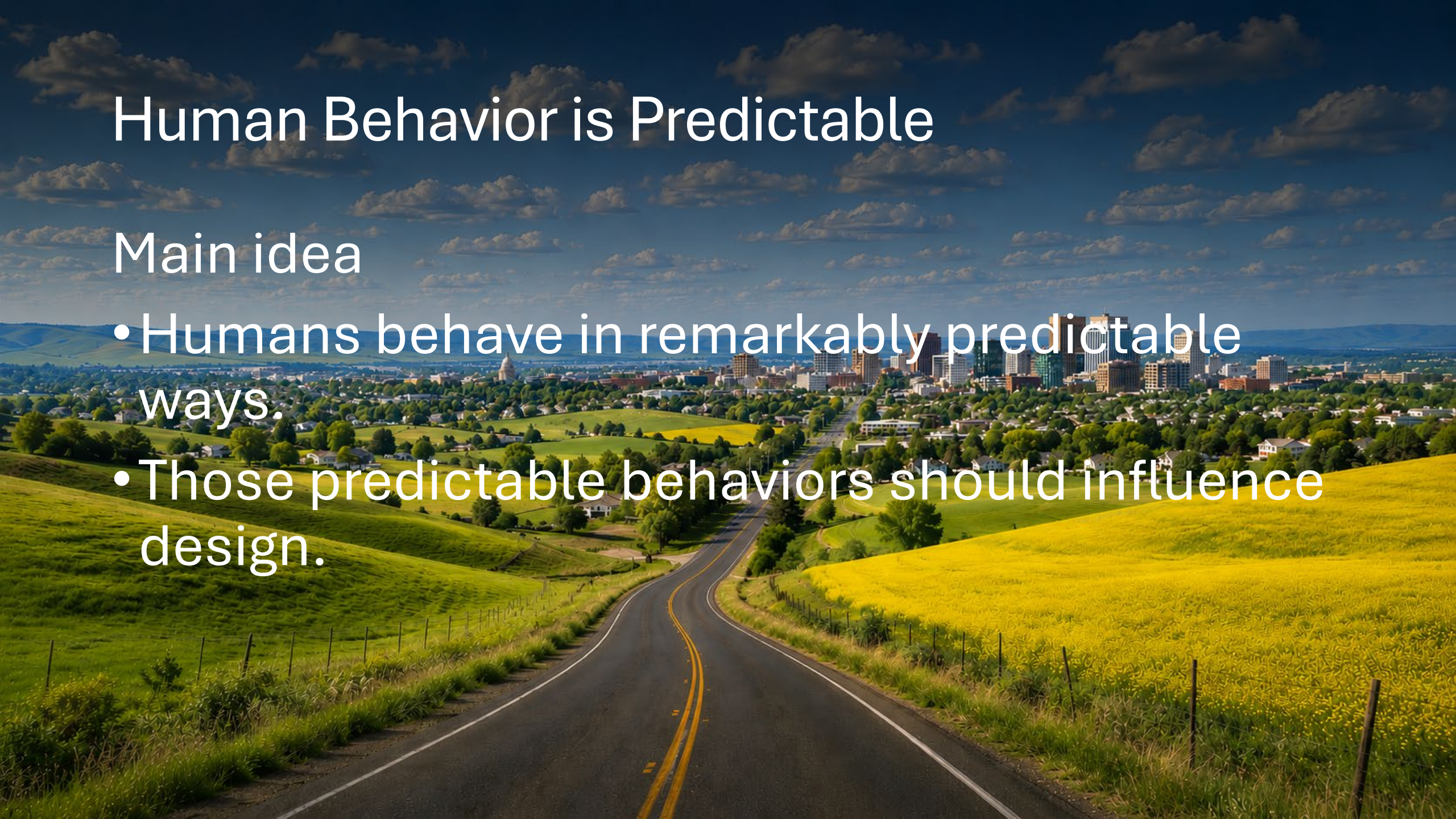
- Piloting vehicles
- Navigation
- Walking
- Crossing through traffic
- Biking



# Human Behavior is Predictable

Broad examples:

- Limited attention
- Limited working memory
- Perceptual limitations
- Automatic versus controlled processing
- Decision making under uncertainty



# Human Behavior is Predictable

Main idea

- Humans behave in remarkably predictable ways.
- Those predictable behaviors should influence design.

# Road User Perception

Visual perception

- Visual search
- Selective attention
  - Orienting
  - Searching
  - Filtering
  - Expecting
- Change blindness

# Road User Perception

Auditory perception

- Detecting approaching vehicles
- Localizing vehicle sounds
- Competing traffic noise

Accuracy

- Adults about 95%
- Children about 50%

# Road User Perception

Judging traffic

- Speed estimation
- Gap acceptance
- Time-to-arrival estimation

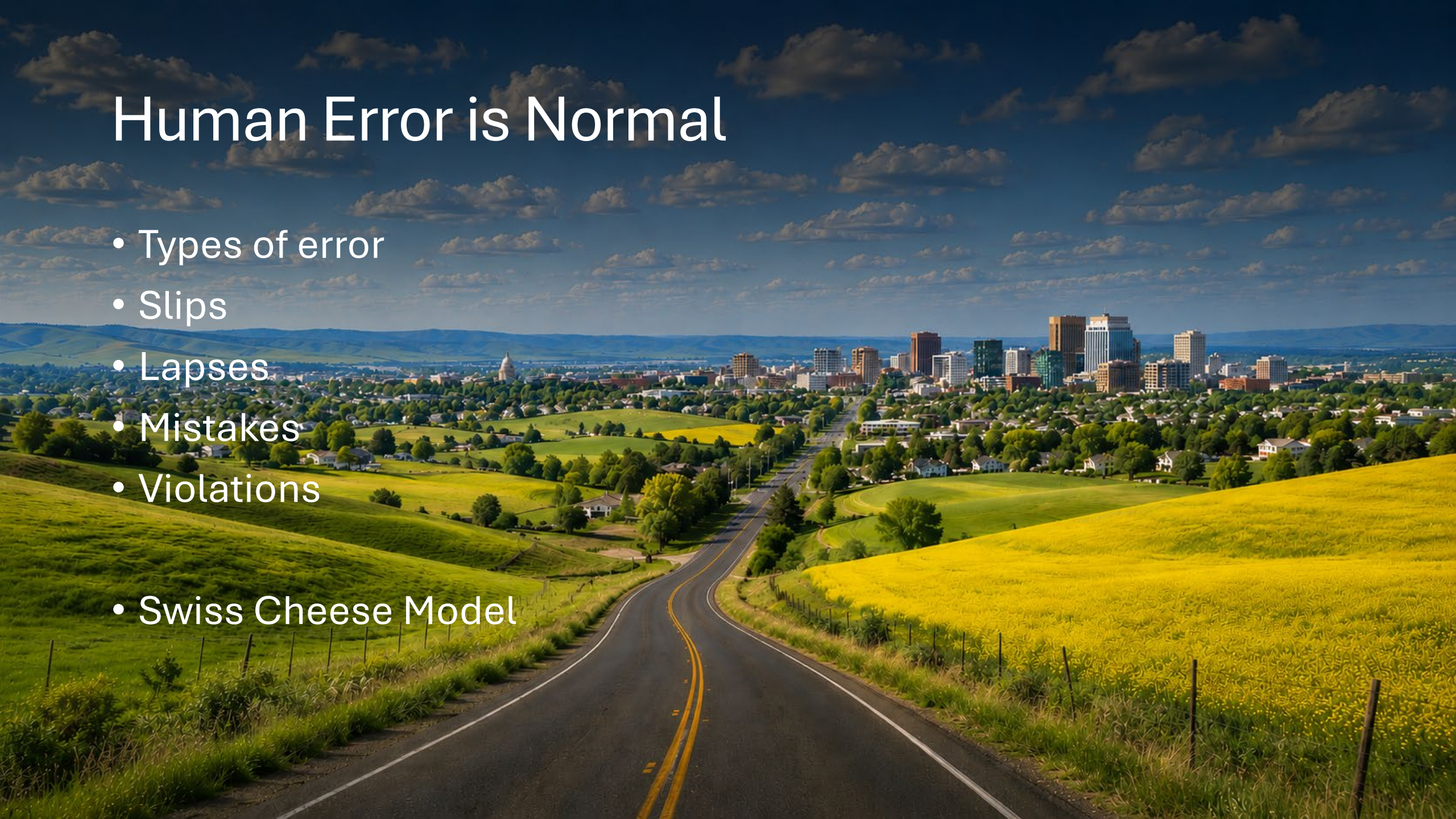
# Attention is a Limited Resource

- Distraction is not simply looking away.
- Distraction is competition for limited cognitive resources.

# Human Error is Normal

- Types of error
- Slips
- Lapses
- Mistakes
- Violations

- Swiss Cheese Model



# Lessons from Pedestrian Safety Research

# Child Pedestrians

Cognitive development and experience affect:

- Working memory
- Visual search
- Auditory information
- Distraction
- Developmental differences
- Gap selection

# Older Adult Pedestrians

The aging process affects:

- Working memory
- Visual search
- Auditory information
- Distraction
- Gap selection
- Mobility and reaction time

# Pedestrian Behavior

- “It’s still a crosswalk”
- Behavior is not shaped entirely by road engineering
- Behavior changed by environmental AND internal, psychological factors
- Spaces should be designed with more than one user in mind


Designing Roads for Human Nature

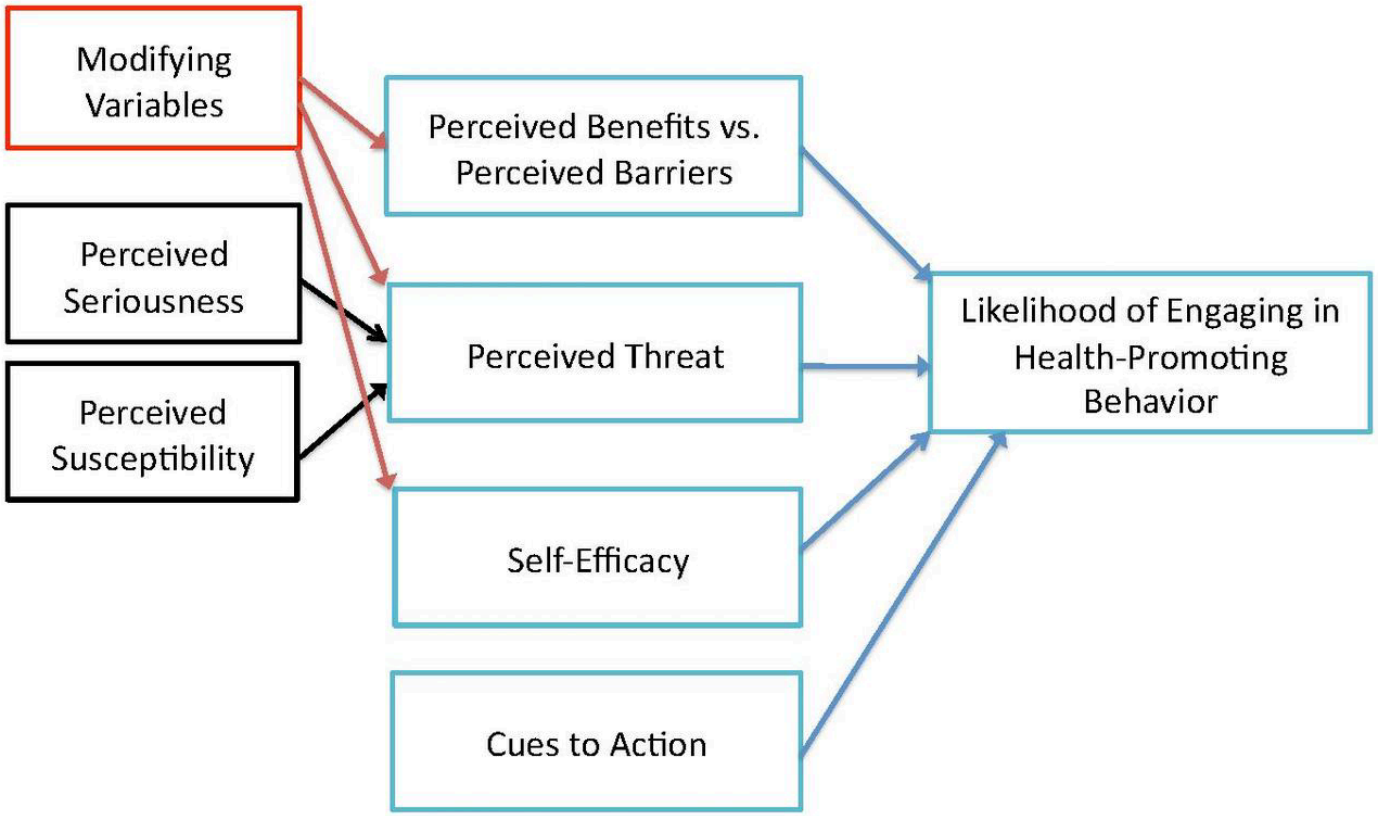
# Applying Psychology

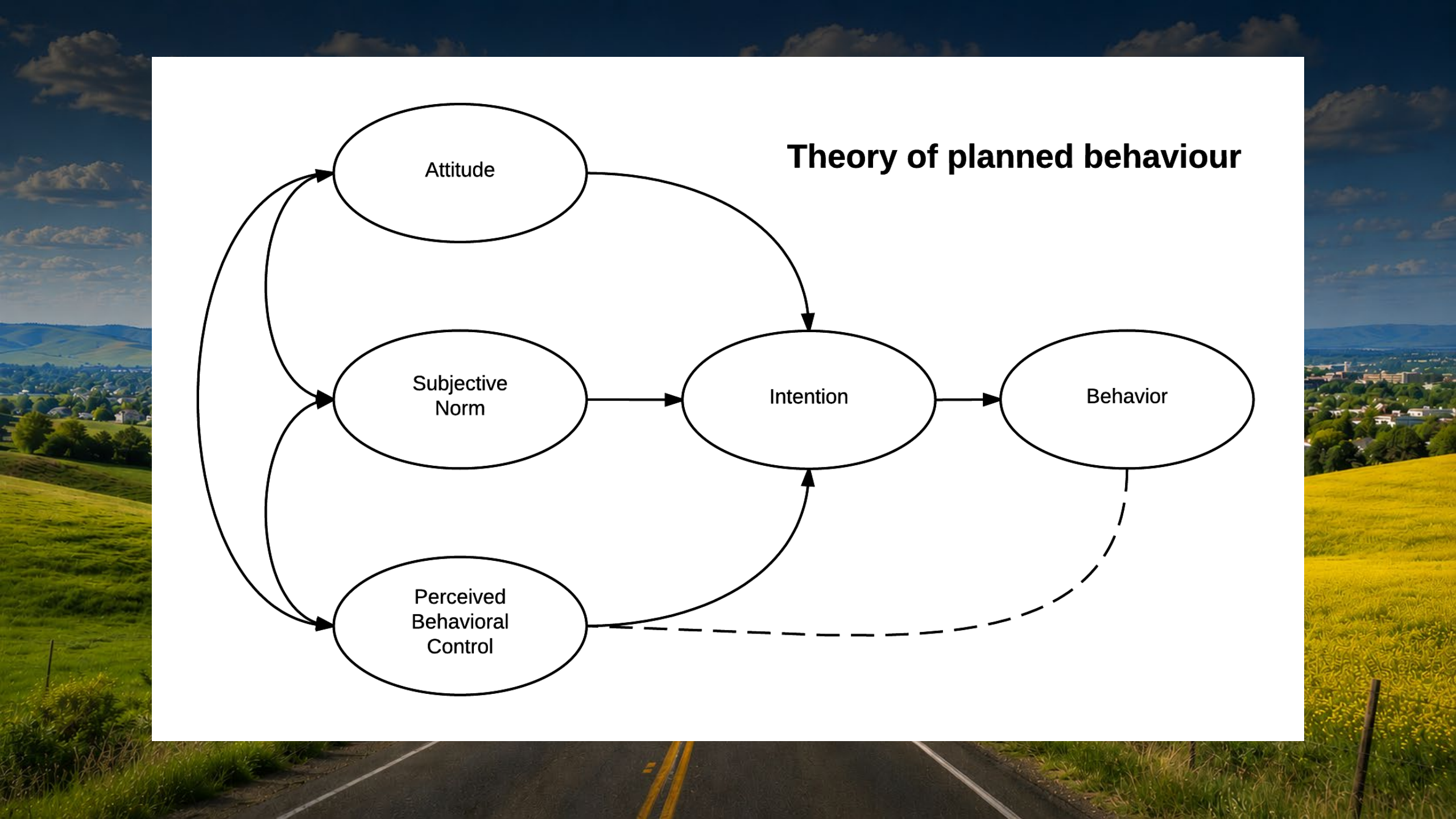
- Roundabouts
- Protected intersections
- Median refuges
- Lighting
- Lane width
- Traffic calming
- Wayfinding

# Examples

- Roundabouts
- → Reduce decision complexity.
- Protected bike lanes
- → Reduce uncertainty.
- Raised crosswalks
- → Increase driver expectancy.
- Center medians
- → Divide one difficult decision into two easier ones.

# The Health Belief Model




Theory of planned behaviour
Attitude
Subjective Norm
Perceived Behavioral Control
Intention
Behavior


Social
Encouragement or modeling of the injury risk behavior by others
Strategy
Planned aspects of a behavior intended to reduce injury risk
Experience
Accumulated successes and failures performing injury risk behaviors
Environment
Affordances and barriers in the physical context in which the injury risk behavior occurs
Efficacy
Feeling of capability and confidence related to performing an injury risk behavior; agency
Injury Risk Behavior


Emerging and Future Issues

# Automation

- It’s already here!

Some key issues

- Trust
- Mistrust
- Complacency
- Human out of the loop

# Autonomous Vehicles

# Public Policy Needs

- Invest in research and planning for transportation safety at all levels
- All stakeholders should be at the table
- Learn more about public attitudes toward transportation modes and regulation


Takeways

# For Planners

- Design for predictable human limitations.
- Measure behavioral indicators before crashes occur.
- Reduce unnecessary cognitive complexity.
- Prioritize consistency and expectancy.

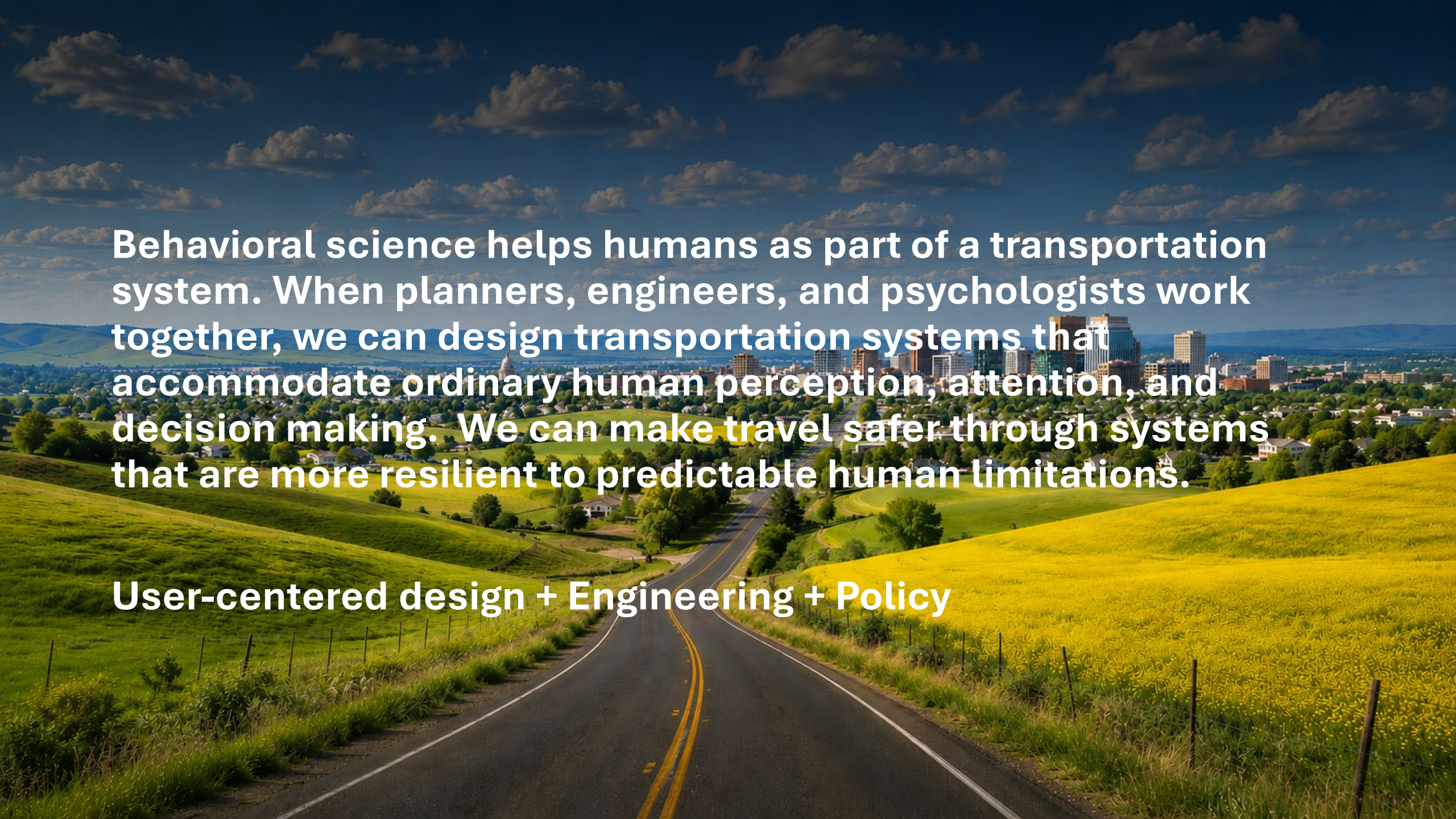
# For Engineers

- Make hazards perceptually obvious.
- Design forgiving infrastructure.
- Reduce decision burden.
- Consider cognitive workload alongside operational performance.

# For Community Leaders

- Integrate behavioral scientists into transportation projects.
- Evaluate interventions with both engineering and behavioral metrics.
- Recognize that safer systems emerge from understanding people, not simply regulating them


Closing Message


Behavioral science helps humans as part of a transportation system. When planners, engineers, and psychologists work together, we can design transportation systems that accommodate ordinary human perception, attention, and decision making.  We can make travel safer through systems that are more resilient to predictable human limitations.
User-centered design + Engineering + Policy