DESIGNING FOR HUMAN NATURE: HOW PSYCHOLOGY CAN IMPROVE TRANSPORTATION SAFETY

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RESEARCH FOCUS

Unintentional injury = “accidents”

Human factors

Safety

- Injury etiology
- Injury prevention

Safety topics

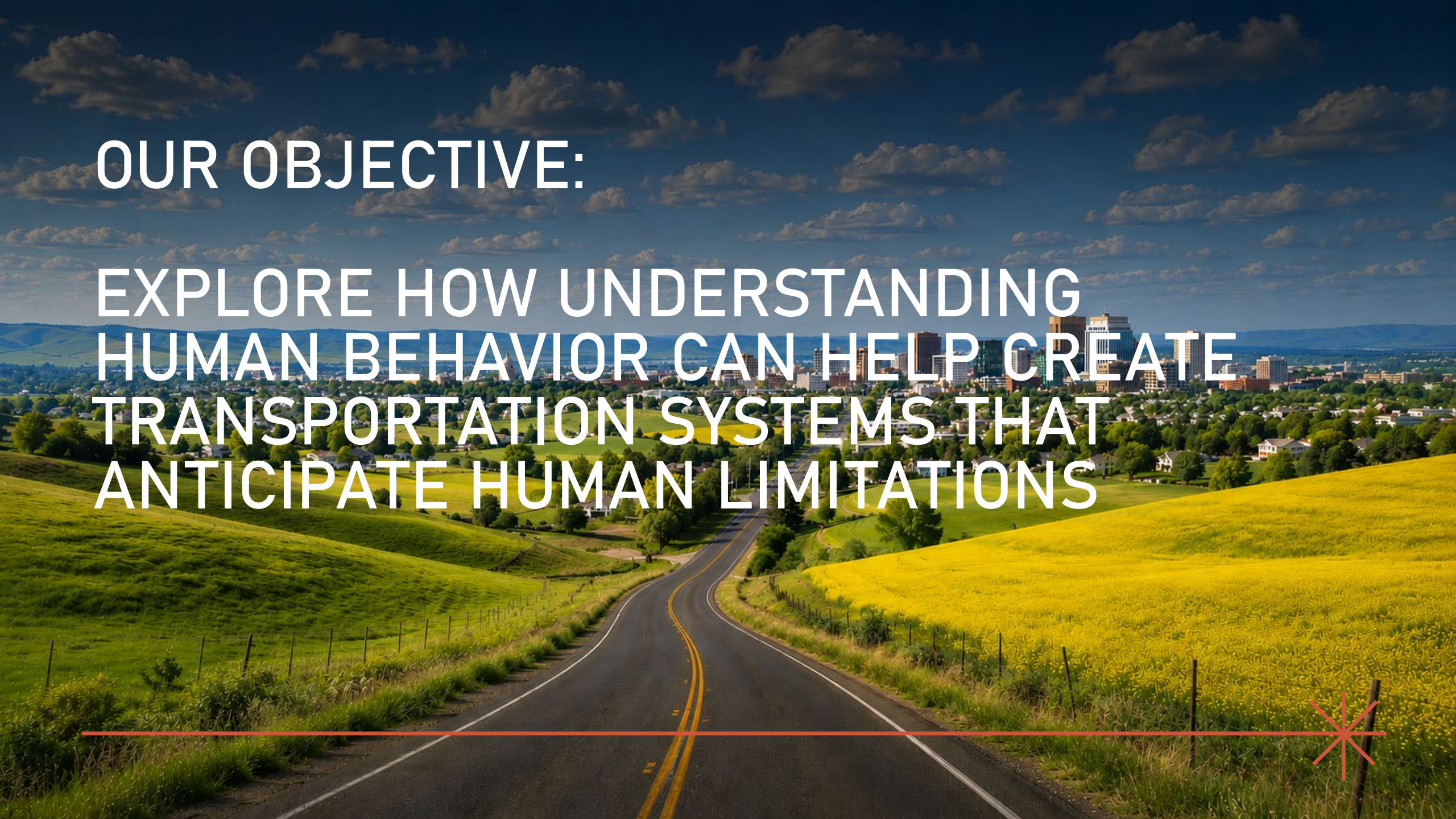
- Human perception and injury risk
- Human error modeling
- Nuclear safety
- Risk Appraisal Model

	<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

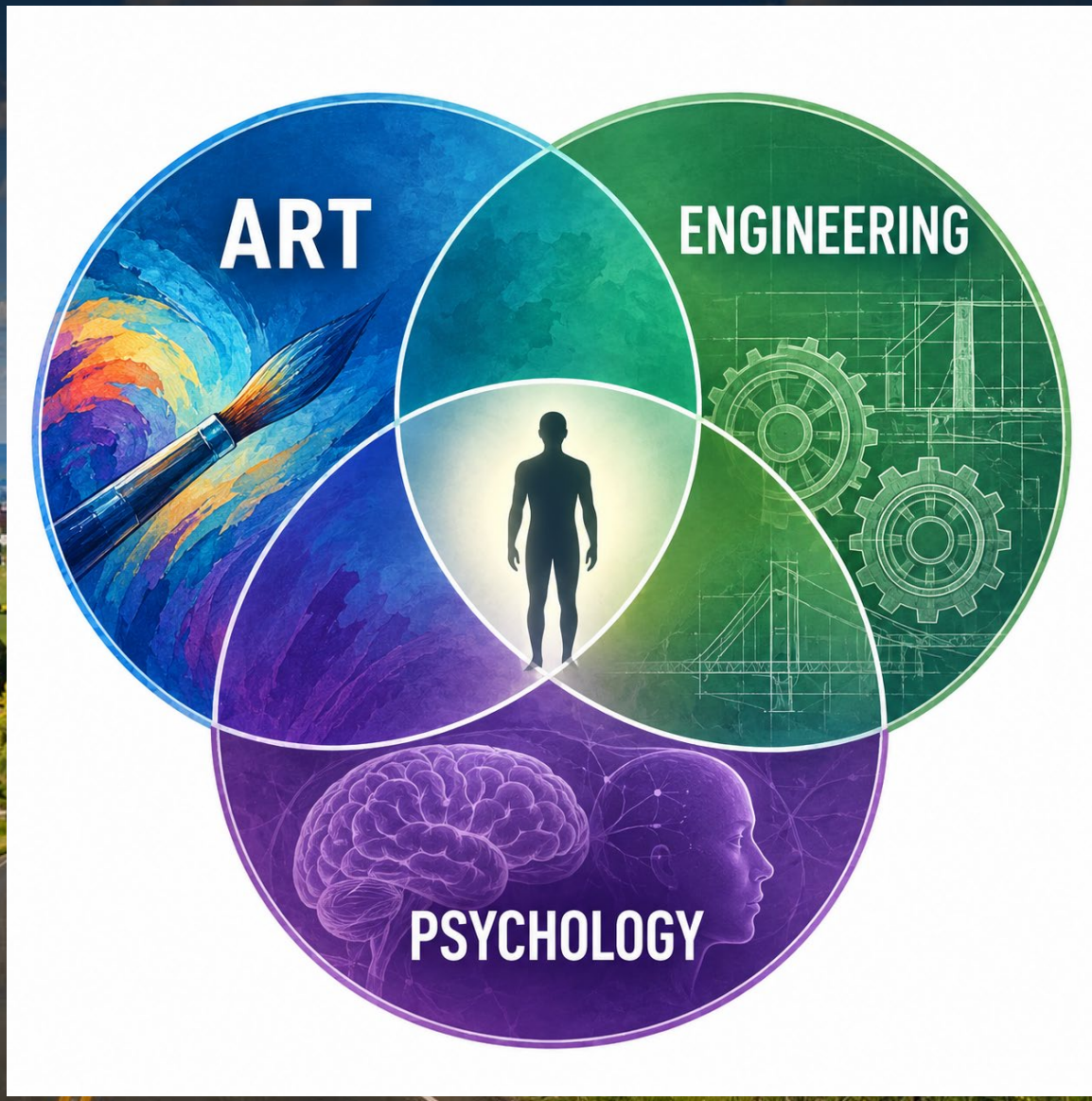
2021, Both sexes, All ages, All races

	<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


OUR OBJECTIVE:
EXPLORE HOW UNDERSTANDING HUMAN BEHAVIOR CAN HELP CREATE TRANSPORTATION SYSTEMS THAT ANTICIPATE HUMAN LIMITATIONS

HOW DOES PSYCHOLOGY DO THIS?

HUMAN FACTORS



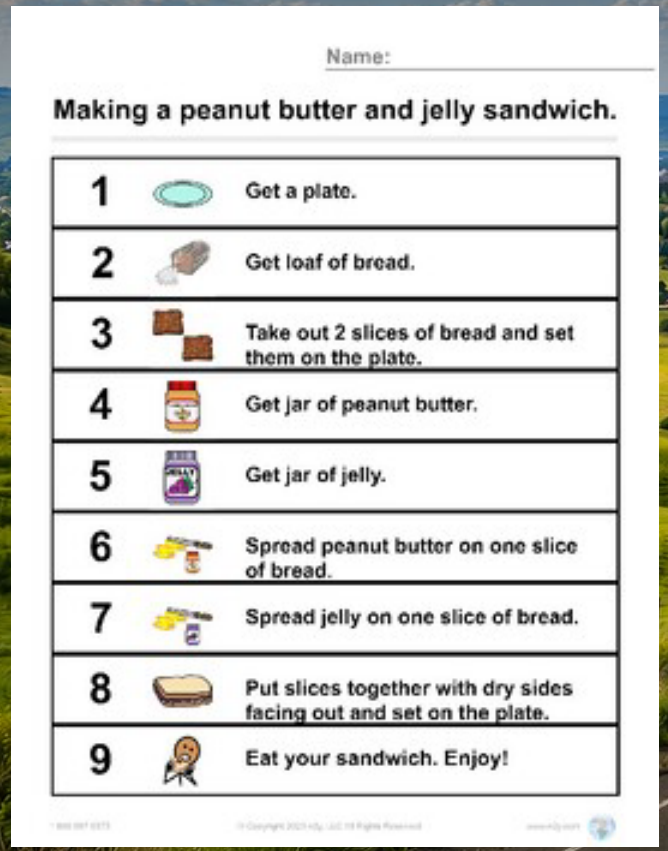
IMPORTANT AREAS IN HUMAN FACTORS

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

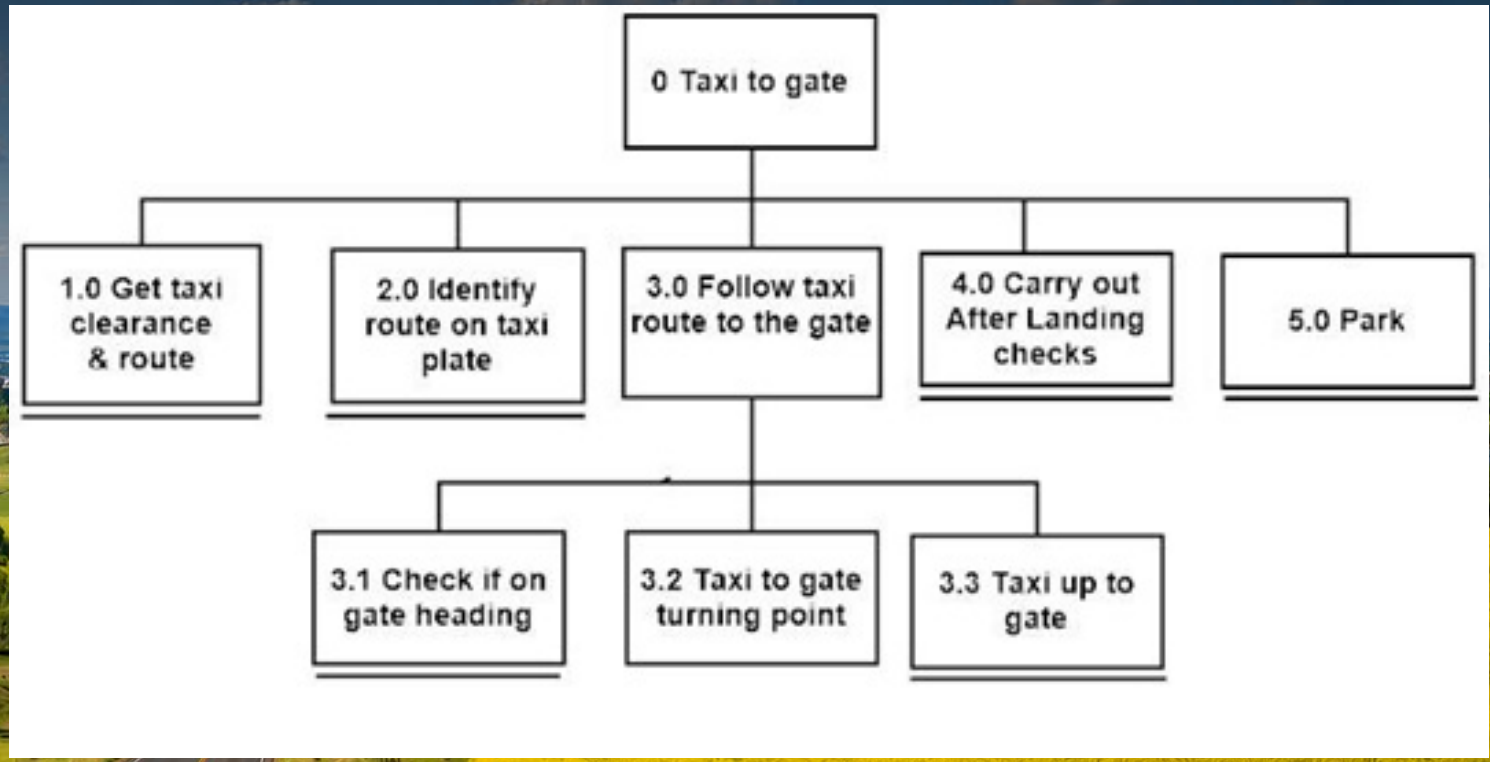
TASK ANALYSIS



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!



WHERE DOES HUMAN FACTORS FIT?

LINKS WITH HUMAN FACTORS PSYCHOLOGY

People

Roads

Vehicles

Speed

Post-crash care


ROAD USERS AND THEIR TASKS
• Driving
• Pedestrian behavior


DRIVERS

DRIVING IS A HUMAN FACTORS TASK

Driving is a continuous cognitive task—not simply operating a vehicle.

Drivers must perceive, decide, and act every few seconds.

Success depends on the interaction between:

- the driver
- the vehicle
- the roadway
- the surrounding environment

Human factors asks:

What mental work does driving require?

How can the roadway support that work?

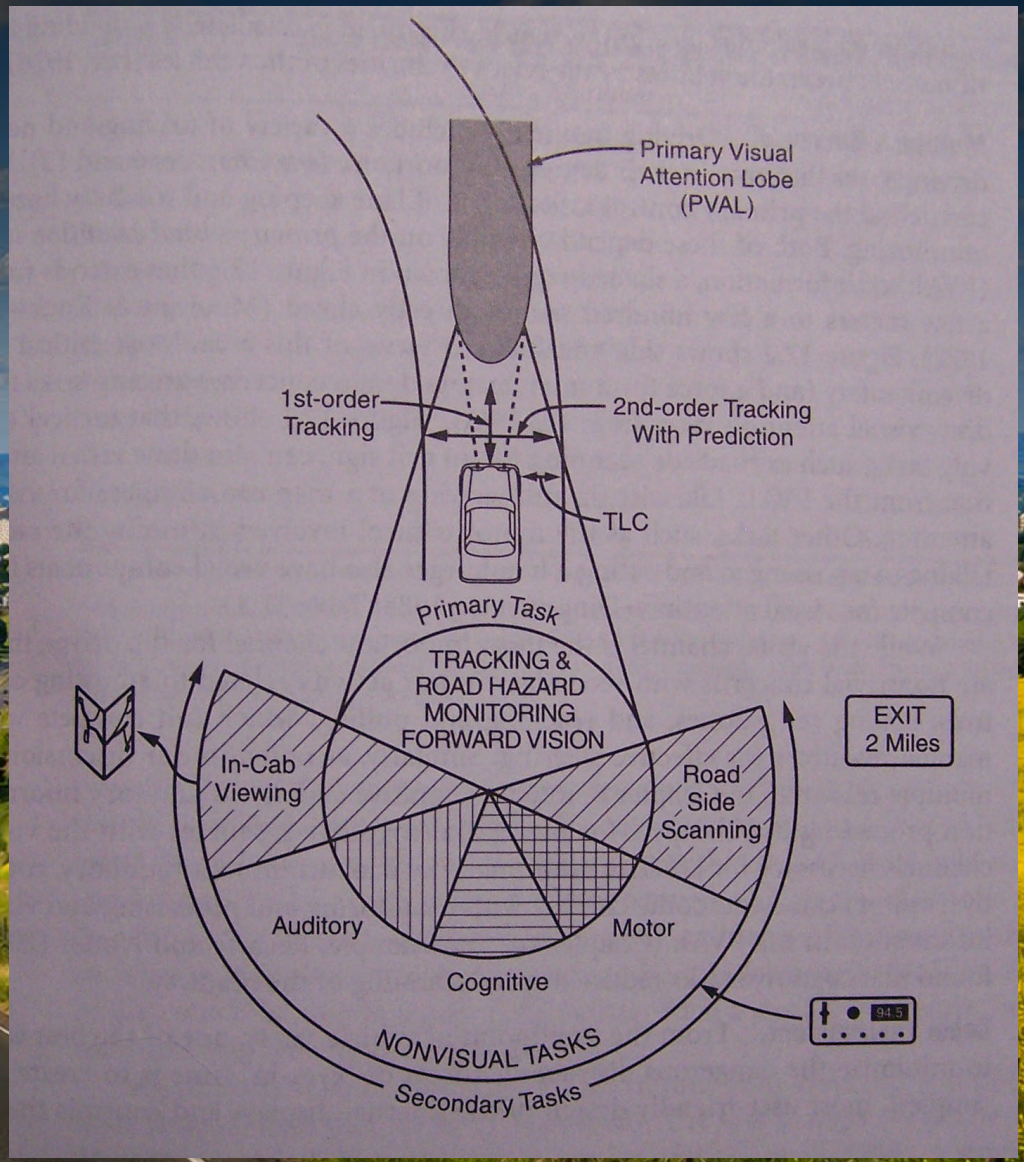
TASK ANALYSIS OF DRIVING

Driving requires simultaneous performance of many subtasks.

- Maintaining lane position
- Monitoring speed
- Searching for hazards
- Reading signs and signals
- Predicting actions of other road users
- Planning navigation
- Vehicle control

Key points

- None of these tasks occur independently.
- They compete for limited cognitive resources.



ATTENTION IS LIMITED

Humans cannot attend to everything.

- Selective attention
- Divided attention
- Inattentional blindness
- Change blindness

Drivers routinely miss information that is directly in front of them—not because they are careless—but because attention is limited.

David Strayer's work demonstrates that distraction reduces situation awareness by disrupting the cognitive processes needed for safe driving.

MENTAL WORKLOAD

Mental workload increases when:

- intersections become complex
- traffic density increases
- navigation becomes difficult
- weather reduces visibility
- unexpected events occur

Performance often declines before drivers recognize they are overloaded.

Good roadway design reduces unnecessary workload.

WORKING MEMORY IS LIMITED

Drivers must temporarily remember:

- route information
- lane assignments
- speed limits
- surrounding vehicles
- recent traffic signals

Working memory is limited.

Simpler roadway layouts reduce memory demands.

PERCEPTION IS IMPERFECT

Drivers estimate:

- distance
- speed
- time-to-arrival
- acceleration

Humans don't measure, they estimate

Patricia Delucia's research has shown that judgments of vehicle speed and time-to-arrival are systematically biased, particularly for fast-approaching vehicles.

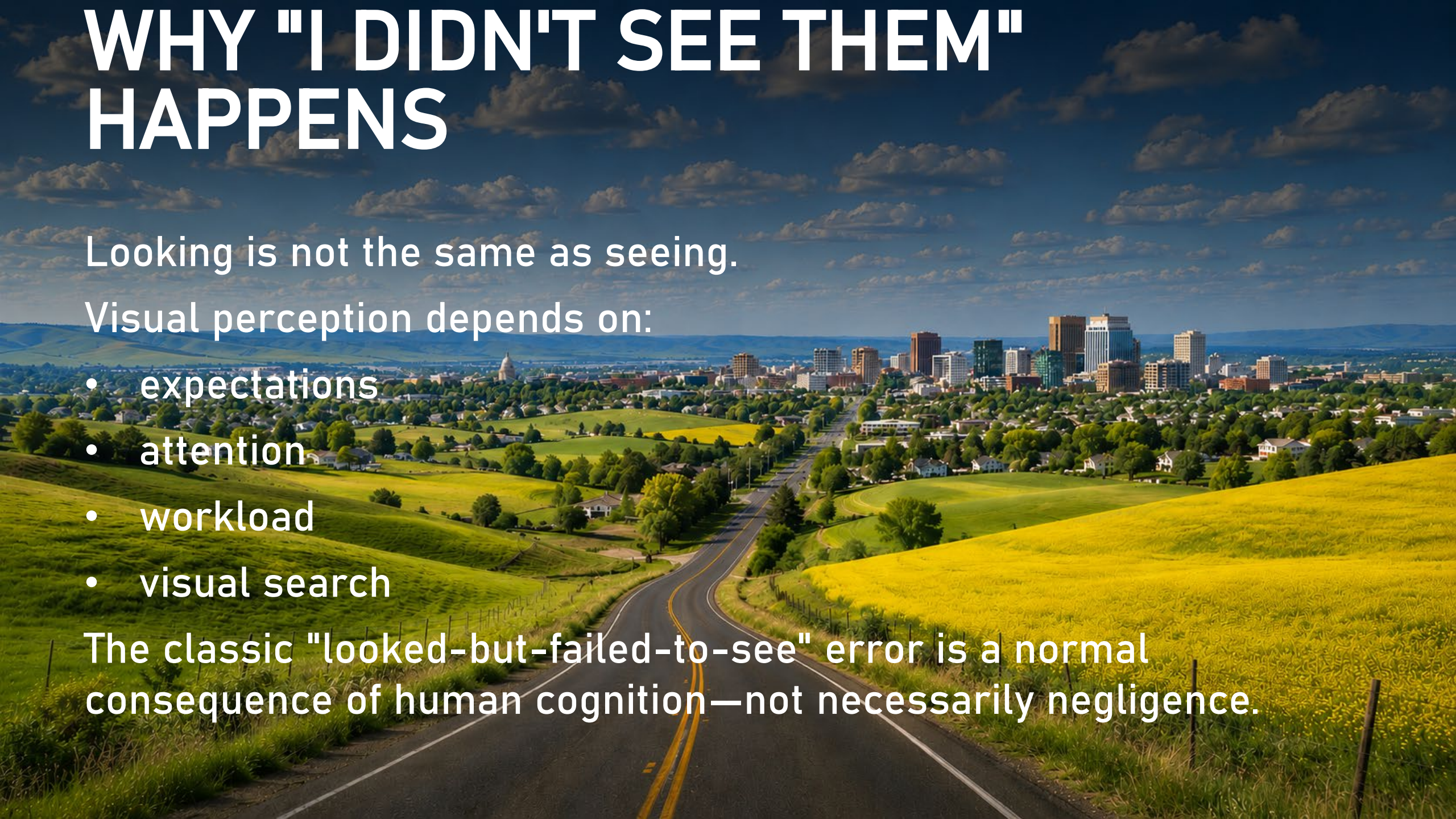
WHY "I DIDN'T SEE THEM" HAPPENS

Looking is not the same as seeing.

Visual perception depends on:

- expectations
- attention
- workload
- visual search

The classic "looked-but-failed-to-see" error is a normal consequence of human cognition—not necessarily negligence.



VEHICLE VS MOTORCYCLE


PEDESTRIANS

THE PEDESTRIAN

Crossing a street requires:

- attention
- perception
- timing
- decision making
- movement coordination

Pedestrians continuously solve cognitive problems while interacting with traffic.

THE TASK

A pedestrian must:

- detect approaching vehicles
- judge vehicle speed
- estimate arrival time
- identify crossing opportunities
- monitor multiple lanes
- continue scanning while walking

Even a simple crossing is cognitively demanding.

GAP SELECTION/ACCEPTANCE

The critical question:

"Do I have enough time to cross?"

This requires estimating:

- vehicle speed
- distance
- personal walking speed

LIMITATIONS OF CHILDREN

Children have developing:

- attention
- executive function
- inhibitory control
- speed perception

They often struggle to integrate distance and speed into safe crossing decisions.

Schwebel and Barton have shown that behavioral training can improve children's pedestrian safety, especially individualized or small-group instruction.

OLDER ADULTS

Normal aging affects:

- walking speed
- divided attention
- visual processing
- decision speed

Infrastructure should accommodate these predictable changes.

DISTRACTION

Pedestrians may be distracted by:

- phones
- texting
- conversations
- headphones
- cognitive preoccupation

Distraction delays detection of traffic and increases unsafe crossings.

ENVIRONMENTAL INFLUENCE

People respond to:

- crossing distance
- refuge islands
- curb extensions
- traffic speed
- signal timing
- visibility

Environment often predicts behavior better than knowledge alone.

EDUCATION HAS LIMITED IMPACT

- Most pedestrians already know:
- ✔️ Look both ways
- ✔️ Use crosswalks
- Knowledge is necessary but does not translate to application
- Behavioral interventions help, but engineering solutions often produce broader and more durable safety improvements.

HUMAN FACTORS PERSPECTIVE

The question is not:

"Why did the pedestrian make a mistake?"

Instead ask:

What features of the environment made that mistake likely?

The goal is to design transportation systems that support normal human behavior—not require perfect human behavior.


TAKEAWAYS

DESIGNING ROADS TO SUPPORT DRIVERS

Design should:

- reduce cognitive workload
- simplify decisions
- increase conspicuity
- provide redundant cues
- allow recovery from mistakes

Bottom line

Good roadway design supports normal human cognition.

DESIGNING FOR PEDESTRIANS

Effective pedestrian design:

shortens crossings

- reduces crossing decisions
- slows vehicles
- improves visibility
- increases predictability

Good design reduces the cognitive demands placed on pedestrians.

For Planners

- Assume distraction.
- Reduce unnecessary complexity.
- Design for novice users.

For Engineers

- Design forgiving systems.
- Make hazards obvious.
- Reduce decision burden.

For Policymakers

- Invest proactively.
- Measure behavior, not just crashes.
- Evaluate designs before injuries occur.