



Perceptual and Cognitive Aspects of Human Road Use in the context of Technological Vehicles Advancements

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המכון לחקר הגורם האנושי

לתאונות דרכים



Research Institute
OF HUMAN FACTORS IN ROAD SAFETY

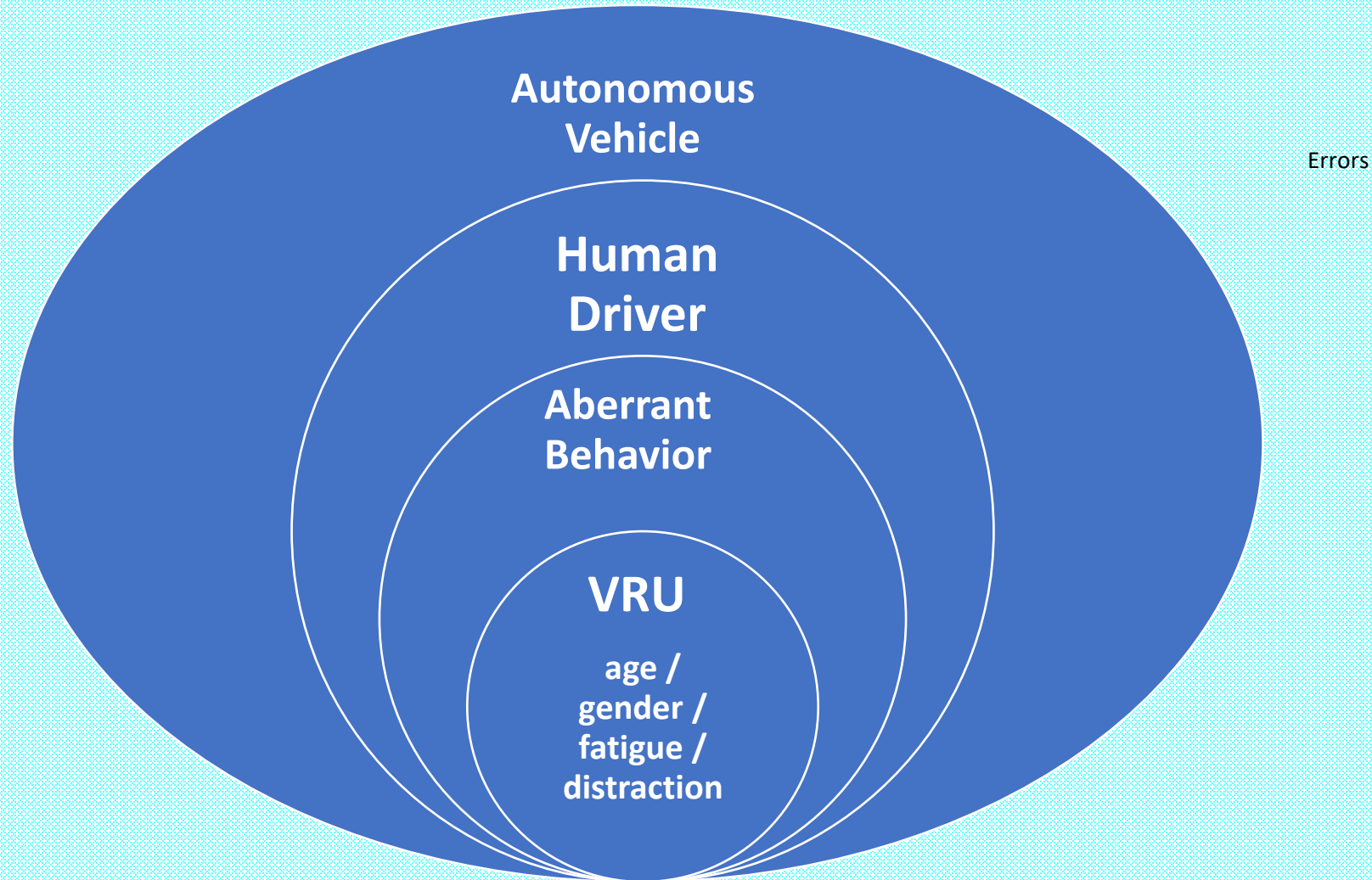
It's all about us on the road

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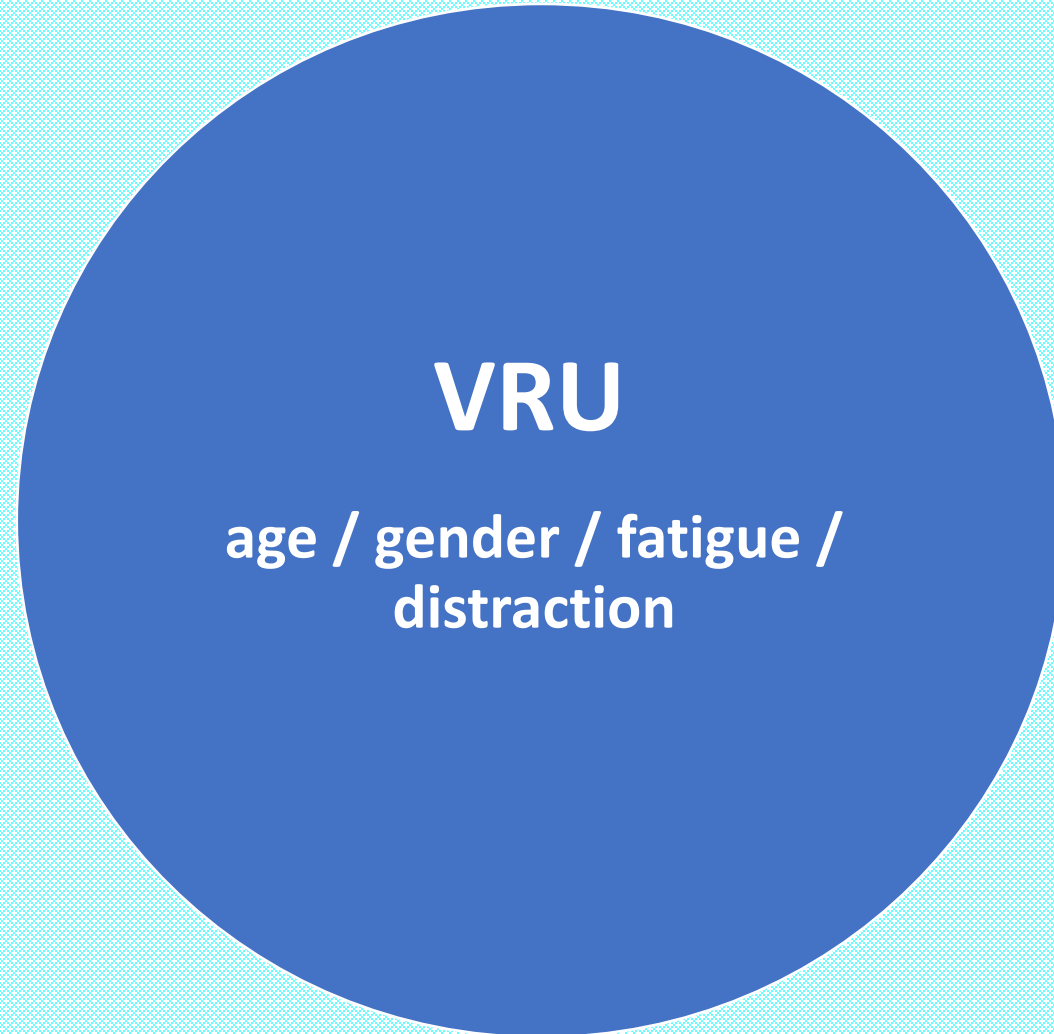
Palais des Nations, Geneva, Switzerland.
for Road Traffic Safety (WP.1)



Vulnerable Road Users (VRU) – Machine Interfaces



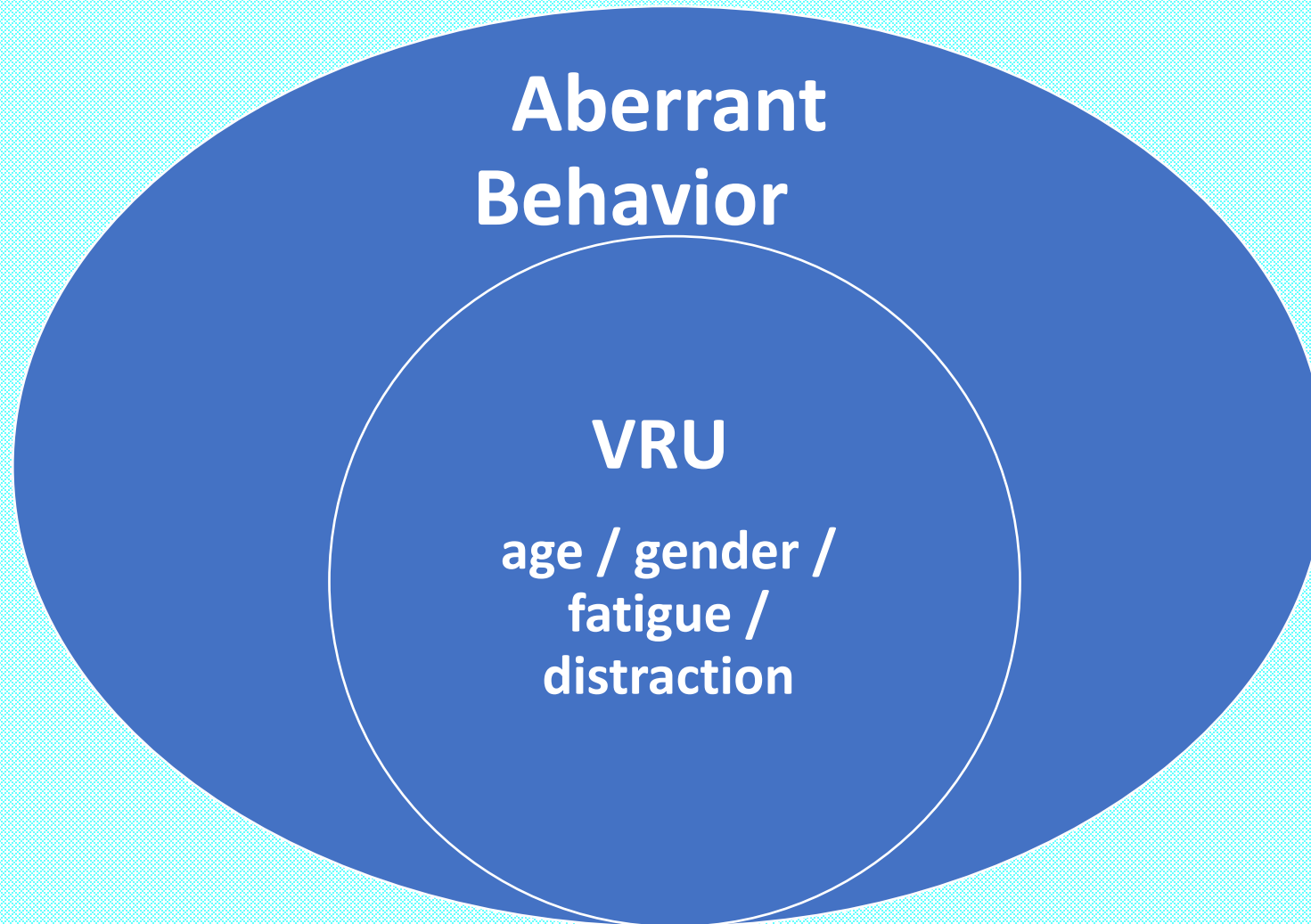
Vulnerable Road Users (VRU) – Machine Interfaces



Errors

- Age – road users behave more cautiously as they get older
- Gender – males take more risks on roads than females
- Fatigue – people after sleep deprivation may make more errors
- Distraction – people who are distracted or have a secondary task in addition to road crossing are more prone to accidents

Vulnerable Road Users (VRU) – Machine Interfaces



Errors

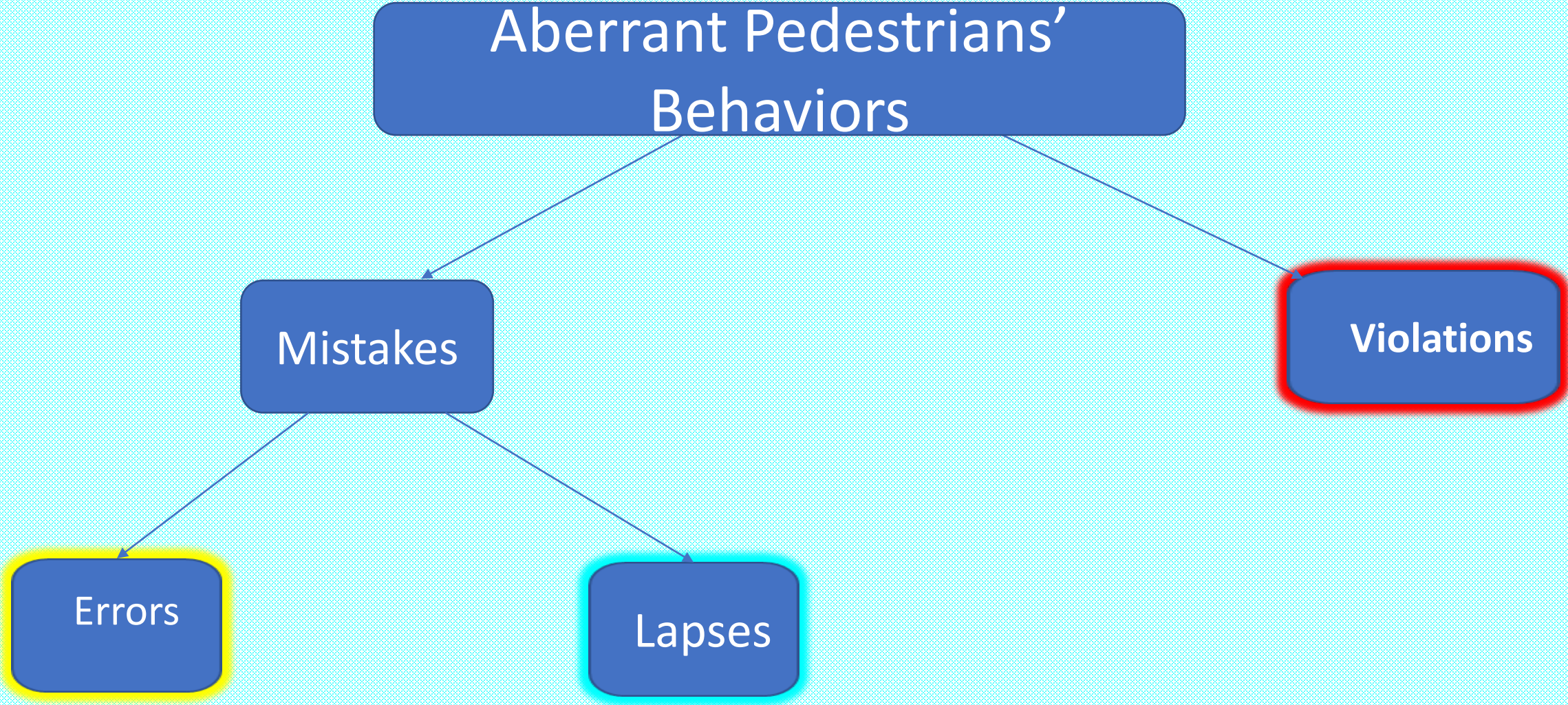
Aberrant Pedestrians' Behaviors

Mistakes

Violations

Errors

Lapses



- Lapses are failure of perception
- Errors are failure of cognition
- Violations are yielded by a negative motivation



VRU - Pedestrians

Violations

- Crossing even though the light is still green for vehicles
- Taking passageways forbidden to pedestrians to save time



Errors

- Crossing between vehicles stopping on the roadway in traffic jams
- Running across the street without looking due to being in a hurry

Lapses

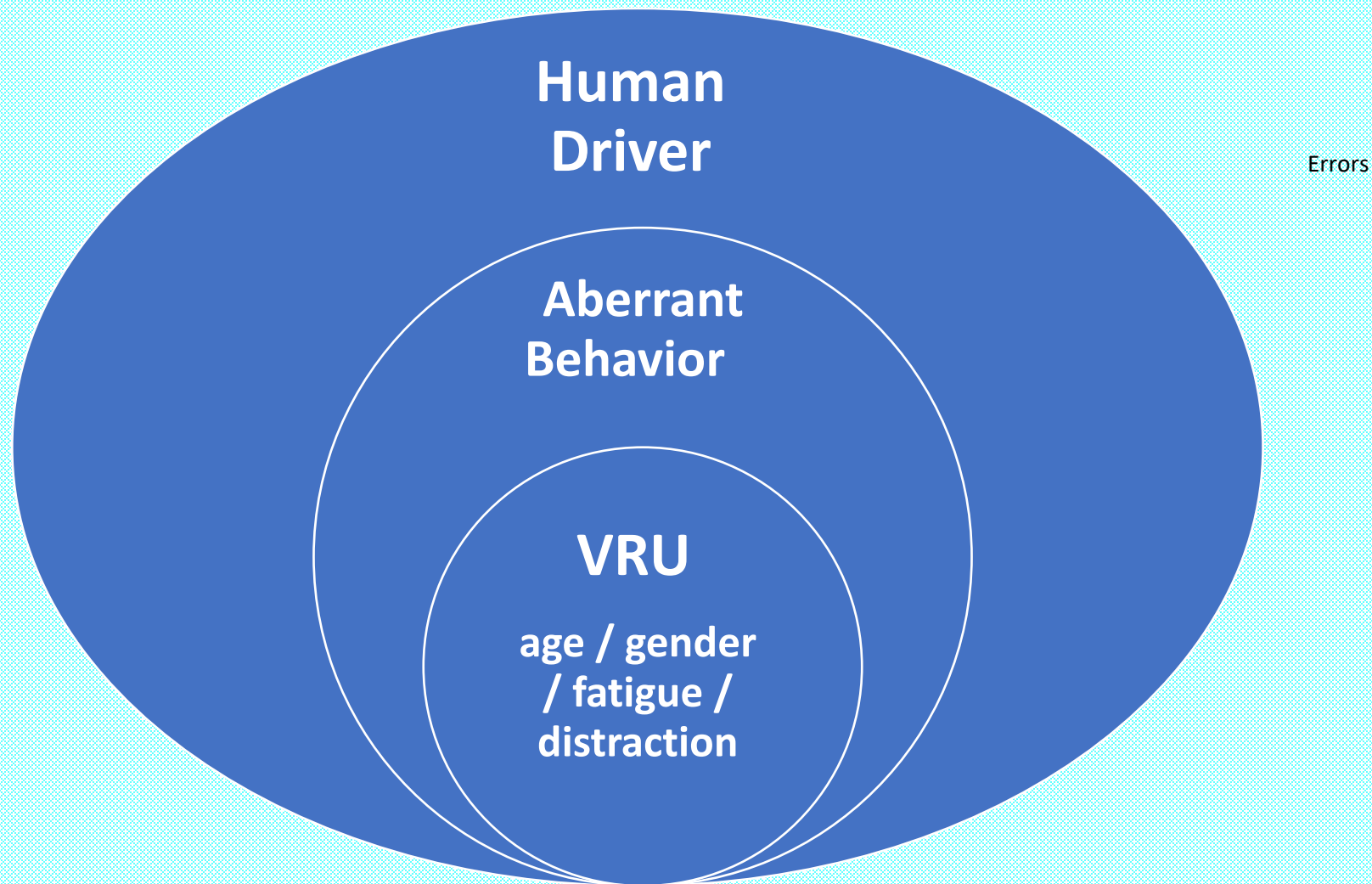
- Crossing without looking when following other people who are crossing
- Crossing without paying attention to traffic
- Forgetting to look before crossing because of thinking about something else

Distraction

- Lapses can occur due to a lot of types of distraction such as using the smartphone or listening to music in earphone
- One of the most prevalent distracting behavior is mind wandering
- Normally, our mind can stray away from the current task and generate task-unrelated thoughts.
- This phenomenon is considered as attention decoupled from the current external task to an internally spontaneous experience (Deng et al., 2022)
- This type of distraction is especially problematic because its invisibility and because it is almost impossible to enforce



Vulnerable Road Users (VRU) – Machine Interfaces



Aberrant Driving Behaviors

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graph TD; A[Aberrant Driving Behaviors] --> B[Mistakes]; A --> C[Violations]; B --> D[Errors]; B --> E[Lapses];
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Mistakes

Violations

Errors

Lapses

Violations

These are actions that break or act against the traffic laws

- Disregarding the speed limit
- Ignoring stop sign or crossing in red light
- Crossing a junction knowing that the traffic lights have already turned red

These actions are intentional

Errors

These are planned actions that fail to accomplish their intended outcomes

- Braking too quickly on a slippery road
- Turning the steering wheel in the wrong direction in a skidding vehicle)
- Wrong estimation of velocity of a vehicle that I plan to overtake
- Underestimation the speed of an incoming vehicle when overtaking
- Misunderstanding a road sign
- Getting into the wrong lane when approaching a roundabout or a junction

These actions are unintentional

Lapses

Lapses are defined as absent-minded behaviors

- Attempting to drive away from traffic lights in third gear
- Missing 'give way' sign and narrowly avoid colliding with traffic having right of way
- Applying sudden brakes on a slippery road or steer wrong way in a skid
- Switching on one thing such as headlights when I meant to switch on something else such as wipers.
- Hitting something when reversing that I had not previously seen

These actions are unintentional

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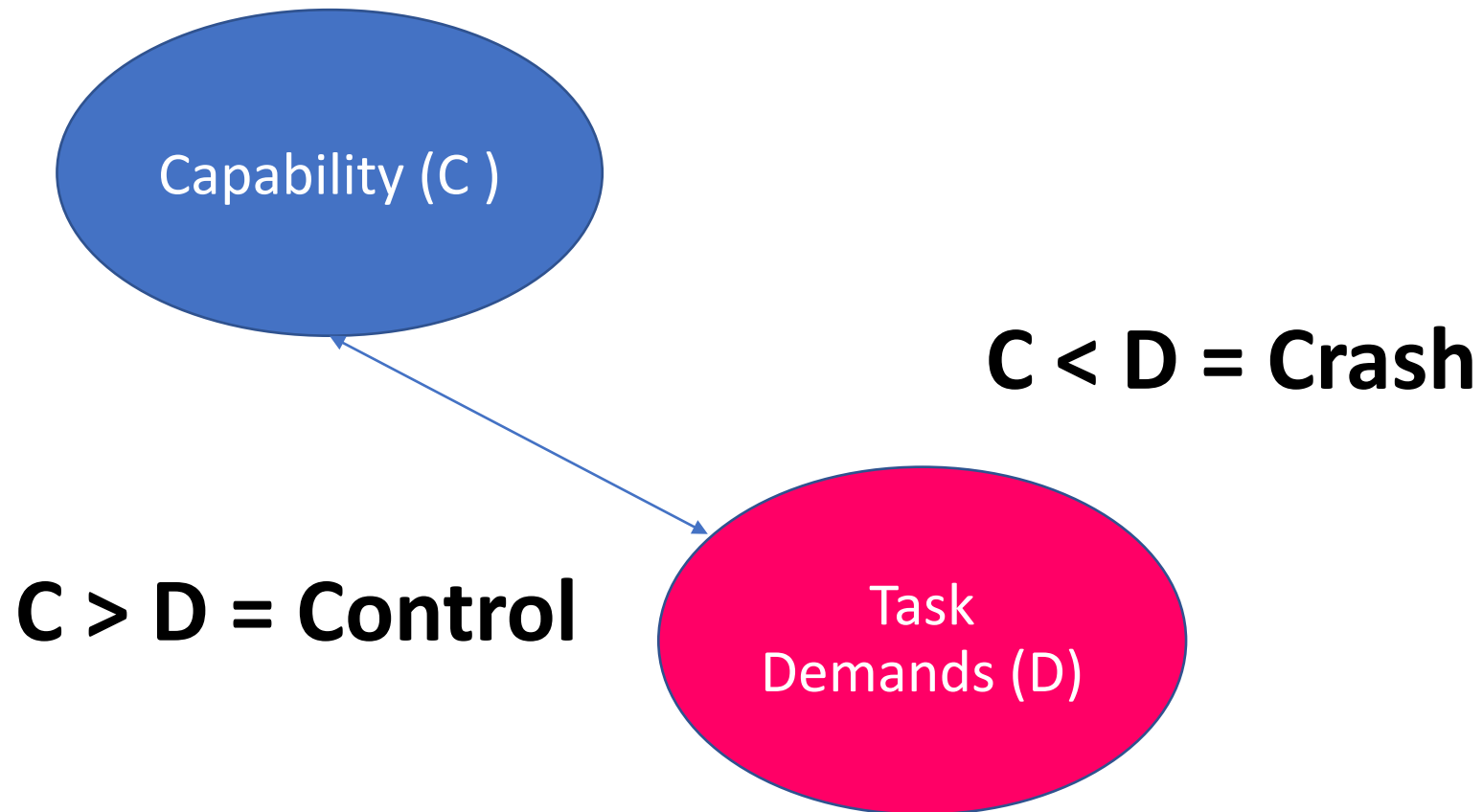
Task-Capability Interface (Fuller, 2000)

Task demand is the objective complexity of the task and arises out of a combination of features of the environment, the behavior of other road users, control and performance characteristics of the vehicle, its speed, road position and trajectory and driver communication

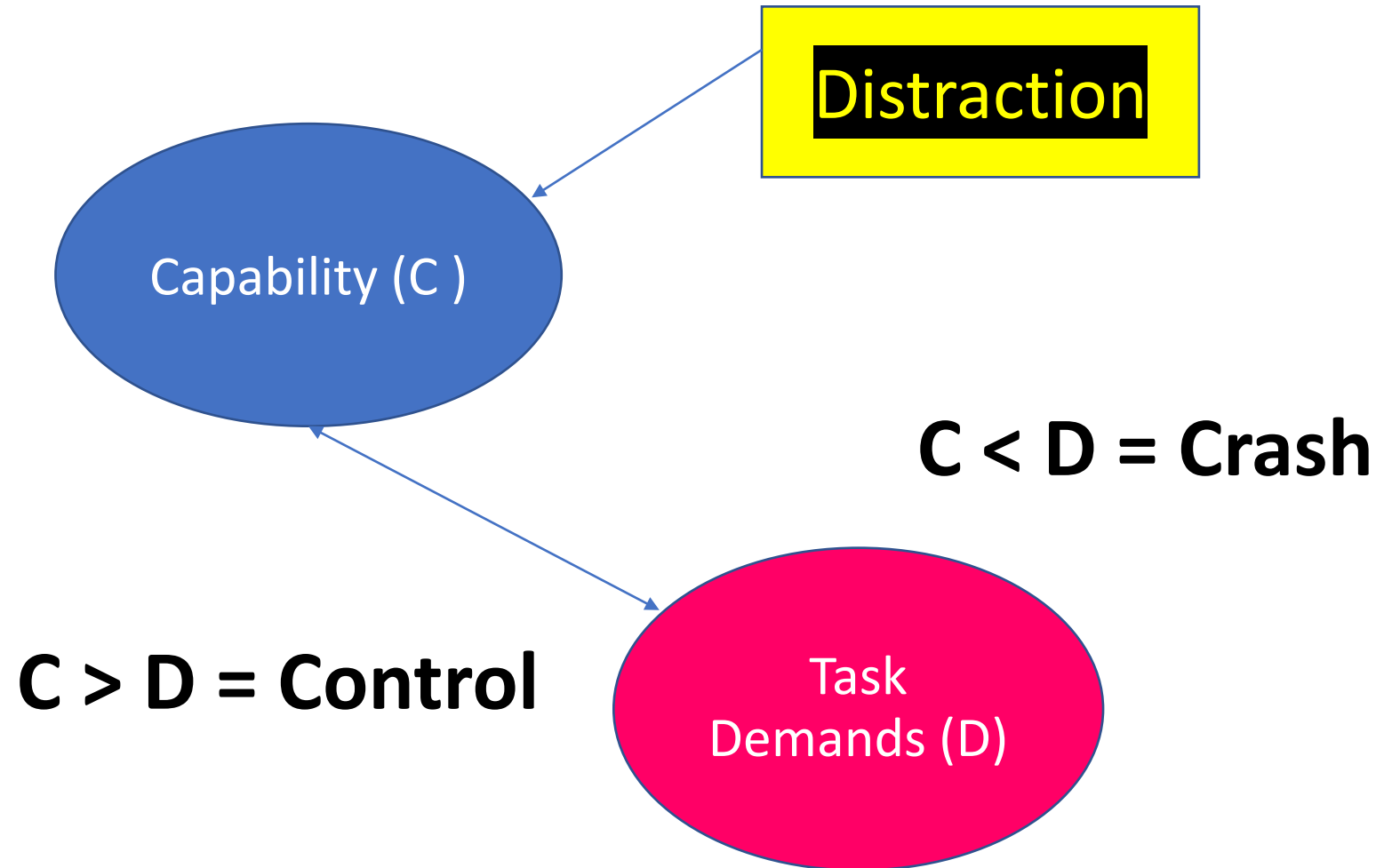
Driver's Capability

- Driver's capability is his or her upper limit of competence and momentary capability.
- Competence here refers to the driver's control skills, ability to read the road (hazard detection and recognition), and anticipatory and defensive driving skills.
- Capability refers to the momentary ability of the driver to deliver his or her level of competence. It refers to what the driver actually is able to do at any given moment.
- Factors such as fatigue, drowsiness, emotion, alcohol and other drugs, stress, distraction and the level of motivation to perform the driving task optimally may reduce Capability.

Task-Capability Interface (Fuller, 2000)

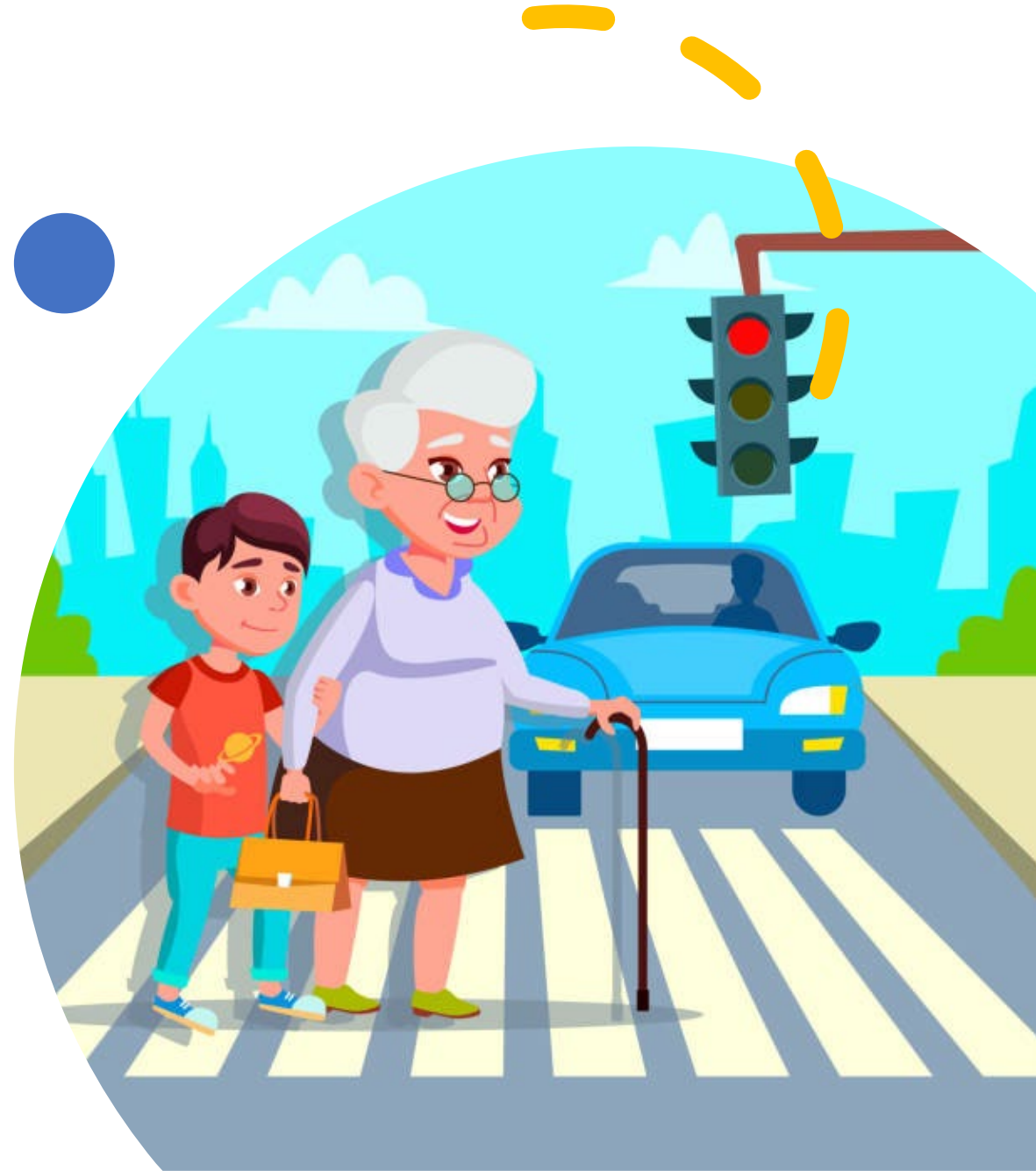


Task-Capability Interface (Fuller, 2000)



Elderly Pedestrians

Elderly people are poor at judging how long it will take them to cross the street. This might partially explain the overrepresentation of elderly people among pedestrians' fatalities (Zivotofsky, Eldror, Mandel & Rosenbloom, 2012)



Children

We studied the development of the conceptual role of the visual timing elements of speed and distance in the appraisal of fear and danger involved in a road-crossing scenario.

Younger children related to less relevant information in their appraisals, conceptualizing speed to be the primary pedestrian risk factor, while distance played a minor role in determining children's appraisals of fear and danger (Rosenbloom et al., 2008).

Children

The children's poor performance is attributed to either their lack of traffic experience or to their state of cognitive development



One of the human-machine interfaces is of pedestrians and human- driven car

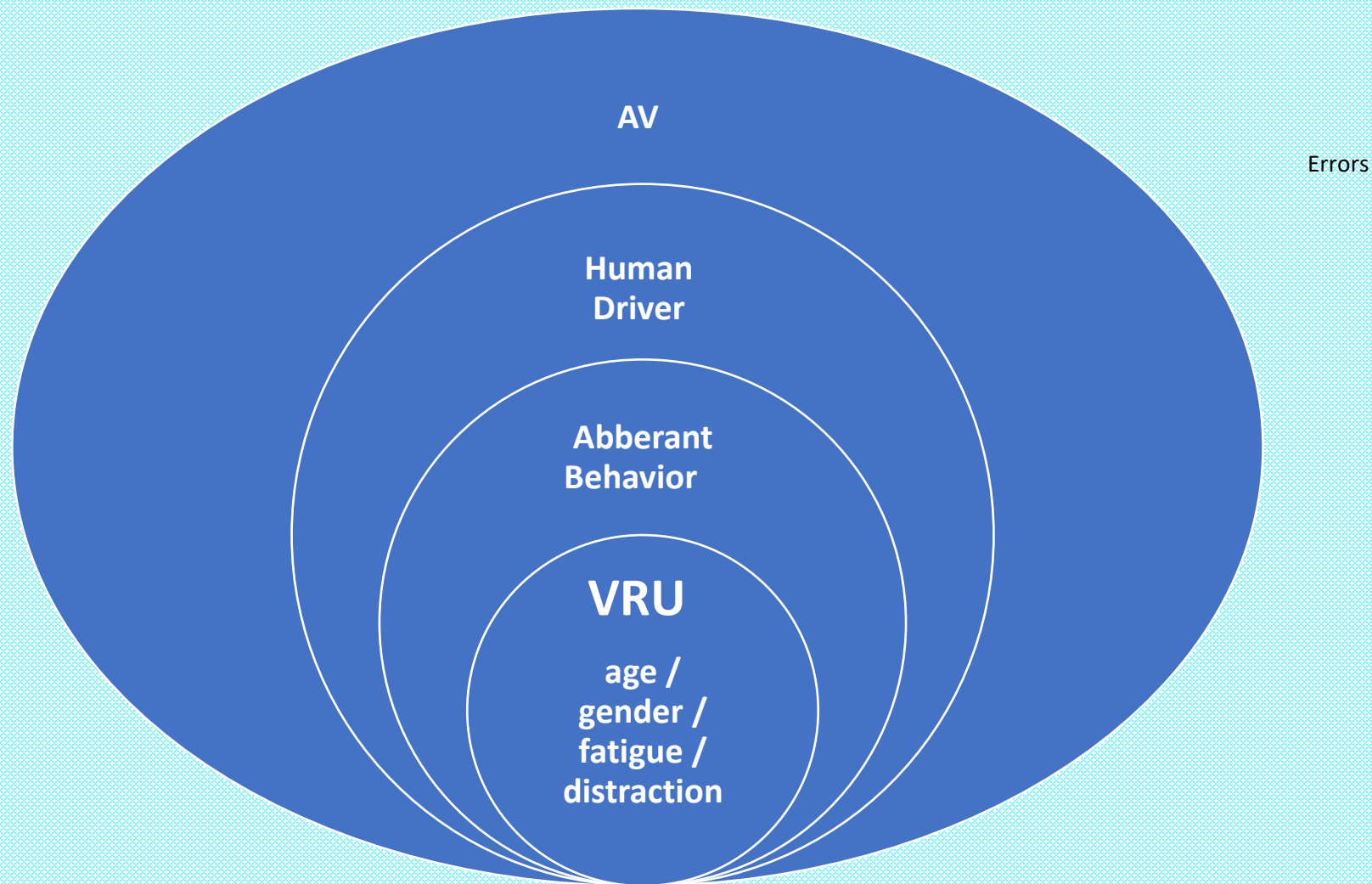


- As seen before, both the pedestrian and the driver are involved in all types of aberrant behaviors that may lead to an accident or to a near-accident.
- So, drivers who are not aware to these possibilities may rely too much on the pedestrian and vice versus

- Moreover, drivers expect the pedestrian to check the road before crossing but many pedestrians don't do that either if they intend to do this (violation) or if they failed to do this (lapse)
- On the other hand, pedestrians rely on that drivers obey traffic laws, but we know that traffic violations are among the main reasons for fatal road accidents
- Errors and lapses of both sides are even worse because nobody mean to make it and it always happens as a surprise

- Following this notion, we found that as people drive more they are more cautious on road as pedestrians (Ratzon, Perlman & Rosenbloom, 2021)
- We attribute this to transfer of learning made by drivers from the task of driver to the task of pedestrian
- People who are driving a lot are aware to the fact that drivers may surprise with violations, errors or lapses so they don't rely on drivers too much as pedestrians but rather on themselves
- We now expand our research to see whether our finding is applied as well on motorcyclists or cyclists

Vulnerable Road Users (VRU) – Machine Interfaces



- The insights gained from the perspective of a human driver have to be adopted to the autonomous vehicle's brain



Some points regarding AV

- The penetration of AV to the transport system will be spread upon some decades
- Till a full automation there will be a transfer phase that will require separate infrastructure
- It is quite complicated to rely on previous studies as most of them were not based on empirical research design

AV – VRU Interface

The big data that underlines the base of the AV must conclude a deeper understanding of the perceptual and cognitive aspects of the human being as described in highlights before

It is required to understand how road users will communicate with the technology, and what possible benefits or difficulties or even dangers they perceive. This information is needed when designing the interfaces and interior of autonomous cars (Chaloupka, R Risser, 2020).

Thank You!

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