# Moving Away From the Trolley Problem

A paradigm shift in ethics of autonomous vehicles (AVs)

# The NeuroComputational Ethics Research Group at NCSU

Group aim: To evaluate the ethics of emerging technologies and to utilize technology for the purposes of empirical research.

Current Research:

- VR simulations of moral decision making for AVs
- Studying adolescent morality
- Reviewing the harms and benefits of Transcranial Magnetic Stimulation
- Assessing the usefulness of repurposed non-stimulate ADHD medications for cognitive enhancement.

# Issue / Assertion

Current moral psychology methodologies are insufficient for guiding the creation of ethical AVs.

Agent-Deed-Consequence (ADC) operationalized virtual stimuli are a better tool for informing the moral actions of AVs.

# Presentation Flow

## AV Background

- Categorization of AVs
- Software Architecture

## Why are Ethically Acting AVs Necessary?

- Collisions are unavoidable
- Ethics Settings in AVs make fully autonomous versions trustworthy

## Sacrificial Dilemmas and their Flaws

- Overview of Sacrificial Dilemmas
- The Moral Machine Experiment (MME) Description
- Binary Choice
- External Validity

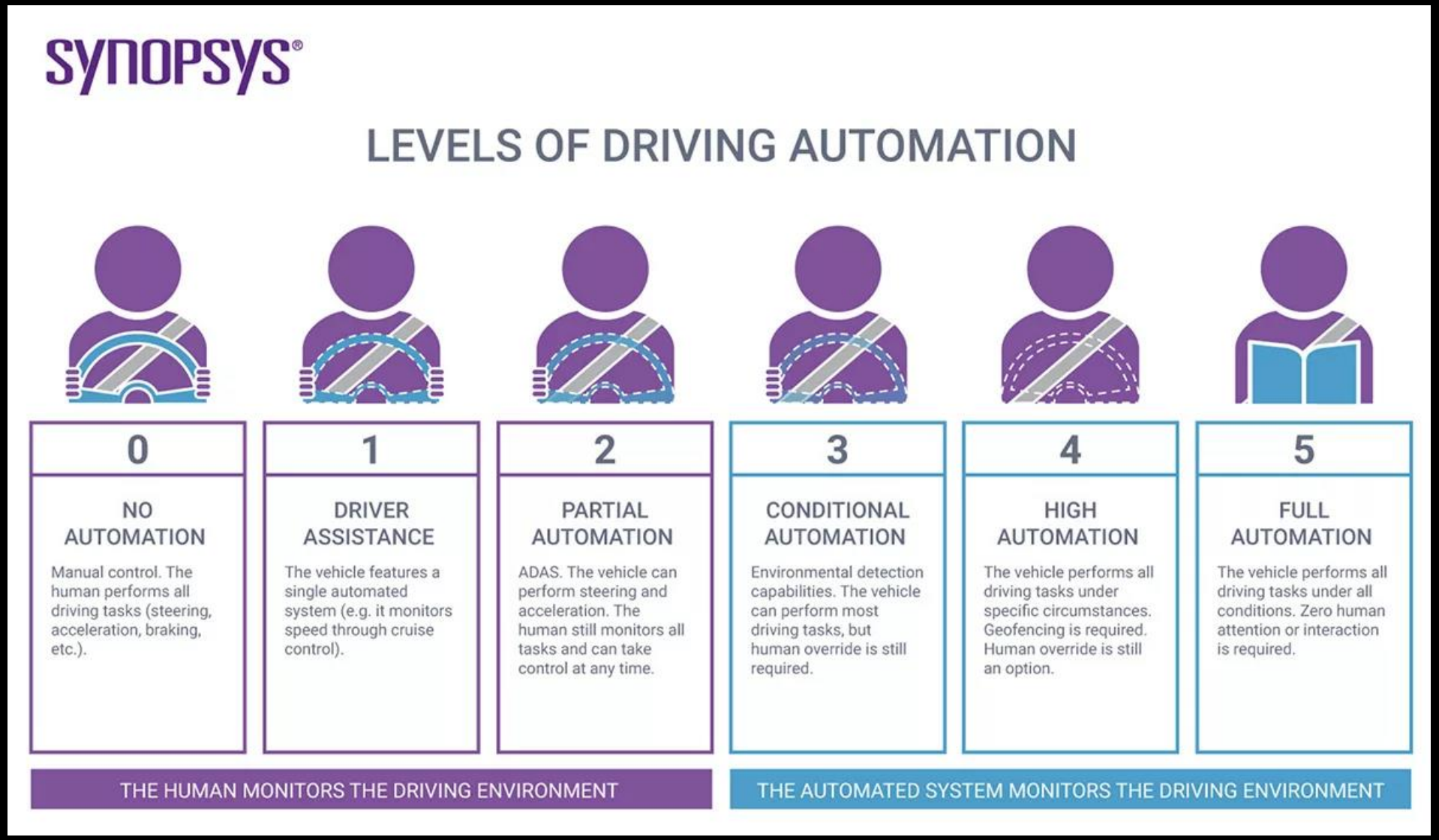
## Our Solution

- ADC model of moral judgment
- Virtual Reality
- Experimental Design
- Content Display

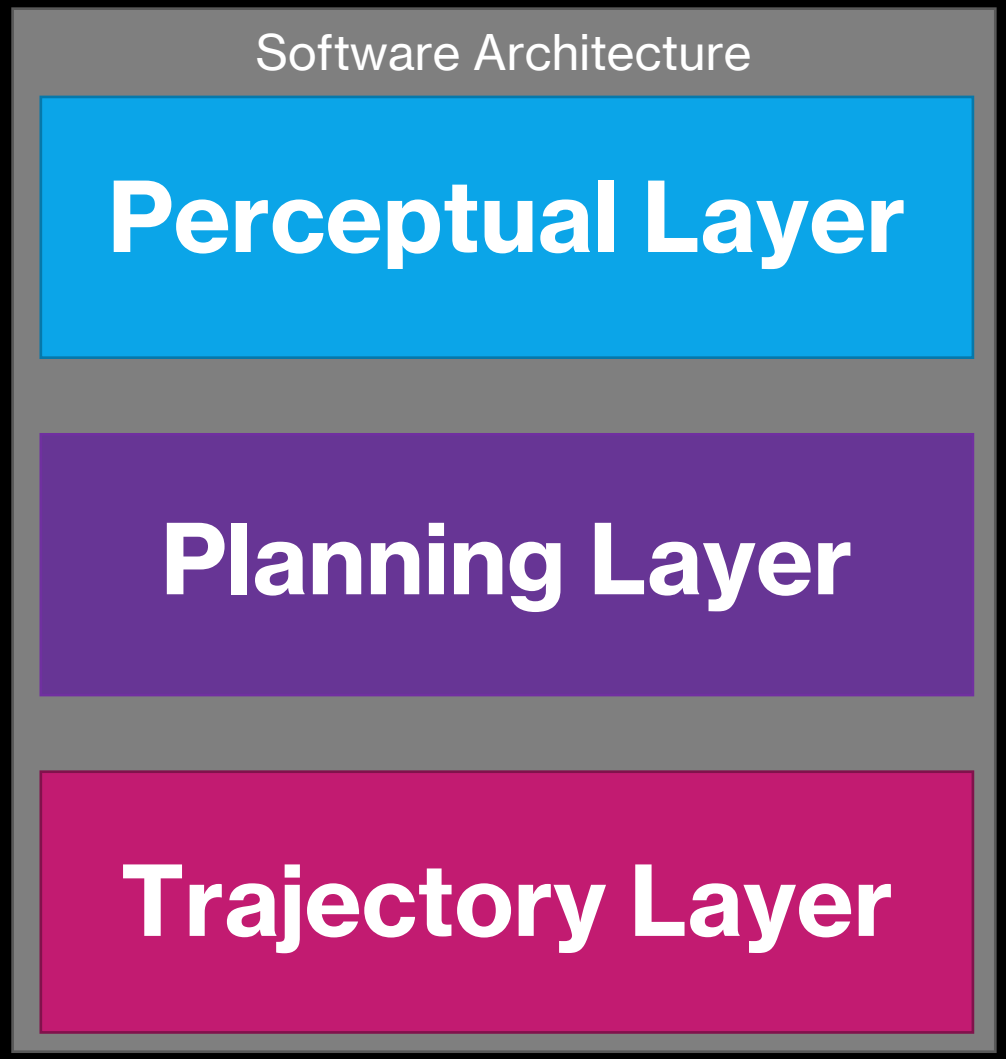
## Conclusion

# AV Background

# Categorization of AVs



# AV Software Architecture




Structured like a nervous system.

Sensory equipment

Integration of information

Where embedded Ethics Settings (ESs) would be located.

Motion control

# Why are Ethical AVs Necessary?

# Collisions

- Collisions are unavoidable part of driving for both non-autonomous and AVs.
  - NHTSA recognized nearly 400 crashes involving level 2 systems (July 2021-December 2022).
- While AV malfunctions are possible, this technologically is likely safer than non autonomous vehicles.
- Therefore, when accidents happen, it is likely that prioritization between unfavorable choices will be required.

Non-automated vehicle crashes (2015)

**Table 1. Driver-, Vehicle-, and Environment-Related Critical Reasons**

| Critical Reason Attributed to | Estimated | |
|---|---|---|
| | Number | Percentage* ± 95% conf. limits |
| Drivers | 2,046,000 | 94% ±2.2% |
| Vehicles | 44,000 | 2% ±0.7% |
| Environment | 52,000 | 2% ±1.3% |
| Unknown Critical Reasons | 47,000 | 2% ±1.4% |
| Total | 2,189,000 | 100% |

*Percentages are based on unrounded estimated frequencies
(Data Source: NMVCCS 2005–2007)

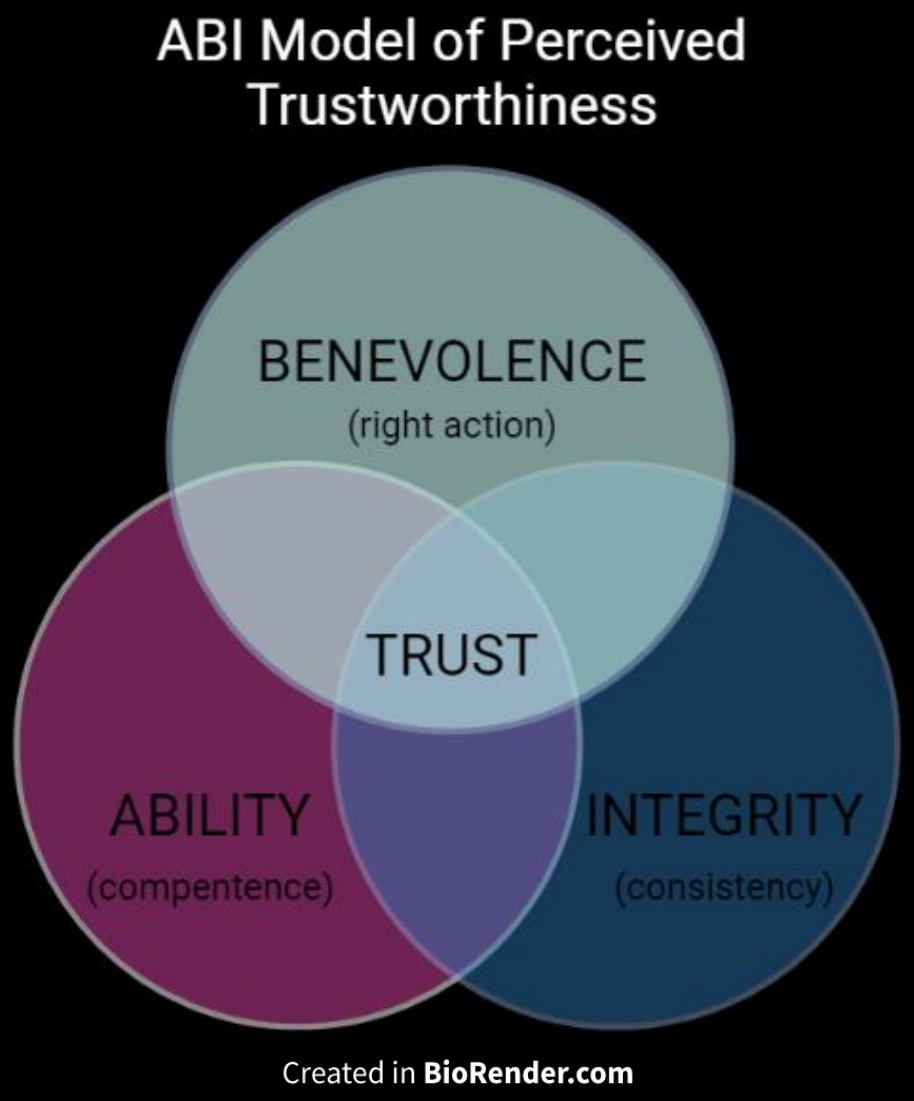
**Table 2. Driver-Related Critical Reasons**

| Critical Reason | Estimated (Based on 94% of the NMVCCS crashes) | |
|---|---|---|
| | Number | Percentage* ± 95% conf. limits |
| Recognition Error | 845,000 | 41% ±2.2% |
| Decision Error | 684,000 | 33% ±3.7% |
| Performance Error | 210,000 | 11% ±2.7% |
| Non-Performance Error (sleep, etc.) | 145,000 | 7% ±1.0% |
| Other | 162,000 | 8% ±1.9% |
| Total | 2,046,000 | 100% |

*Percentages are based on unrounded estimated frequencies
(Data Source: NMVCCS 2005–2007)

2015. *Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey.* A Brief Statistical Summary, Washington, D.C.: National Highway Traffic Safety Administration.

# Trust




Trust is a crucial determinate of technological adoption by the public.

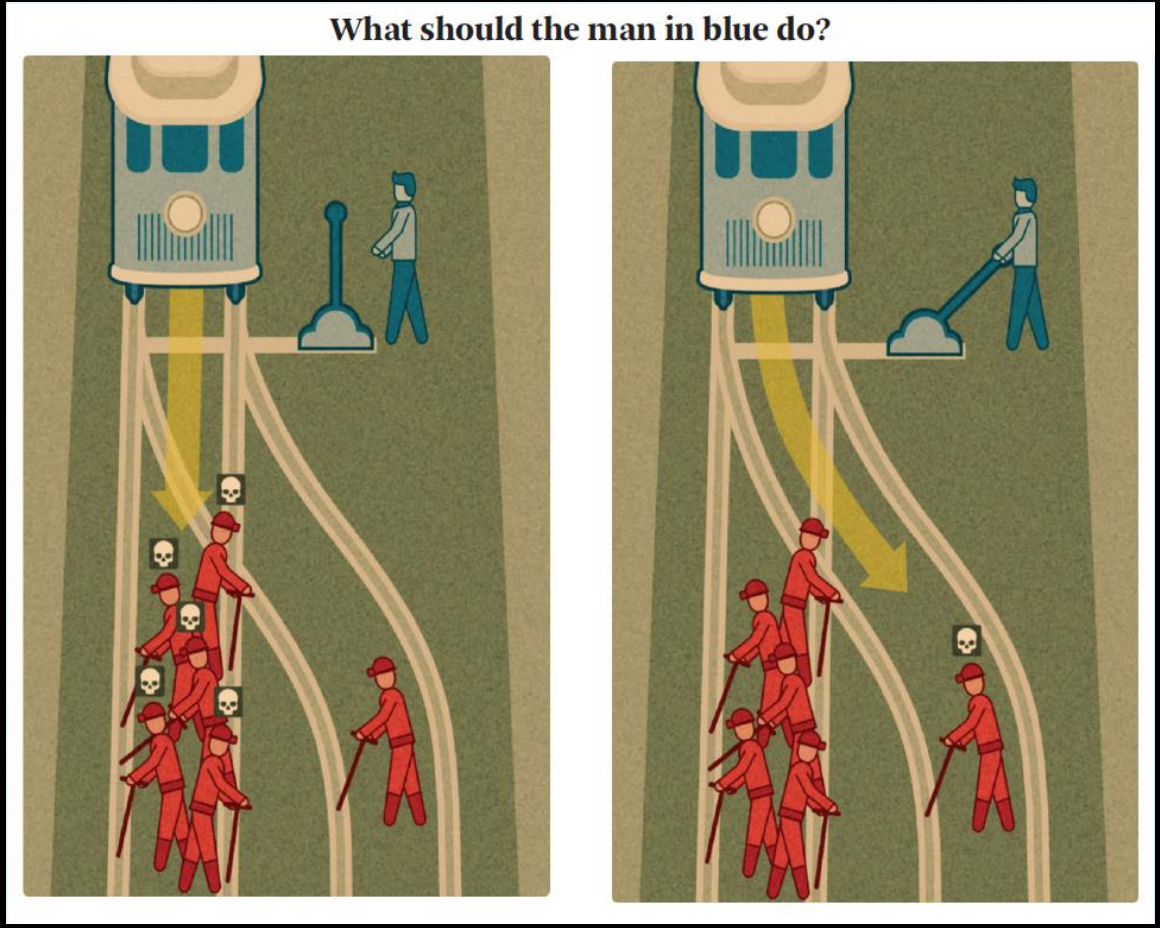
A ‘correct’ set of ESs could drastically increase benevolence and integrity.

AVs informed by human moral intuition are more likely to be accepted by the public and produce trustworthy actions.

# Sacrificial Dilemmas and their Flaws

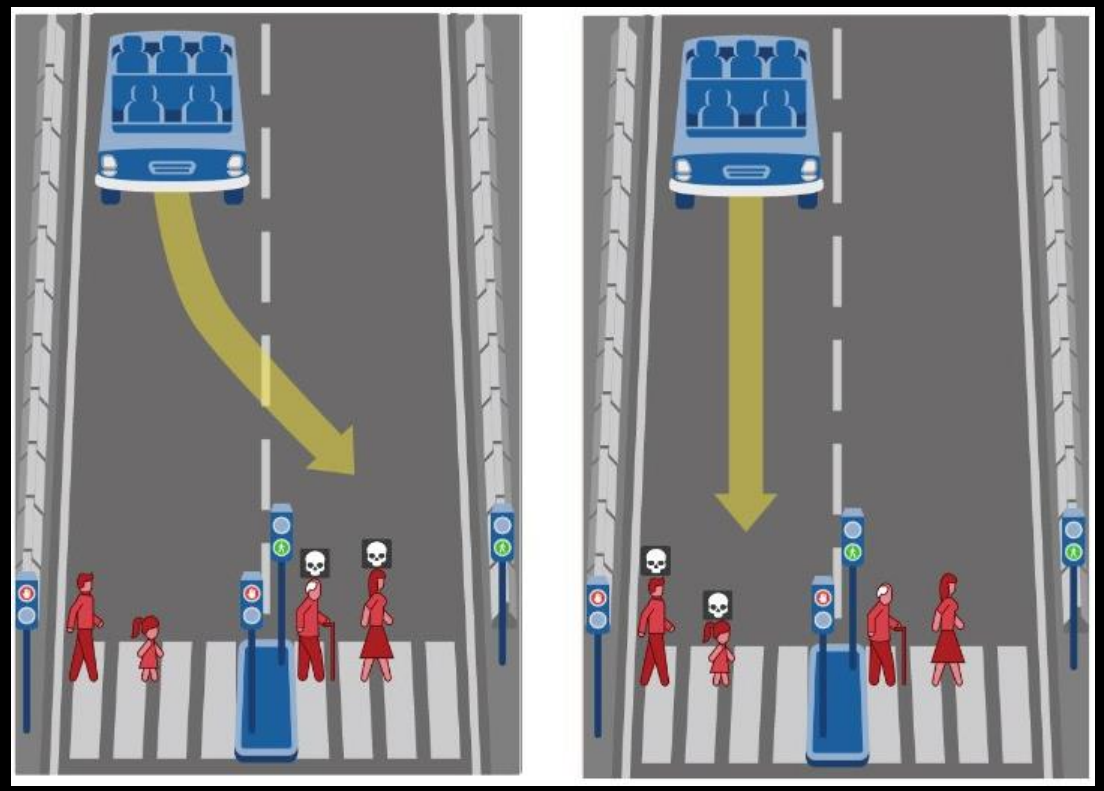
# Sacrificial Dilemmas

- The Trolley Problem
  - Proposed in 1967 by Philippa Foot.
  - Popularized by Judith Jarvis Thomson 1985.
- Dilemma's Core Theme
  - Is killing a single person to save more people permissible?
- Pits consequentialist (consequences) and deontological (rules) intuitions against each other.



# Moral Machine Experiment

This experiment presents subjects with 13 scenarios varied over 9 factors.



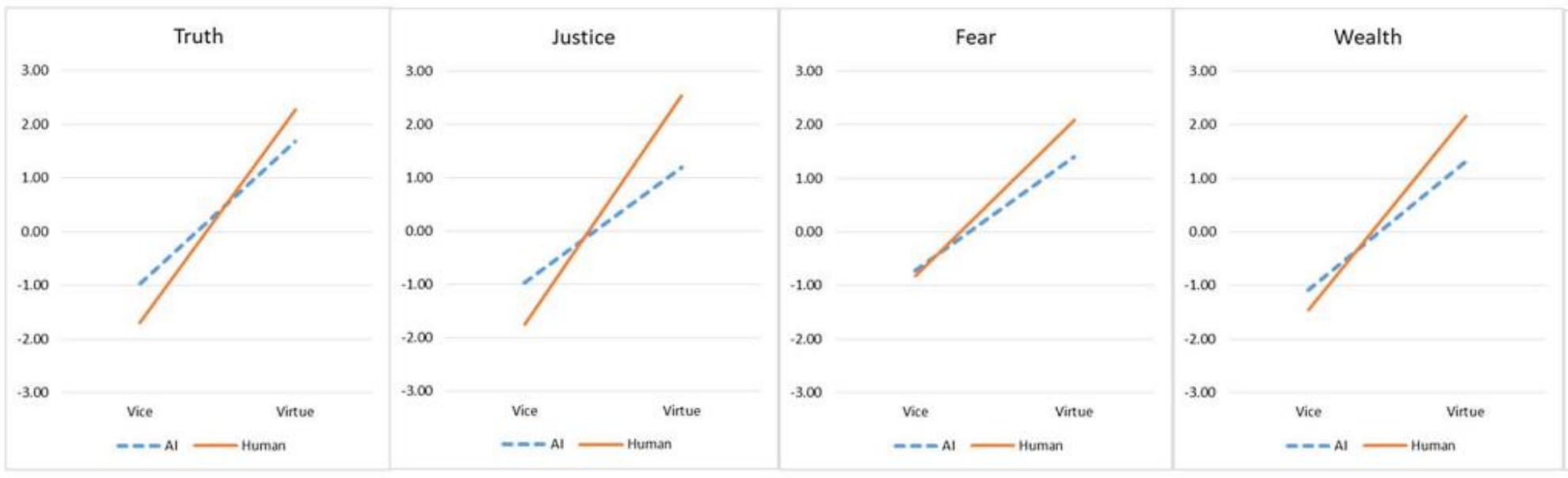
| Strongest Preferences Observed | |
|---|---|
| 1. Humans over pets | 4. Lawful |
| 2. More lives | 5. Perceived social status |
| 3. The young | 6. Physically fit |

| Pros | Cons |
|---|---|
| • 39.6 million data points<br>• 130 countries with at least 100 respondents | • Binary<br>• Lacks external validity (realism)<br>1. Experimental<br>2. Mundane<br>3. Psychological |

# Binary Choice

Typically, this framework is a good experimental design, but in the sacrificial dilemma paradigm it fails to incorporate other moral theories.

Virtue ethics is a critical component in the formation of the moral evaluations of humans and recent studies suggest people attribute moral traits to AI systems in a similar fashion.



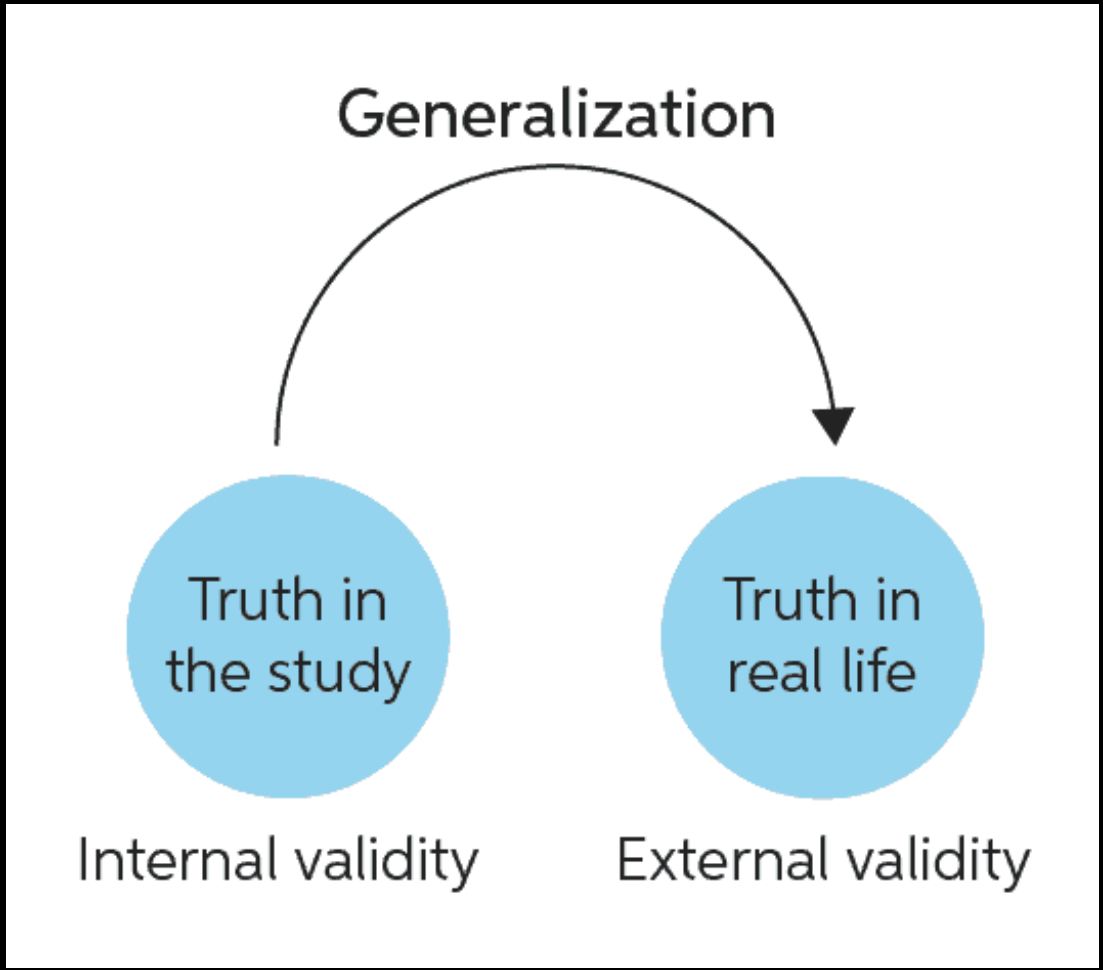

Gamez, Patrick, B., Daniel Shank, Carson Arnold, and Mallory North. 2020. "Artificial virtue: the machine question and perceptions of moral character in artificial moral agents." *AI & SOCIETY* 795-809.

# External Validity

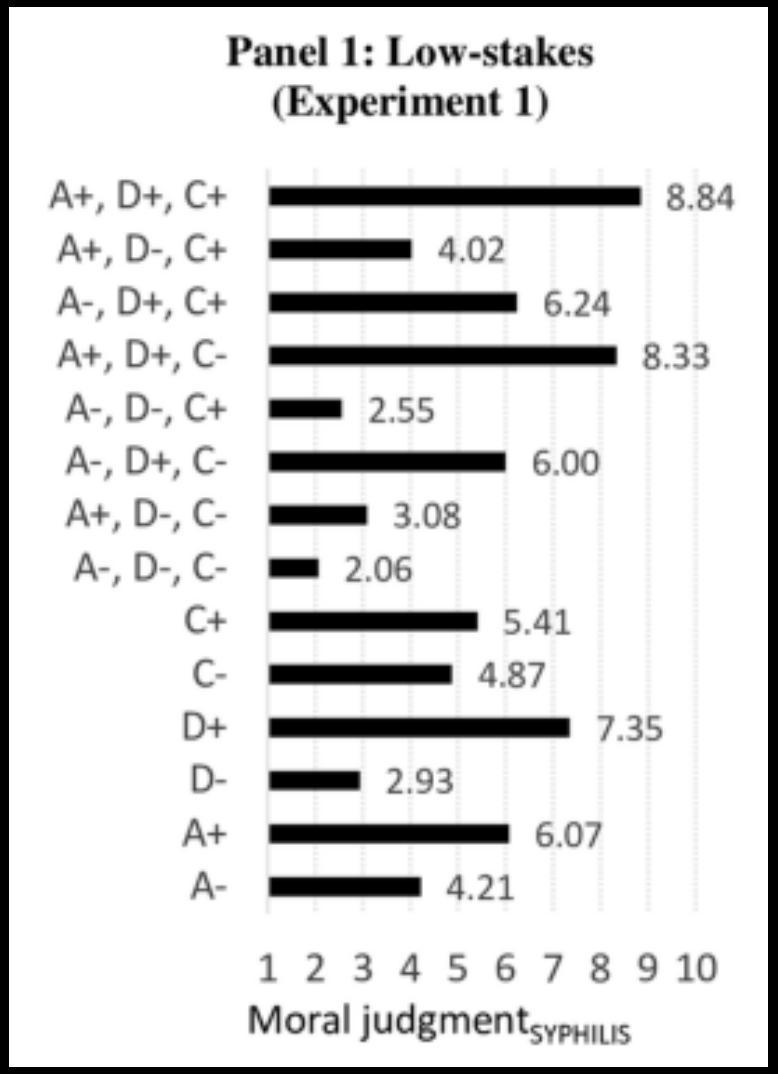
Defined as the generalizability of a study's' results to other situations.

Sacrificial dilemmas fail to display:

1. Experimental realism - Sometimes elicit a humorous response.
2. Mundane realism - Only includes high stakes scenarios.
3. Psychological realism - Likely do not active the psychological processes as real-world moral judgments.



# Our Original Solution




Dubljević, Veljko, Sebastian Sattler, and Eric Racine. 2018. "Deciphering moral intuition: How agents, deeds, and consequences influence moral judgment." *PLOS ONE*

# ADC Model of Moral Judgment

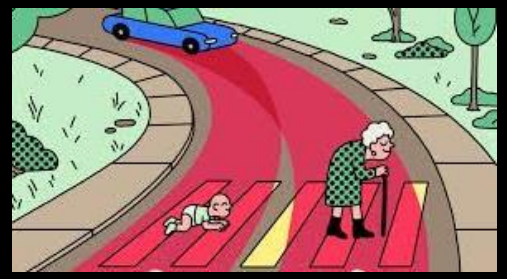
- Incorporates three central pillars of ethical theory into one model.
  - Virtue Ethics - (Cowardice vs. Bravery)
  - Deontology - (Abiding by rule sets)
  - Utilitarianism - (Greater good outcomes)
- Varies each model aspects over positive / negative axis.
- Allows each aspect to compete equally in the domain of moral evaluation.

# Virtual Reality

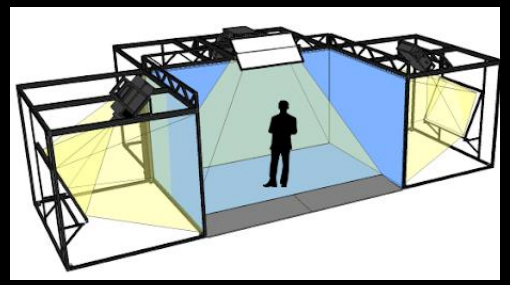
Identical task environments except for manipulated stimuli.

Can safely expose to subjects to a range of situations.

Facilitates the presentation of 3 dimensional audio-visual stimuli.



The same scenario can be displayed across a range of devices.



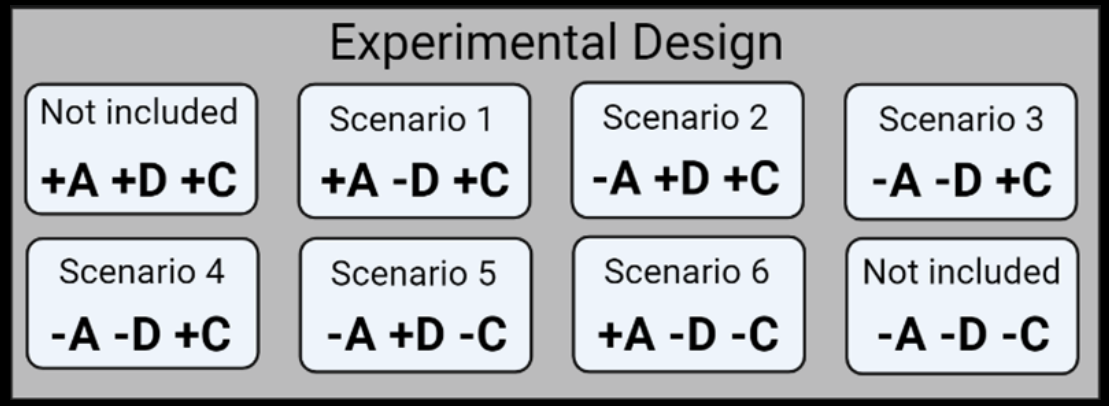
# Experimental Design

We have created six virtual vignettes each consisting of six versions of the same situation.

All versions follow the same structural pattern:

1. Agent displays + / - character trait.
2. Obeys / disobeys some traffic rule.
3. Experiences some vehicle related + / - consequence.

Participants are asked to observe these events and give a moral acceptability rating at the end.




# Content Display

# Conclusions

- Given the inevitability of collisions, for fully autonomous vehicles to be a trusted part of the traffic community, functional ethics settings are necessary.
- Sacrificial dilemma paradigms need to be abandoned for more realistic methodologies.
- ADC model operationalized virtual stimuli:
  1. Includes virtue ethics (removing binary choice)
  2. Offers realism (increasing experimental and mundane realism)
  3. Utilizes VR (increasing psychological realism while still enabling big data collection)