Potential Impact of Autonomous Vehicles on Movement Behaviour:
Winter is Coming!

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UNIVERSITY OF ALBERTA
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Let’s Design an Organism!

Rules

- It requires energy to exist;
- Though available, sources of this energy are difficult to obtain;
- It resides in a harsh and dangerous environment;
- To maintain the existence of its species/kind, it must pass on genetic material via mating with another.

Considerations

- Would you allow it to move around?
- Is energy conservation an issue?
- Can it defend itself?
- Would you allow it to expend energy frivolously?

Me Thinks

1. Our biology constrains our energy expenditure and, thus, our physical activity;
   - We seek energy efficiencies and love progress traps

2. The environment (e.g., availability of food) shapes our physical activity;

3. Therefore, <u>exercise</u>-based interventions will be constrained by our biology and ineffective if environmental and structural factors are not addressed.

Time Spent in Steps per Day

(Tudor-Locke et al., 2011)

- 1-19 (incidental movement)
- 20-39 (sporadic movement)
- 40-59 (purposeful steps)
- 60-79 (slow walking): 16 mins
- 80-99 (medium walking): 8 mins
- 100-119 (brisk walking): 5 mins
- 120+ (all faster locomotion): 2 mins

Approx 8.7 hours

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Transport – A New Way Forward

Andrew Jackson

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Tomorrow will not necessarily be the same as today. This is the dilemma facing transport systems throughout the world as nations consider how best to invest in their transport infrastructure. History tells us a story of how stable the transport system can be for decades, but it also shows how technology can bring a sea change, from the arrival of the bicycle to the train, automobile and airplane. Each in their own way has changed the shape of society. We hear stories in the paper every day of new transport technologies with the potential to bring in the next era of transport. This presentation will consider the uncertainties ahead, the possible changes we might see and what that means today for how best we might prepare for that future.....!

What is an Autonomous Vehicle?

- A vehicle that can sense and navigate its environment with little or no human involvement.

- "…automated vehicles require a driver to be present to resume the driving task under certain conditions, an autonomous vehicle can cope with uncertain situations and a driver is not required."
  https://www.nzta.govt.nz/vehicles/vehicle-types/automated-and-autonomous-vehicles/

- Also known as a driverless car or self-driving car.

Levels of Automation

https://www.2025ad.com/latest/the-levels-of-automation/

← driver — automated vehicle →

0	1	2	3	4	5
The driver constantly performs all aspects of the dynamic driving task. No systems intervene – only those that warn the driver.	The system can take over **either** steering **or** acceleration / deceleration. The driver must continuously carry out the other.	The system takes over **both** steering **and** acceleration / deceleration in a defined use case.	The system takes over both steering and acceleration / deceleration in a defined use case. It is capable of recognizing its limits and notifying the driver.	The driver can hand over **the entire driving task** to the system in a defined use case.	The system can take over the entire dynamic driving **task in all use cases**.
The driver must constantly monitor the drive.	The driver must constantly monitor the drive. He must be ready to resume full control immediately.	The driver must constantly monitor the drive. He must be ready to resume control immediately.	The driver does not need to monitor the drive, but be ready to resume control within a given time frame if the system so requests.	The driver would not be required at all during these cases – neither for monitoring, nor as backup.	The driver is no longer required at all.

TERMINOLOGY

SAE (J3016)	No Automation	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation
VDA*	Driver only	Assisted	Partly automated	Highly automated	Fully automated	Driverless
BASt	Driver only	Assisted	Partially automated	Highly automated	Fully automated	——
NHTSA**	0	1	2	3	3/4	

* used on this platform
** only roughly corresponding with the other taxonomies

Benefits of AVs (Alessandrini et al., 2015)

Table 2. Expected results according to AV penetration in the US.

AV market penetration			
	10%	50%	90%
Lives saved*	1100	9600	21,700
Fewer crashes	211,000	1,880,000	4,220,000
Road safety economic cost savings ($ billion)*	5.5	48.8	109.7
Travel Time Savings (million hours)	756	1680	2772
Fuel saving (millions liters)	386	847	2740

*According to NTHSA, road fatalities in 2012 numbered more than 30,000, and the overall costs of road un-safety were about 300 billion $/year

Source: Eno Center for Transportation, 2013.

Sequential Effect of Automated Driving on Mobility and Society (Milakis, van Arem, & van Wee, 2016; 2017)

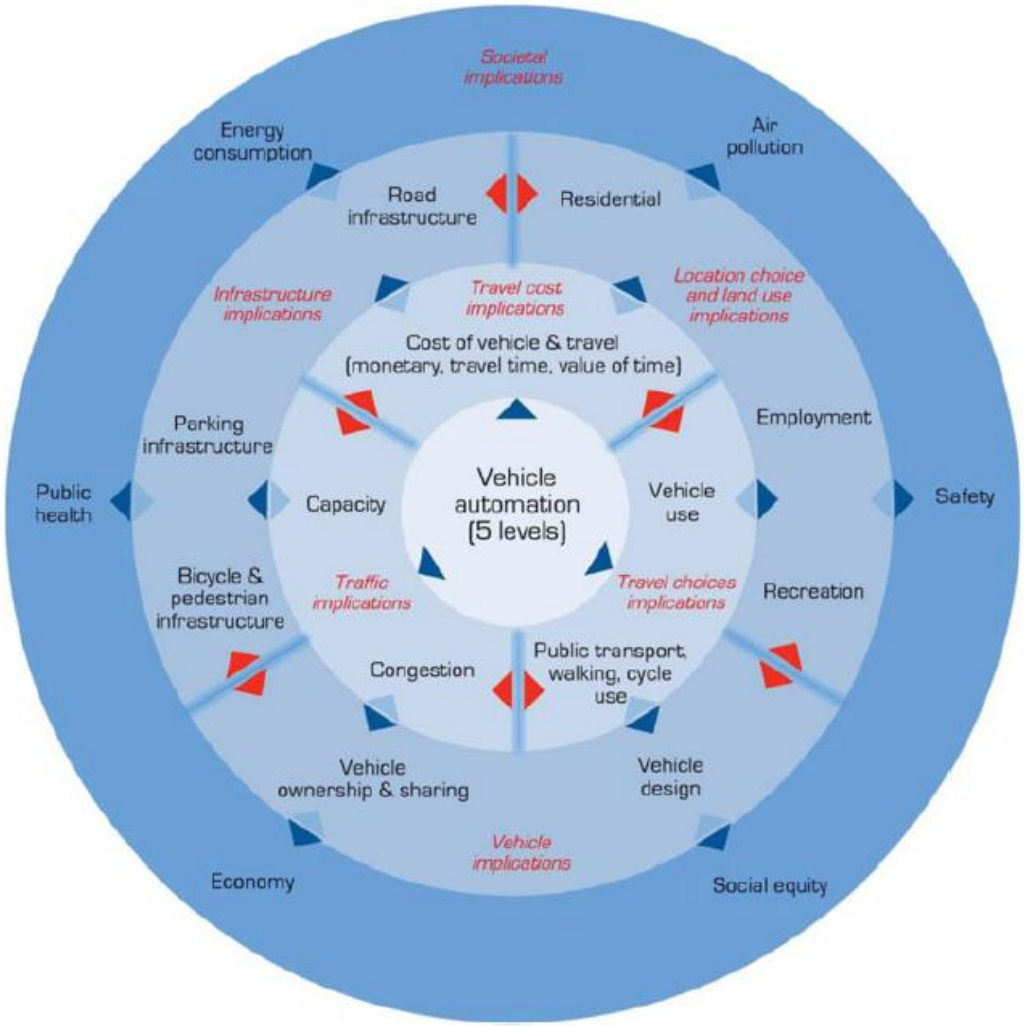

Figure 1. The ripple effect of automated driving.

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Policy and society related implications of automated driving: A review of literature and directions for future research

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ABSTRACT

In this paper, the potential effects of automated driving that are relevant to policy and society are explored, findings discussed in literature about those effects are reviewed and areas for future research are identified. The structure of our review is based on the ripple effect concept, which represents the implications of automated vehicles at three different stages: first-order (traffic, travel cost, and travel choices), second-order (vehicle ownership and sharing, location choices and land use, and transport infrastructure), and third-order (energy consumption, air pollution, safety, social equity, economy, and public health). Our review shows that first-order impacts on road capacity, fuel efficiency, emissions, and accidents risk are expected to be beneficial. The magnitude of these benefits will likely increase with the level of automation and cooperation and with the penetration rate of these systems. The synergistic effects between vehicle automation, sharing, and electrification can multiply these benefits. However, studies confirm that automated vehicles can induce additional travel demand because of more and longer vehicle trips. Potential land use changes have not been included in these estimations about excessive travel demand. Other third-order benefits on safety, economy, public health and social equity still remain unclear. Therefore, the balance between the short-term benefits and long-term impacts of vehicle automation remains an open question.

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Autonomous vehicles: Developing a public health research agenda to frame the future of transportation policy

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ABSTRACT

Recent advancements in autonomous vehicle technology have led to projections that fully autonomous vehicles could define the transportation network within the coming years. In preparation for this disruptive innovation in transportation technology, transportation scholars have started to assess the potential impacts of autonomous vehicles, and transportation policymakers have started to formulate policy recommendations and regulatory guidance concerning their deployment. However, there has been little analysis of the public health implications arising from the widespread adoption of fully autonomous vehicles. We examine these prospective public health impacts—both benefits and harms to individual and population health—and analyze how they can be considered in the development of transportation policy. In this manuscript, we discuss the evolving relationship between technological innovations in transportation and public health, conceptualize automated transportation as a disruptive technology necessitating a public policy response, and define a research agenda to examine the public health implications of autonomous vehicle policy, as seen through existing evidence on road casualties, environmental health, aging populations, non-communicable disease, land use, and labor markets. We conclude that such a public health research agenda would provide a basis to frame autonomous vehicle policies that best support the public's health, realize the United Nations Sustainable Development Goals to ensure healthy lives and create sustainable cities, and provide a basis for public health participation in transportation policy reforms.

Scoping Review of Potential impact of Autonomous Vehicles on Movement Behaviour

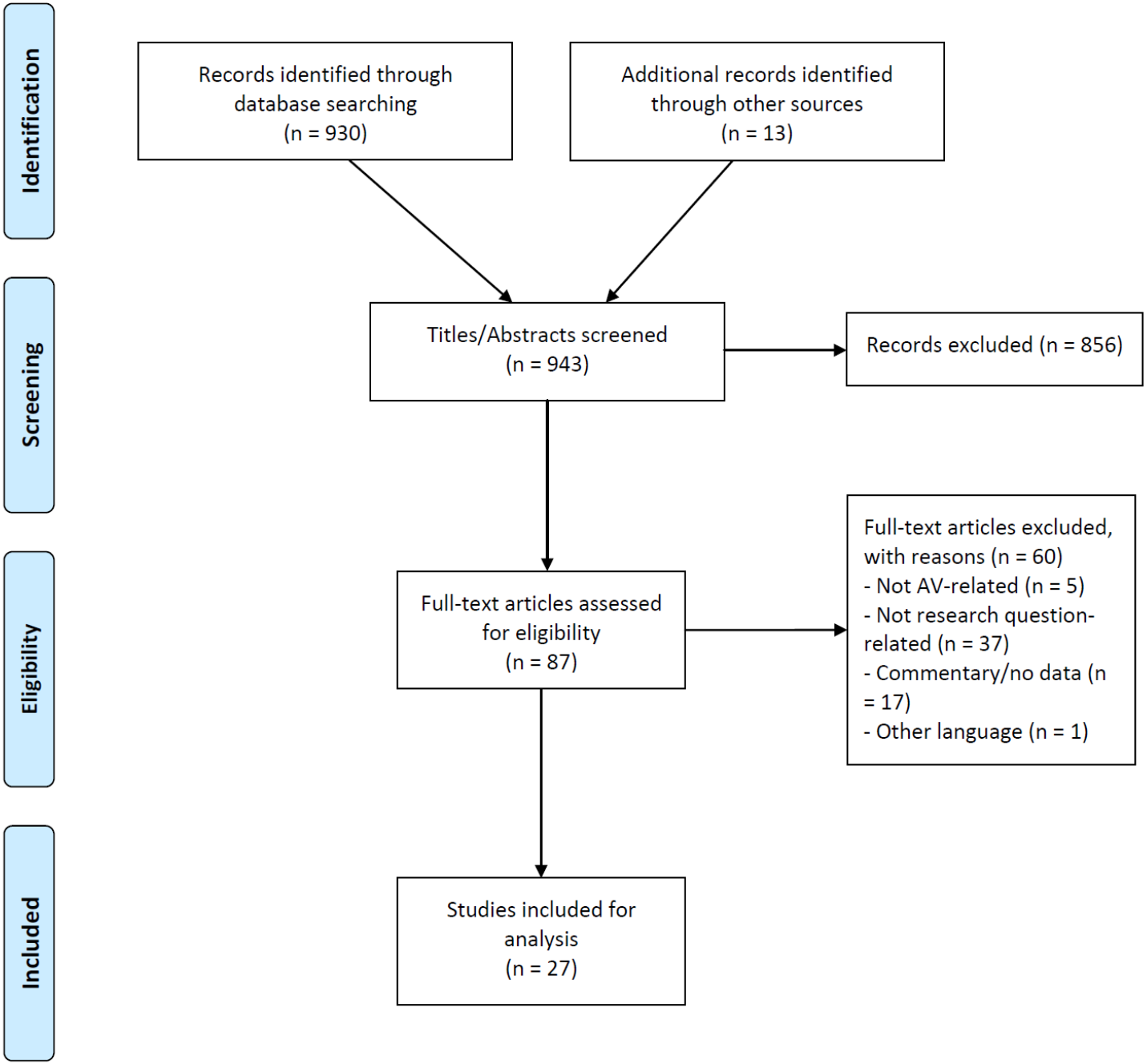
Purpose

- To explore the potential impact of autonomous vehicles (AVs) on movement behaviour (MB) (i.e., physical activity, sedentary behaviour, and sleep).

Research Questions

- What is the potential impact of AVs on:
  1. MB or mode choice (MC);
  2. Beliefs about MB or MC; and/or
  3. The associated environment(s).

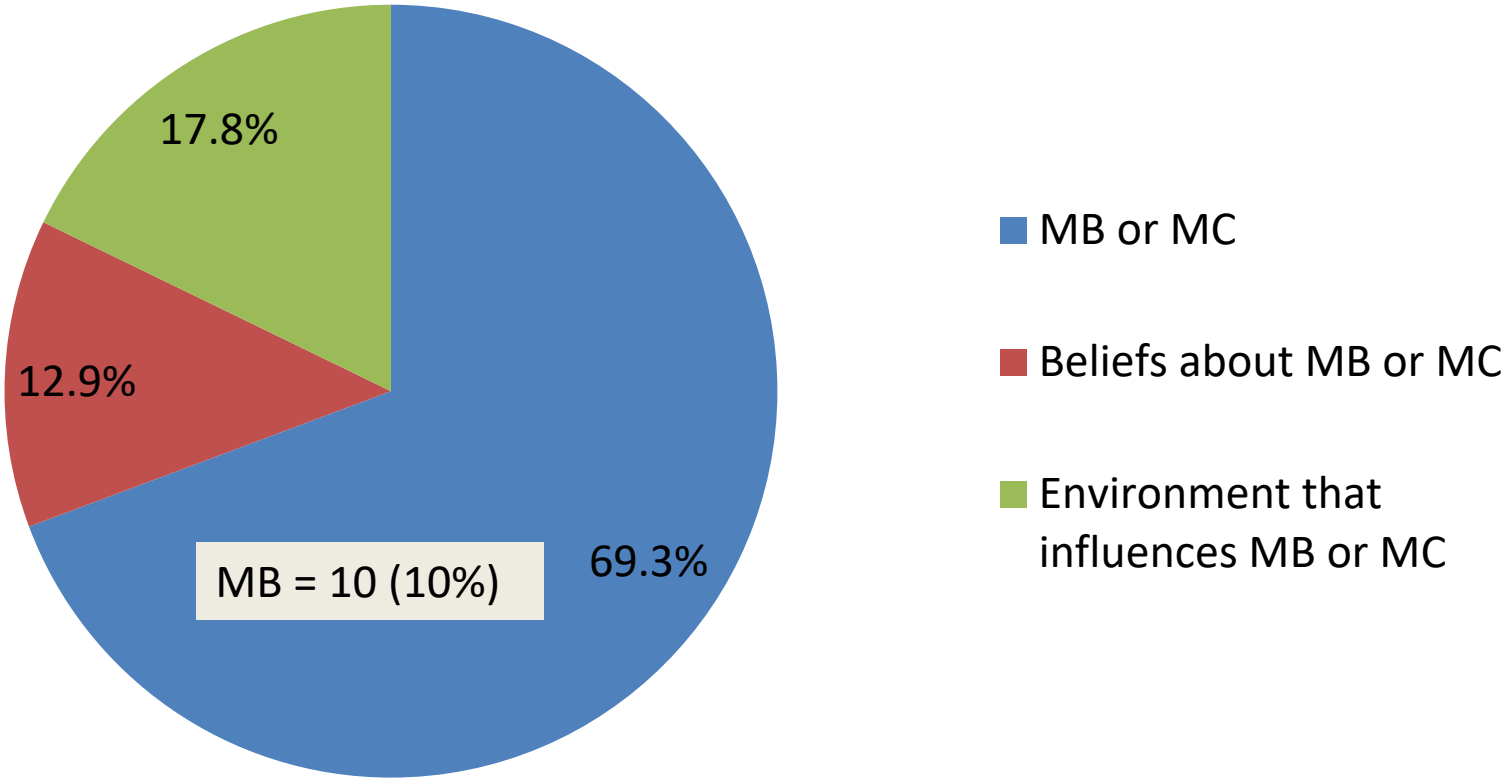
Scoping reviews are more inclusive than other forms of systematic reviews and may include qualitative studies and unpublished works. They are ideal for a body of literature that deals with novel topics or lacks clarity.


Identification
Screening
Eligibility
Included
Records identified through database searching (n = 930)
Additional records identified through other sources (n = 13)
Titles/Abstracts screened (n = 943)
Records excluded (n = 856)
Full-text articles assessed for eligibility (n = 87)
Full-text articles excluded, with reasons (n = 60)
- Not AV-related (n = 5)
- Not research question-related (n = 37)
- Commentary/no data (n = 17)
- Other language (n = 1)
Studies included for analysis (n = 27)

Description of Studies and Findings

		N	%
# of studies		27	
# of findings		101	
Journal discipline			
	Transportation	25	92.6
	Urban planning	2	7.4
Geographic location			
	North America	13	48.1
	Europe	8	29.6
	Other	6	22.3
Study design			
	Simulation/modeling	15	55.6
	Cross-sectional	7	25.9
	Other	5	18.5

Findings by Research Question



Impact on Movement Behaviour

Behavior	$n_{findings}$ (%)
Increased sitting-related behavior	4 (40)
Increased sleeping	3 (30)
Decreased walking	2 (20)
Increased walking	1 (10)

- "Respondents would be able to **use their travel time for working (54%)** and **watching movies or playing games (46%)**"[2].
- "Might go out more, **could nap on the way there**"[3].
- "When AVs are present, **walking can be avoided**"[4].

Impact on Mode Choice

Mode choice	$n_{findings}$ (%)
Increased use of AVs	22 (37.3)
Decreased use of public transportation	12 (20.3)
Increased use of public transportation	8 (13.6)
Decreased use of conventional vehicle	7 (11.9)
Decreased active transportation	5 (8.5)
Decreased use of AVs	3 (5.1)
Increased use of conventional vehicle	1 (1.7)
Increased active transportation	1 (1.7)

- "**AVs** could induce an **increase of travel demand between 3% and 27%**, due to changes in destination choice (i.e. longer trips), **mode choice (i.e. modal shift from public transportation and walking to car)**, and mobility (i.e. more trips)"[1].
- "**Community transit** has a negative effect on walking and cycling as well**, attracting travelers from both these modes**"[5].
- "**One SAV will be able to replace around 14 privately owned vehicles, or even more** when the level of willingness to share is higher." (Zhang, 2015)

Impact on Beliefs about MB or MC

MB: N = 5 (33.3%)

- "I spend a lot of time driving, **it would nice to be able to do other things**."

- "Might **move farther out to get more house** for the money and **be productive and less stressed** on the way to work." (Zmud, 2017)

MC: N = 9 (60%)

- "I am concerned that **resources may be diverted from public transportation or other more affordable options into autonomous vehicles."**

- "I feel there are **other advances we need to put first - transit, walking, biking**. We need to make these a priority." (Lu, 2017)

Impact on Environments that Influence MB or MC

Environment	$n_{findings}$ (%)
Parking	8 (44.4)
Land use in general	7 (38.9)
Sprawl	3 (16.7)

- "The number of cars would decrease, which can create positive outcomes **as less parking is needed**"[7].
- **"The land use impacts of AVs will be substantial"**[8].
- **"Sprawl would be further encouraged"**[7].

Park It!

- The typical automobile is parked for about 95% of its lifetime (Shoup, 2005, *The High Cost of Free Parking*).

- The total area devoted to parking spaces in 41 major cities from around the world was equivalent, on average, to about 31% of the district area (e.g., it is 41% in LA).

Summary (Spence et al., in preparation)

- The majority of studies took place in **Europe or North America** and involved **simulations** or **cross-sectional designs**.

- The bulk of the research examined **impact of AVs on the built environment** (e.g., reduced demand for parking) and/ or **mode choice** (e.g., shift from public transit to shared AVs).

- Almost **no research examined direct influences of AVs on MB**.

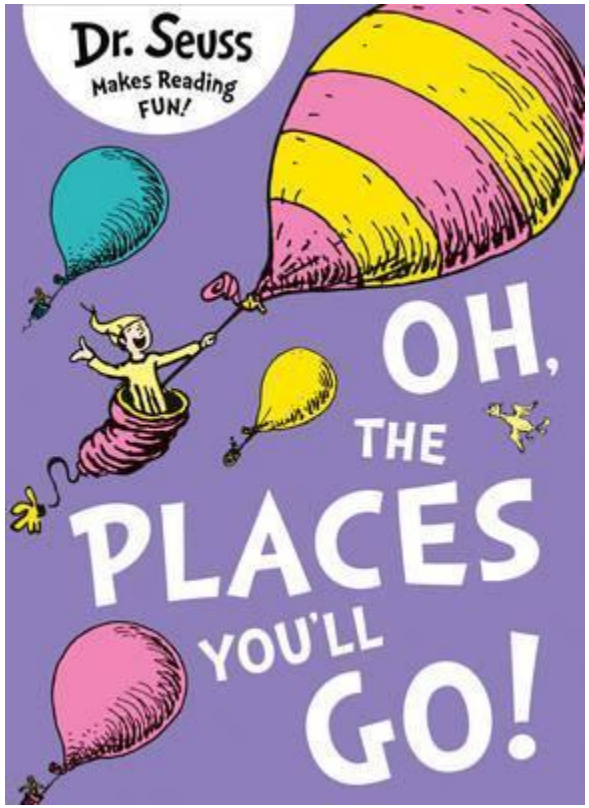
What Moves you?

You have brains in your head.

You have feet in your shoes.

You can steer yourself any direction you choose.

But first, you'll need to overpower the DNA from the primordial ooze!



It’s gotta be FUN or it will not get done!

- **Fufilling**
  - Play, Sports
  - Social engagement
  - Boredom avoidance
  - Self-actualization
- **Useful**
  - Active transportation saves time & money
  - Explore the environment
- **Necessary**
  - Part of the job (e.g., postal workers)
  - Put food on the table

Conclusion

- AVs will have a profound impact on mode choice (1st order ripple) and the built environment (2nd order ripple) of people residing in much of the developed world.

- As a result, the movement behavior of residents in urban areas will likely be altered.
  - **Based on our understanding of FUN, we speculate that people will take fewer steps on a daily basis.**

Implications

- More public health attention and research needs to be focused on potential impacts of autonomous vehicles on movement behaviour.

- If demand for parking decreases, what will cities/communities do with the space?

- Do not confuse the public health message with the exercise message.

Questions?