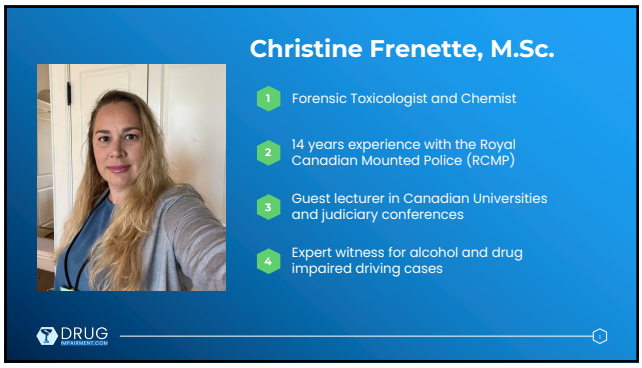
Christine Frenette, M.Sc.
1 Forensic Toxicologist and Chemist
2 14 years experience with the Royal Canadian Mounted Police (RCMP)
3 Guest lecturer in Canadian Universities and judiciary conferences
4 Expert witness for alcohol and drug impaired driving cases
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The Impacts of Alcohol on Driving Abilities
Christine Frenette, M.Sc.

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Disclosures
I, Christine Frenette, have no financial or nonfinancial relationships to disclose.
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Learning Objectives
1
Understand what is driving and necessary faculties required
2
Understand the type of alcohol-impaired driving studies
3
Understand the main skills impacted by alcohol while driving
4
Understand how alcohol impairment and intoxication impact driving
5
Understand the impacts of tolerance and other variables
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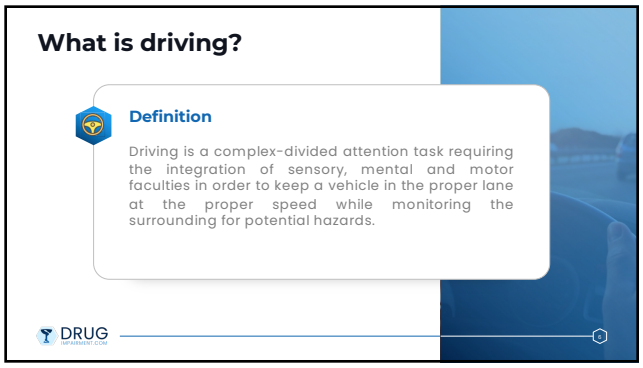
What is driving?
Definition
Driving is a complex-divided attention task requiring the integration of sensory, mental and motor faculties in order to keep a vehicle in the proper lane at the proper speed while monitoring the surrounding for potential hazards.
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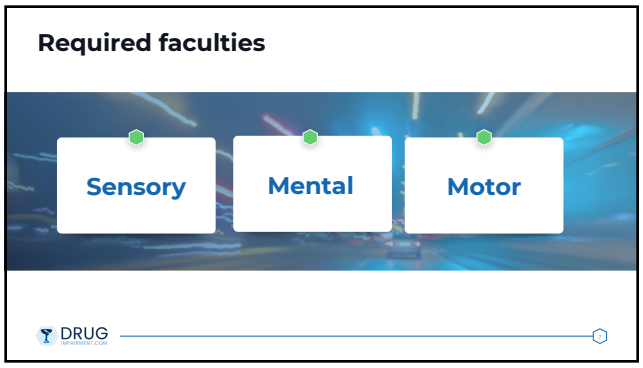
Required faculties
Sensory
Mental
Motor
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Sensory Faculties

Impacting driving
Vision
Hearing

Not impacting driving
Touch
Smell
Taste

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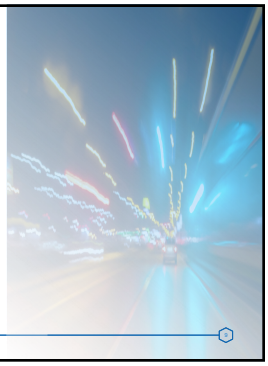
Vision

Acuity
Clarity or sharpness of vision diminished with increasing BAC

Peripheral vision
Ability to see objects outside of the point of fixation. Field of vision is decreasing with increasing BAC

Movement detection
Saccadic eye movement is the ability to detect sudden stimuli.
Affected in both light and heavy drinkers



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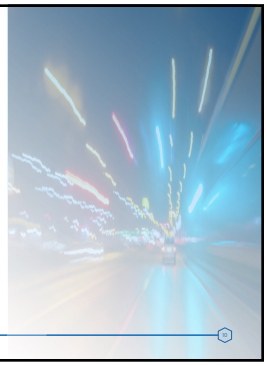
Vision

Luminance
Low luminance negatively impacts driving, with an increase in halo perception and other visual disturbances.

Glare recovery
Significantly increased (0.03 to 0.05%) after low dose of alcohol

Loss of color vision
At high BAC, ability to see color diminishes



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Mental Faculties

Impacting driving
- Divided attention
- Executive functions
- Perception
- Psychomotor skills
- Reaction time
- Vigilance
- Judgement
- Memory

Not directly impacting driving
- Imagination
- Willpower
- Intuition

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Divided Attention and Executive Functions

Divided Attention

Impairment in speed and/or accuracy at BAC ranging between 0.02% to 0.10%.

Executive Functions

Impairment in spatial problem-solving capacity, visual learning and memory at BAC at 0.08%

Specific Literature:
- Breitmeier et al., 2007
- Jongen et al., 2014
- Montisci 2009
- Verster et al., 2009
- Charlton and Starkey, 2015
- Starkey and Charlton, 2014
- Cromer et al., 2010

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Perception and Psychomotor Performance

Perception

Significant deficits in response time at BAC of 0.03% and significant impairment in accuracy at BAC between 0.08% to 0.12%

Psychomotor Performance

Visuomotor processing speed and accuracy were negatively impacted by 0.08%

Specific Literature:
- Breitmeier et al., 2007
- Jongen et al., 2014
- Montisci 2009
- Verster et al., 2009
- Charlton and Starkey, 2015
- Starkey and Charlton, 2014
- Cromer et al., 2010

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Reaction Time and Vigilance

Reaction Time

Reported impairment in choice reaction time with no threshold BAC

Vigilance and Judgement

Vigilance: Paying close and continuous attention, quality or state of alertness or likelihood of detecting
Judgement: Reduced ability to plan, leading to poor decision making

Memory

Short term/working memory, related to attention
E.g. destination, best routes, ability to recognize the location/environment

Literature:
- Hindmarch et al., 1992
- Liguori et al., 1999
- Jongen et al., 2014

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Motor Faculties

Impacting driving
Sitting, Standing, Walking
Balance
Coordination

Not impacting driving
Running
Jumping

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Motor Coordination

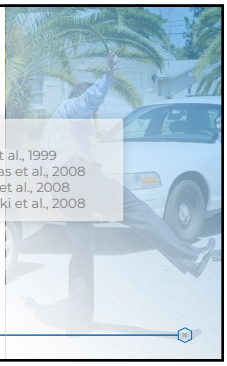
Tracking

Lateral movements are more sensitive to alcohol in bended roads or unexpected hazards

Proportional impairment with BAC

Stopping distances
Lane position
Ability to negotiate curves

Literature:
- Liguori et al., 1999
- Rakauskas et al., 2008
- Fillmore et al., 2008
- Marczinski et al., 2008



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Motor Coordination - Physical Signs

Staggering gait (WAT and OLS)
Significant in an intoxicated state

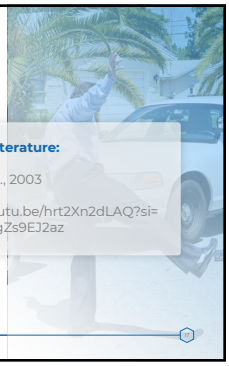
Horizontal Gaze Nystagmus
Most reliable physical test for BAC > 0.1%

Postural ataxia / Body sway
Increases with alcohol consumption (BAC > 0.1%), especially with closed eyes

Slurred speech
Muscles coordination

Links and Literature:

- Citek et al., 2003
- https://youtu.be/hrt2Xn2dLAQ?si=0hO3KKrgZs9EJ2az



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Type of Studies

Laboratory experiment and simulators
Great control, cost-effective, easy to administer, wide variety of tests

Closed-Course and on-road driving
Actual operation of a motor vehicle, more sensitive to impairment

Epidemiological
Assess probability of a driver's involvement in a motor vehicle collision as a function of BAC

***Per Se* Limits**

Per se limits are not entirely based on scientific data and should not be considered as a BAC threshold for impairment or ability to safely operate a motor vehicle.

There is no BAC below which impairment is not present.

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Type of Studies – Laboratory

Simple and Complex Reaction Time

Time required to respond to one or more stimuli and several possible responses

Complex reaction time allows a driver to react quickly and appropriately in emergency situations

Consistently demonstrated at BAC <0.05% or 50 mg%

Divided Attention

Ability of a driver to divide attention between the operation of the motor vehicle and information from the environment (street signs, traffic, hazards, etc.)

When impaired, attention is allocated to fewer aspects of driving

Consistently demonstrated at BAC <0.05% or 50 mg%

Tracking

Ability to maintain position on a roadway

- Mainly performed in simulators
- Standard Deviation of Lane Position (SDLP)

Impairment increases with task complexity and BAC

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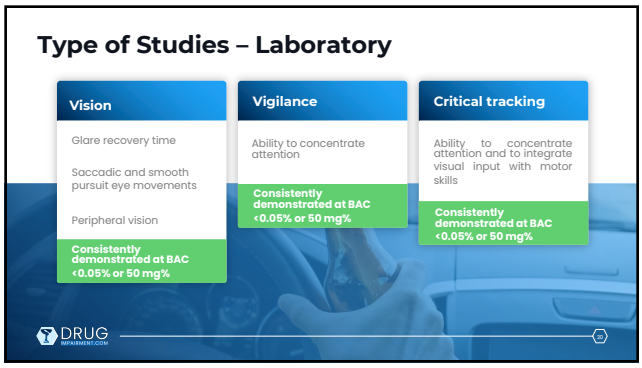
Type of Studies – Laboratory
Vision
Glare recovery time
Saccadic and smooth pursuit eye movements
Peripheral vision
Consistently demonstrated at BAC <0.05% or 50 mg%
Vigilance
Ability to concentrate attention
Consistently demonstrated at BAC <0.05% or 50 mg%
Critical tracking
Ability to concentrate attention and to integrate visual input with motor skills
Consistently demonstrated at BAC <0.05% or 50 mg%
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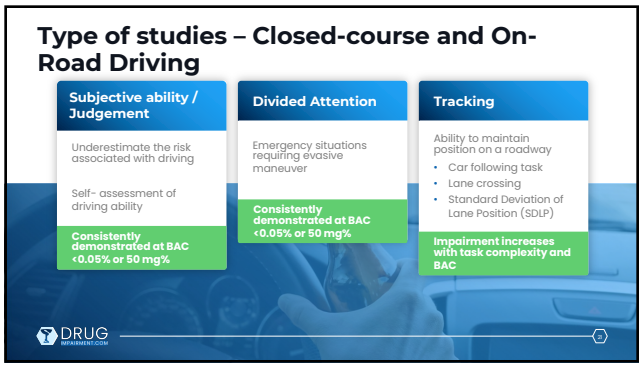
Type of studies – Closed-course and On-Road Driving
Subjective ability / Judgement
Underestimate the risk associated with driving
Self- assessment of driving ability
Consistently demonstrated at BAC <0.05% or 50 mg%
Divided Attention
Emergency situations requiring evasive maneuver
Consistently demonstrated at BAC <0.05% or 50 mg%
Tracking
Ability to maintain position on a roadway
Car following task
Lane crossing
Standard Deviation of Lane Position (SDLP)
Impairment increases with task complexity and BAC
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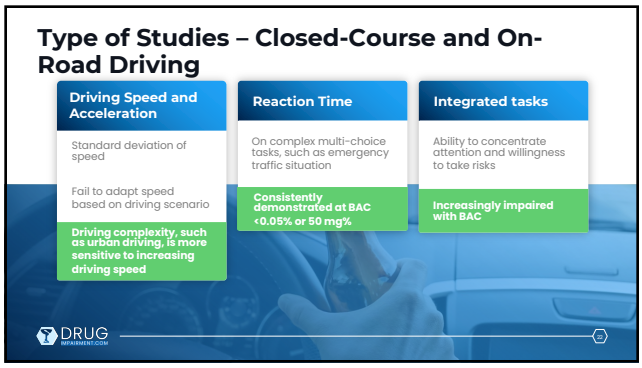
Type of Studies – Closed-Course and On-Road Driving
Driving Speed and Acceleration
Standard deviation of speed
Fail to adapt speed based on driving scenario
Driving complexity, such as urban driving, is more sensitive to increasing driving speed
Reaction Time
On complex multi-choice tasks, such as emergency traffic situation
Consistently demonstrated at BAC <0.05% or 50 mg%
Integrated tasks
Ability to concentrate attention and willingness to take risks
Increasingly impaired with BAC
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Type of Studies – Epidemiological

Grand Rapids (1964)

Most extensive and widely recognized study

Risk of causing a crash:

- 2x at BAC of 0.06%
- 3x at BAC of 0.08%
- 7x at BAC of 0.10%
- 25x at BAC of 0.15%

BAC >0.04% or 40 mg% associated with increased accident rate

Long Beach/Fort Lauderdale (2009)

Exponential increase in crash risk > 0.10%

Zador (2000)

BAC of 0.05 to 0.079% relative risk of driver fatality increase to 3.6 to 17x

Philips (2011)

Causing death or severe injury

- BAC of 0.003 to 0.05% relative risk >10x
- risk of serious injury is 40x at BAC >0.05%

Others

Kruger (2004)
Connor (2004)

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Required skills for safe driving

- Vision
- Judgement and Perception
- Motor coordination
- Reaction time and Multi-tasking

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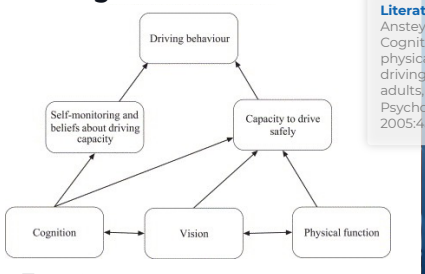
Driving Abilities



Literature:
Anstey KJ et al., Cognitive, sensory and physical factors enabling driving safety in older adults, Clinical Psychology Review, 25(1), 2005:45-65

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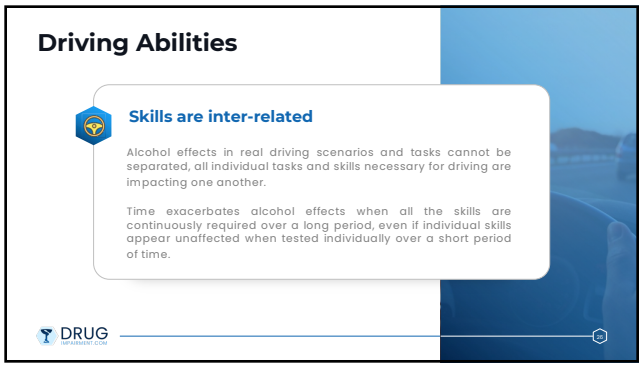
Driving Abilities
Skills are inter-related
Alcohol effects in real driving scenarios and tasks cannot be separated, all individual tasks and skills necessary for driving are impacting one another.
Time exacerbates alcohol effects when all the skills are continuously required over a long period, even if individual skills appear unaffected when tested individually over a short period of time.
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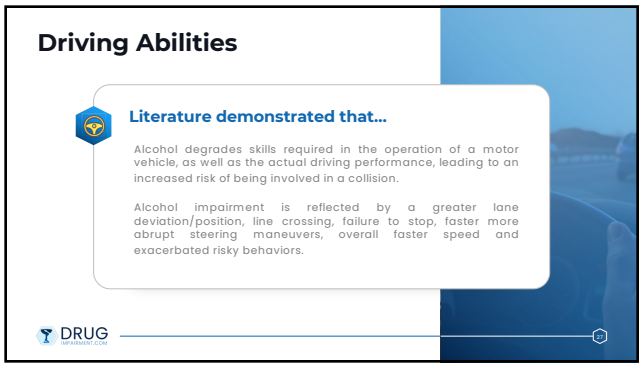
Driving Abilities
Literature demonstrated that...
Alcohol degrades skills required in the operation of a motor vehicle, as well as the actual driving performance, leading to an increased risk of being involved in a collision.
Alcohol impairment is reflected by a greater lane deviation/position, line crossing, failure to stop, faster more abrupt steering maneuvers, overall faster speed and exacerbated risky behaviors.
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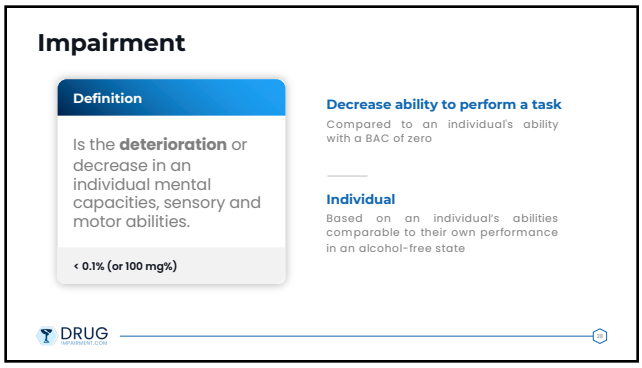
Impairment
Definition
Is the deterioration or decrease in an individual mental capacities, sensory and motor abilities.
< 0.1% (or 100 mg%)
Decrease ability to perform a task
Compared to an individual's ability with a BAC of zero
Individual
Based on an individual's abilities comparable to their own performance in an alcohol-free state
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Intoxication

Definition

Is a more pronounced or **advanced state of impairment** where behavioral and physical outwards signs of alcohol consumption are **visible**.

> 0.1 % (or 100 mg%)

Observable

There are clear, visible indications of impairment state, motor coordination decrement are more obvious (slurred speech, staggering gait, difficulty with balance)

Progressive effects

Intoxication effects will keep increasing with BAC (not able to stand, apathy, etc.) and may lead to respiratory depression

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Signs of Alcohol Consumption

Definition

Presence of observable clues of previous alcohol consumption **not necessarily link to effects**.

Any BAC

Smell of alcohol

On the breath
But… other individuals around or spill on clothing or in vehicle

Red watery eyes

Link to vasodilation
But … eye infection, crying, smoky environment, etc.

Flushed face

Highly correlated to acetaldehyde blood concentration
But… hypertension, physical exertion, heat, etc.

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Tolerance

Definition

Is a diminished response or adaptation of the body after repetitive heavy dose of alcohol over an extended period of time.

Lead to an increased BAC to display signs of alcohol impairment and/or intoxication

Simple vs Complex tasks

Impairment may not be evident during simple repetitive tasks

Impairment from unpredictable complex task (i.e. driving) cannot be compensated

Other Considerations

Mellanby effect:
- Increased self-confidence
- Increased willingness to drive

Scientific support only for simple and predictable tasks at low to moderate BAC.

Similar impairment of psychomotor function regardless of increasing or decreasing phase

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Subject Variables

Definition

Faculties are not impaired equally, and study participants do not demonstrate equal impairment

- Age
- Gender
- Driving Proficiency

No scientific evidence of greater impairment

Age

Young drivers are more likely to undertake risky behavior

Older drivers have diminished psychomotor faculties

Driving Proficiency

Skilled and less-skilled drivers showed marked impairment at BAC of 0.05%

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Other Variables

Definition

Multiple factors impact the ability to operate a motor vehicle even in the absence of alcohol

- Sleep Deprivation
- ADHD

May have an impact

Sleep

Lack of sleep in combination with low level of alcohol markedly worsened abilities, especially under full and monotonous conditions

ADHD

Alcohol might impair the performance of drivers with ADHD in an additive fashion, generally exhibiting poorer driving performance

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Drug Combinations

Definition

Presence of 2 or more drugs, affecting the central nervous system (CNS), in the blood at the same time.

Consumption doesn't have to be simultaneous

There is no drug that eliminates all alcohol effects

THC

When alcohol is mix with THC, there are compounding effects, leading to greater impairment at low BAC and low THC levels

Stimulants

Don't cancel CNS depressant effects

CNS stimulants are acting on different receptors

Both CNS depressant and stimulant effects are present

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Conclusions

- SDLP is the most sensitive measurable test
- Speed adaptation is negatively affected
- HGN is the most sensitive physical test
- Complex multiple choice, reaction time, vision and judgment are the most impacted skills

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Conclusions

- As the BAC increases the magnitude of impairment also increases
- Whether impairment is observable depends upon the complexity of the task
- There is no lower limit of BAC at which impairment does not exist
- Speed and accuracy of complex cognitive processes are adversely affected at low BAC, while highly practice and habitual processes show impairment at higher BAC

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