



Introducing a Bioptic Driving Framework

April 2020



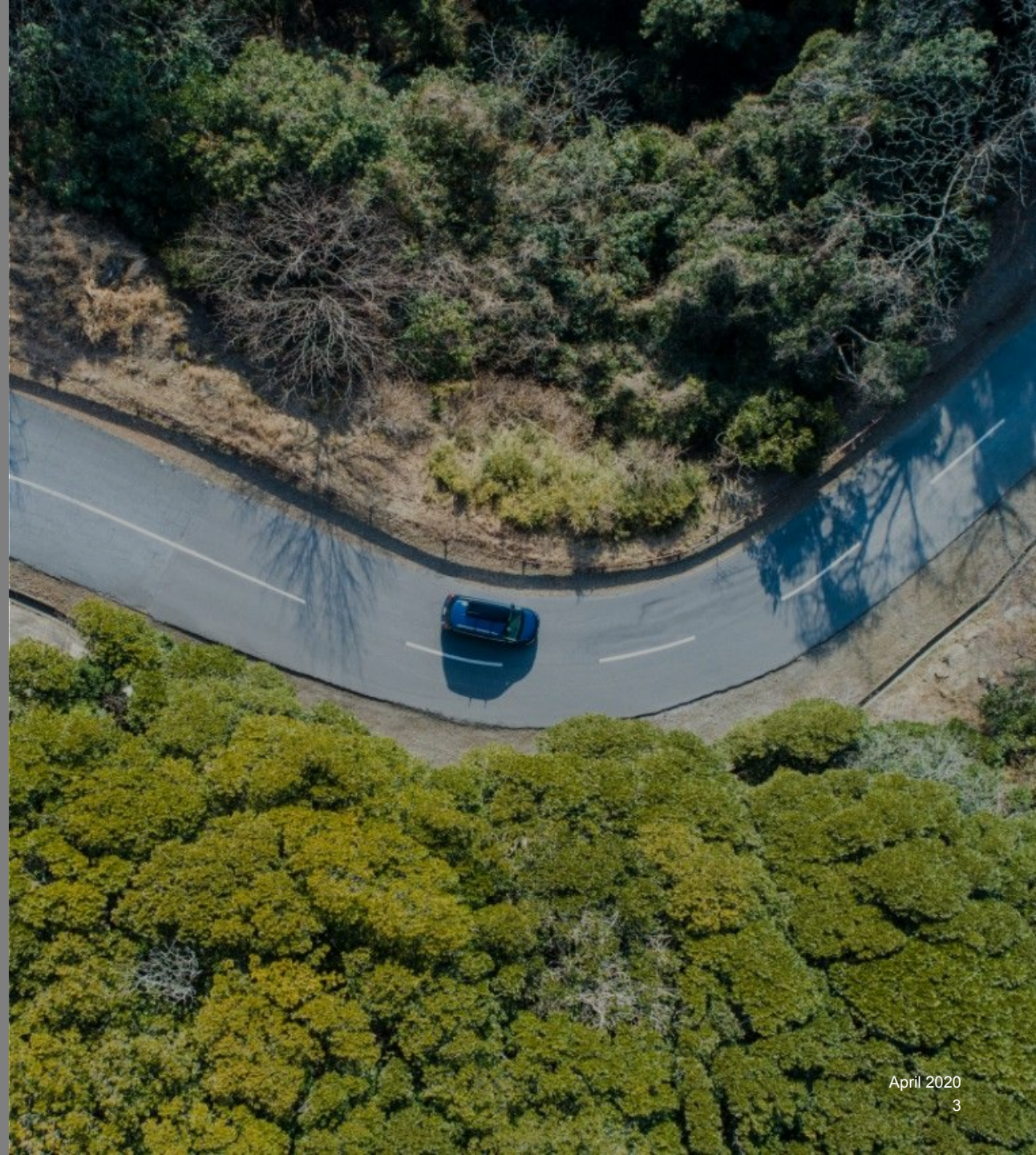
Agenda

Introducing a bioptic driving framework

- 1. Executive summary**
- 2. Bioptic driving and opportunity sizing**
 - Central vision loss & key challenges
 - Driving with bioptic telescopes
 - Bioptic driving opportunity sizing approach
- 3. Current situation and potential benefits**
 - Bioptic driving situation
 - Key benefits from bioptic driving
 - Success stories
- 4. Global case studies and research safety**
 - Lessons learned from global references
 - Safety considerations & research
- 5. Key elements for a bioptic driving framework**

1. Executive summary

A formalised bioptic driving framework has the potential to enable many individuals to pursue more independence through driving, and can be implemented with changes to relevant national guidelines



A bioptic driving framework, shown to be comparably safe, can remove discrimination and enable many individuals to gain independence through driving

Executive Summary

A number of individuals with central vision loss could benefit from bioptic driving

- 1 **Central vision loss presents challenges that reduce independence & wellbeing, e.g. limiting the ability to drive; however, bioptic telescopes can address this issue**
- 2 **The population with central vision loss that could benefit from bioptic driving can be calculated**
 - Estimates can be made for those who live in smaller cities, rural & remote areas, in which not driving is more impactful
 - The population within studying & working age can also be calculated, which could have additional benefits in job seeking and access to higher education

Use of bioptics for driving is limited to a select number of countries, but greater use could deliver many benefits

- 3 **Access to bioptics globally may be due to:**
 - **Unclear regulation** on how bioptic devices apply to vision requirements to drive, resulting in inconsistent assessment of potential bioptic users
 - **Unfamiliarity** amongst eye professionals, resulting in low prescription of bioptics
 - **Low awareness** of the technology amongst potential users
- 4 **Bioptic driving may deliver social & economic benefits:**
 - Increased independence and inclusion for users
 - Better access to employment and educational opportunities
 - Enhanced wellness and healthcare access with potentially reduced system costs

Global cases and research show that a framework increases access and that bioptic driving is comparably safe

- 5 **Key global case** (USA, Canada and Netherlands) **learnings** are that a **uniform bioptic driving framework can increase access to bioptics, ensure consistent assessments** and deliver appropriate training
- 6 Global cases & research support **comparable safety of bioptic driving:**
 - Globally, no jurisdiction which implemented bioptic driving has revoked those privileges
 - Authorities that commissioned research permit bioptic driving
 - Research shows that bioptic drivers' performance is, at maximum, comparable to the general public and, at minimum, comparable to many groups with higher collision rates that are permitted to drive
- 7 Global cases also suggest that a **bioptic driving framework** can include **training** and **multi- disciplinary assessment**

Bioptic driving frameworks have the ability to remove current discrimination, along with education & awareness efforts

Key next steps can include:

- Engaging govt. stakeholders to support a formalised **bioptic driving framework, with clear integration in national guidelines**
- Training and education initiatives to **increase familiarity with bioptics** for eye health, rehabilitation & driving instruction professionals
- Information efforts to **increase awareness about bioptic driving** amongst potential users






Central vision loss presents challenges through reduced independence; bioptic devices can help by enabling driving

① Central vision loss & bioptic driving

Many individuals with central vision loss don't have the opportunity to drive

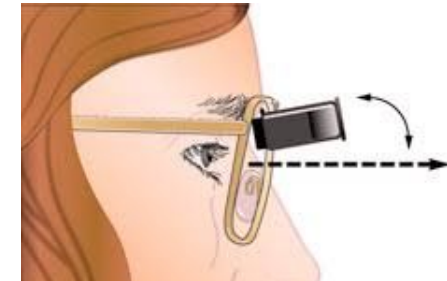
- **Central vision loss (CVL)** is a **loss of discrimination of visual detail** while **other aspects important for driving are intact** (e.g. visual field & contrast sensitivity)
- **Many conditions can cause CLV**, such as diabetic retinopathy, macular & retinal dystrophies and albinism
- Many individuals with low vision **never have the chance to drive or be evaluated for obtaining a licence**

Denial of driving privileges limits independence for individuals with CVL in many ways

-  Commuting to work, university or health-related appointments
-  Doing shopping and groceries alone
-  Picking up children at school and childcare
-  Visiting friends and family and engage in community activities
-  Attending leisure & cultural activities

Bioptic telescopes can help individuals with CVL to drive

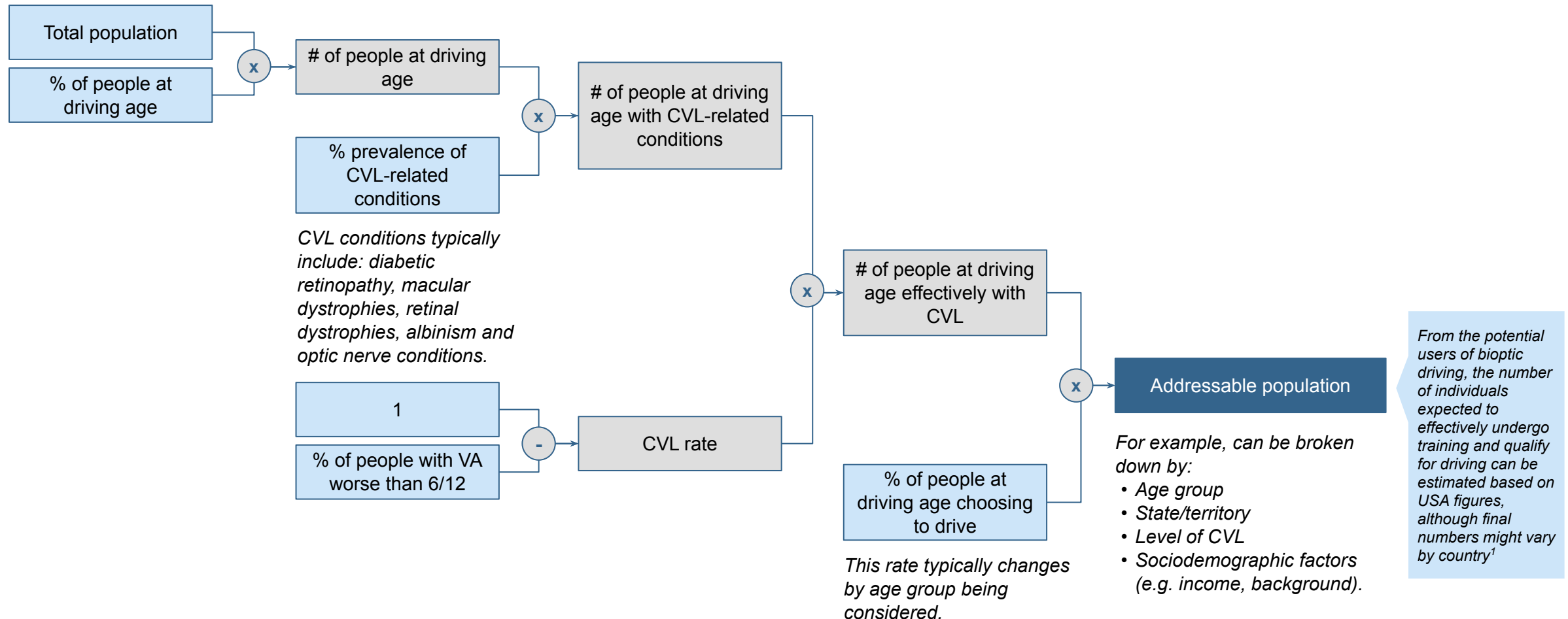
- Bioptics are an assistive device that **allow seeing details at a distance**
- Bioptic devices are **usually mounted at the top of regular glasses**
- Drivers view the road through regular glasses most of the time (wide vision field) and **quickly tilt their heads down to see details through the bioptics (~1 sec)**



The quick head movement is comparable to checking side mirrors, which enable drivers to maintain their attention and peripheral vision.

The number of potential bioptic drivers can be estimated based on prevalence rates of conditions linked to central vision loss

② Potential approach for sizing the bioptic driving opportunity



Currently, access to bioptics is typically limited due to unclear regulations, unfamiliarity and low awareness

3 Bioptic driving globally



Unclear regulation and no standards for bioptic driving

- Global guidelines may allow candidates to meet medical standards and qualify for conditional licences with corrective lenses, but may **not be clear as to how bioptic devices are included**
- Guidelines may or may not have **standards set for bioptic telescopes**
- **As a result, the ruling for bioptic driving is generally open to interpretation** by each state's driver licensing authority, **generating inconsistency in the assessment of potential bioptic users**



Unfamiliarity with bioptics in the eye health community

- Generally, guidelines recommend that potential users of bioptic devices be assessed by eye professionals with expertise in the technology
- However, **most eye health professionals are unfamiliar with bioptics and there are few bioptic experts globally**
- As a result, **few professionals prescribe bioptics** and potential users might need to travel to consult with specialists, making it an expensive and restrictive process



Low awareness amongst potential bioptic users

- **Many individuals with CVL assume that they will never drive** or are told so by their eye health professionals, especially those born with certain medical conditions (e.g. albinism)
- Also, many individuals with CVL **never have a chance to be comprehensively assessed** and demonstrate driving proficiency
- As a result, **most potential users of bioptic devices for driving are unaware of them**

Notable exceptions are USA, Canada and Netherlands, which have formalised bioptic driving frameworks

Non-discriminatory access to driving may deliver social and economic benefits

4 Key potential benefits from bioptic driving



Greater inclusion, non-discrimination

A clear framework for bioptic driving can remove barriers and enable thousands of individuals to be assessed to drive, in line with a social model of disability and non-discrimination principles

"My world has expanded beyond from where I can walk to and from and I can help others too." - Ron K (USA)



Access to employment & education

Those potential bioptic driving users who are of working or studying age, have the potential for **increased access to employment¹ and educational opportunities**, potentially reducing welfare spend for the government

"After not driving for about a full year I regained an Indiana driver's licence and my life began to change. I felt I could return to my old job and be successful. I applied with my old employer and was hired to return to work doing what I have done as a career and what I love doing." - Michael S (USA)



Better transport options

For potential bioptic users living outside major cities, with **limited public transport** options, driving gives them an alternate option for transport, **reducing travel time and increasing ease of movement**

"My driving licence expired and I was fired from my job, because I live in a rural area with no public transportation to work. My life came to a standstill!" - Richard B (USA)

"I live in the country and driving is a must as everything is at least half an hour away and I had no neighbor who could take me or a taxi service to use." - Nina B (USA)



Increased independence & wellness

Being able to drive independently **can increase social connections and access to healthcare & wellness activities**. This is also likely to increase the demand for eye health, occupational therapy, rehabilitation and driving instruction professionals

"It's pretty cool. [Until now] I've always been relying on people." - Tommy Roberts (New Zealand)

"Bioptic driving gives me the ability to take myself to work. It gives me the ability to go grocery shopping when I want to go, not just when someone else is going." - Sharon D (USA)






Improved self-esteem and mental health

Potentially reduced need for medical and social care³, including mental health related costs, as non-drivers typically show higher risk of depression² and increased care needs

"I can't describe how happy and elated I felt afterwards it truly is a dream come true, I have never given up looking for a way to drive since I turned about 17" - Robert Eaves (Australia)

Global cases show that a bioptic driving framework can increase access and standardise assessment and training

5 Lessons learned from global references in bioptic driving

	 USA	 Canada	 Netherlands
Key learnings	<ul style="list-style-type: none"> • Bioptic driving rules vary across states and generate inconsistency, e.g.: <ul style="list-style-type: none"> ◦ Different visual acuity requirements (most states require VA 6/12 to 6/20, but some allow 6/60 up to 3/60, often with restrictions) ◦ Whether bioptics can be used to meet standards and pass tests (some states allow it, some don't and some are unclear) ◦ Restrictions vary for similar cases in different states (e.g. daytime only, max. speed, etc.) 	<ul style="list-style-type: none"> • Rules clearly define that candidates can use bioptics to meet visual acuity criteria • Candidates are holistically assessed by a team of multidisciplinary professionals • A comprehensive bioptic driving program is utilised to enhance training and safety, and includes pre-training on a simulator • Bioptic drivers undergo periodic visual and driving re-evaluations 	<ul style="list-style-type: none"> • A national bioptic driving framework was introduced in 2009 based on USA rules adapted to the Netherlands' reality • Candidates are holistically assessed by a team of multidisciplinary professionals • Specific rules are used to assess night time driving and apply restrictions as needed
Takeaways for new bioptic driving frameworks	<ul style="list-style-type: none"> • A national framework should be introduced to increase consistency in candidate assessment and the application of rules 	<ul style="list-style-type: none"> • Assessment guidelines should clearly define when bioptics can be used to meet criteria • A multidisciplinary approach should be used to holistically assess candidates • A structured bioptic training approach should be used to assess candidates throughout the process, enhancing safety • Periodic reviews ensure bioptic drivers are maintaining visual and driving proficiency 	<ul style="list-style-type: none"> • Countries should draw on international cases to develop national frameworks • A multidisciplinary approach should be used to holistically assess candidates • Restrictions might be introduced based on functional capability and local conditions

Global cases and research support the comparable safety of bioptic driving

6 Safety considerations & research

Bioptic driving has been proven to be comparably safe globally...

40 years of bioptic driving globally

3 countries¹ have bioptic driving frameworks
(including 45 independently regulated USA states)

0 jurisdictions have revoked bioptic driving
(including where driving authorities commissioned safety research)

...with research further supporting its comparable safety



Studies show that bioptic drivers have, at maximum, comparable performance to average population and, at minimum, comparable performance to many groups that have higher collision rates than the average of the population and are permitted to drive (e.g. hearing impairments, cognitive impairment, heart disease, etc.)²



Research also demonstrates that driving with bioptic telescopes does not increase risk of accidents and offenses when a bioptic training program is completed³



Contrary to common misconceptions, the majority of bioptic users continue to employ the device after obtaining their licences⁴⁻⁵



Traditional medical standards such as visual acuity, visual field and contrast sensitivity might not be accurate indicators to predict safety, and factors such as age and driving experience might be more significant^{2-3,6}

“

There really [is] no evidence to support excluding bioptic drivers if one both reads the papers and considers the question logically”⁷

Dr. Eli Peli

Professor of Ophthalmology at Harvard University and Co-Director of Harvard's Mobility Enhancement and Vision Rehabilitation Center of Excellence

Refer to pages 24, 28 and 29 for details on global cases and research about safety

Based on global cases, a bioptic driving framework can include specific training and a multidisciplinary assessment

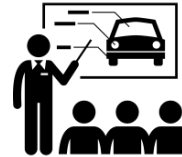
7 Key elements for a bioptic driving framework

Specific bioptic assessment & training:

- **Specify** in national guidelines **that medical standards can be met with** corrective lenses including **bioptic devices** and colour differentiation filters
- **Introduce a bioptic pre-driving program** including practical usage, risk mitigation and commentary driving techniques
- **Create specific bioptic driving practical training** with bioptic driving instructors held in different conditions to inform licence restrictions (e.g. daytime only)
- **Consult** with the bioptic driving and low vision community **to continuously improve assessment & training**

Potential exits along the process:

- **Design the process to allow candidates to exit at different stages**, versus the current situation in which most candidates are held at the eligibility assessment stage
- As a result, **more candidates are expected to progress through the process and have a chance to demonstrate driving proficiency** with bioptics



**Bioptic driving
candidates**

Multidisciplinary candidate assessment:

- Assess candidates with a **team of multidisciplinary professionals** (eye health, rehabilitation, occupational therapy & driving instructor professionals)
- **Multiple professionals to provide inputs in assessment outcomes**, e.g. to inform potential restrictions on licences and use of compensatory supports
- As a result, the **driving fitness assessment decisions are shared amongst professionals** (versus current decisions that are held mainly by eye professionals)

Enhanced periodic review and support:

- Conditional licence **periodic reviews to include functional vision & practical driving** tests for some profiles (e.g. first time, younger or drivers w/ degenerative conditions)
- **Recommend drivers to engage with the bioptic community for peer support** and to complete defensive driving instruction to enhance driving proficiency

2. Bioptic driving and opportunity sizing

Central vision loss presents challenges through reduced independence that can be addressed by bioptic devices, and a number of individuals could benefit from bioptic driving



Central vision loss presents challenges that limit independence and reduce wellbeing

Central vision loss definition and impacts

Central vision loss is a type of low vision with different causes

- CVL¹ is a **loss of discrimination of visual detail** while **other aspects important for driving are intact** (e.g. visual field & contrast sensitivity)
- **Many conditions can cause CVL**, e.g.:
 - Diabetic retinopathy
 - Macular dystrophies (e.g. macular degeneration and Stargardt's disease)
 - Retinal dystrophies
 - Albinism
 - Optic nerve conditions

CVL includes both:

- *Individuals born with certain medical conditions and which are generally stable (e.g. albinism)*
- *Individuals who acquired CVL through a disease or injury, to whom the condition can be stable or progressive (e.g. macular degeneration)*

Many people with central vision loss don't have the opportunity to drive

- **Individuals with low vision have some functional vision**
- However, **vision loss might impact performance** of vocational, recreational and social activities
- Many individuals with low vision **never have the chance to drive or be evaluated for obtaining a licence**
- **As a result, they face challenges**, e.g. job seeking, access to education and **limited independence**

Denial of driving privileges limits independence for individuals with CVL in many ways



Commuting to work, university or health-related appointments



Doing shopping and groceries alone



Picking up children at school and childcare



Visiting friends and family and engage in community activities



Attending leisure & cultural activities

Barriers in mobility are one of the main challenges faced by individuals with central vision loss

Challenges in transportation

“

Few things are more fundamental than the ability to get where one needs to go. Without access to transport, participation in critical activities such as education, employment and health care is difficult, if not impossible”

National People with Disabilities and Carer Council¹

Of individuals with visual disabilities,

17%

reported **transportation difficulties** as the biggest challenge in **obtaining employment**²

Depression in former drivers is higher,

21%

versus 8% in current ones; possible correlation between **stop driving & depression**³

Bioptics are an assistive device that can help to see details at a distance, and are highly valued by users

Bioptic driving

Bioptics can address challenges

- The **challenge for drivers with CVL is needing to get too close to see details clearly**, with less time for adjustments
- **Bioptic telescopes allow drivers with CVL to see targets sooner**, increasing reaction time



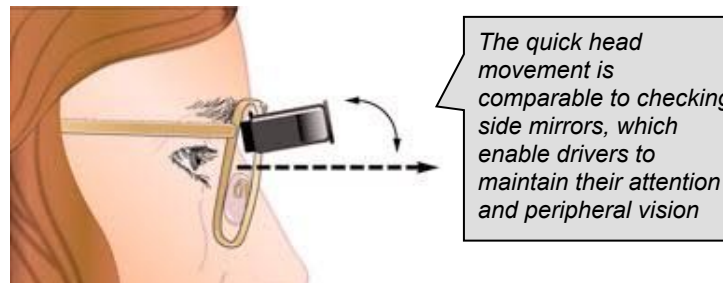
Traffic sign viewed from a 5 degree field of view with 3x galilean bioptic



Traffic sign viewed from a 12 degree field of view with 3x keplerian bioptic

Bioptics are an assistive device

- Bioptic telescopes are an assistive device that **allow seeing details at a distance**
- Bioptic devices are **usually mounted at the top of regular glasses**
- Drivers view the road through regular glasses most of the time (wide vision field) and **quickly tilt their heads down to see details through the bioptics (~1 sec)**



Users greatly value bioptics

- **The majority of bioptic drivers find the telescopes essential** as an assistive device for driving tasks¹:

74%

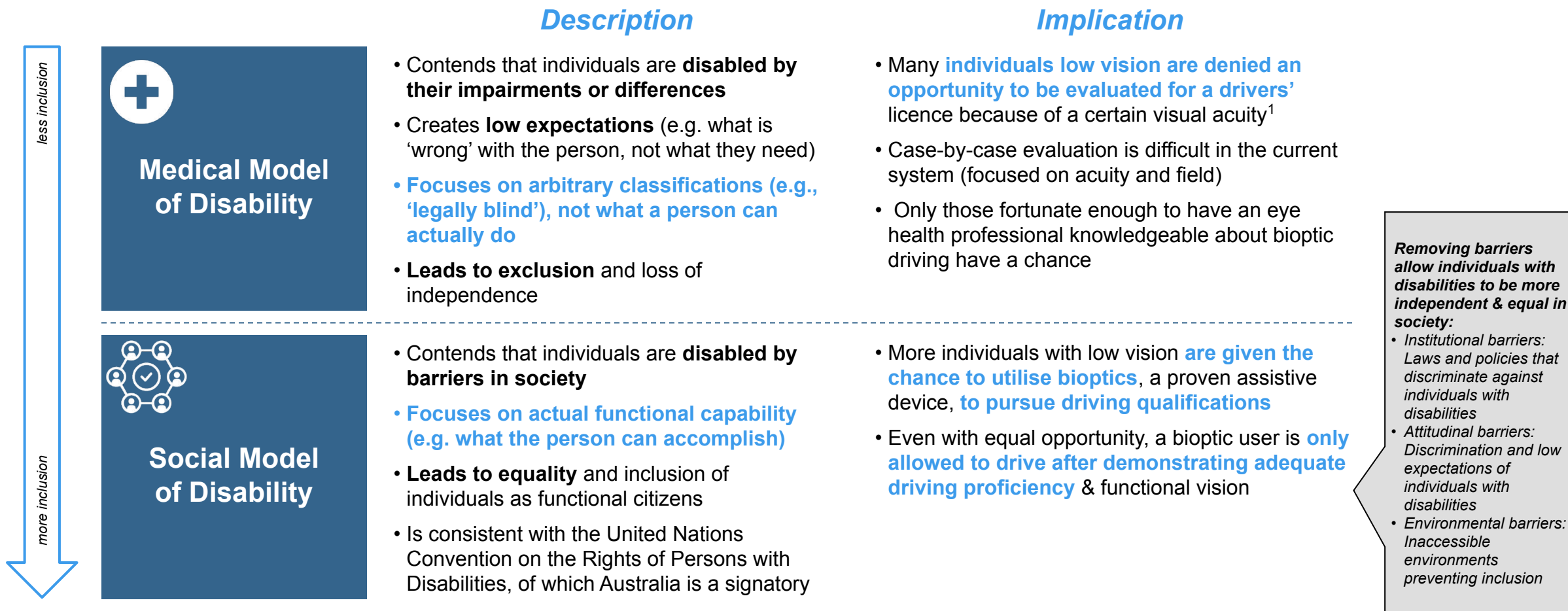
of users rate bioptic telescopes as very helpful²

90%

of user would continue to use it for driving, even if it were not required for their driving licence²

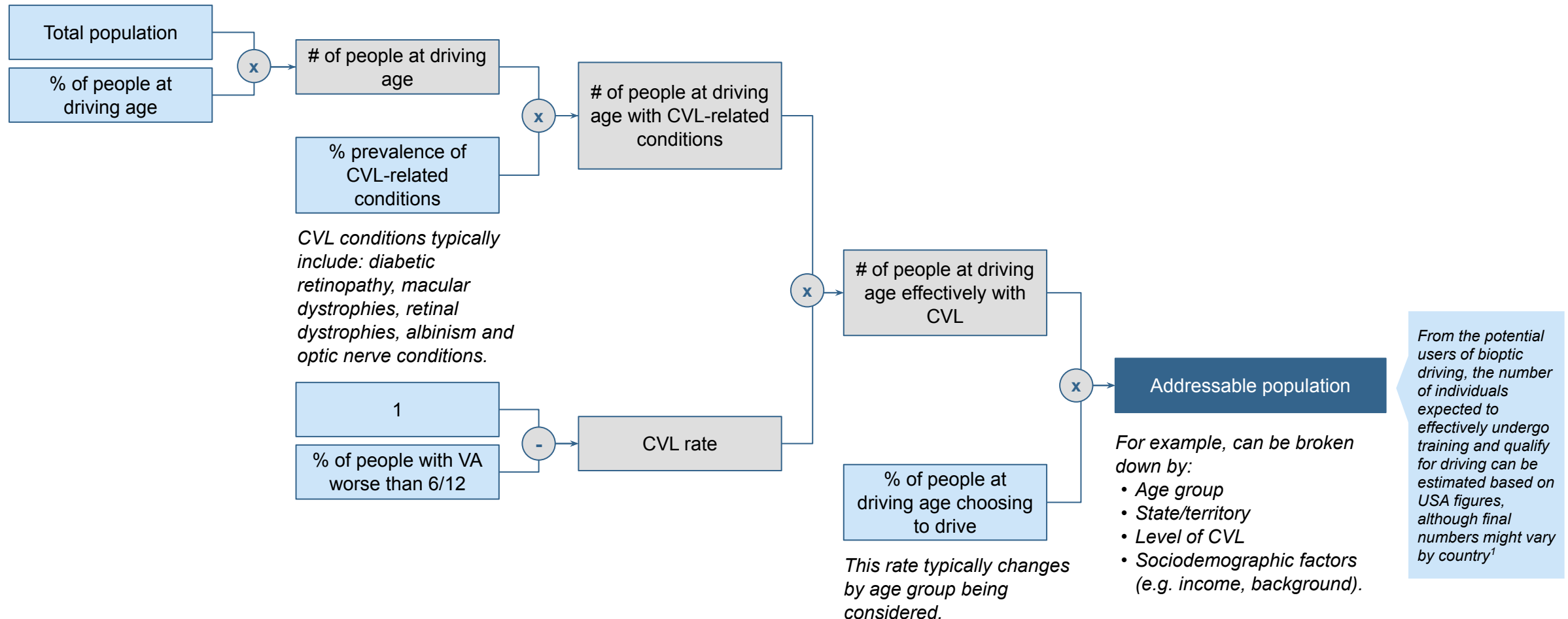
A social model of disability can offer equal opportunity to low vision individuals with driving performance assessments

Medical vs social model of disability



The number of potential bioptic drivers can be estimated based on prevalence rates of conditions linked to central vision loss

Potential approach for sizing the bioptic driving opportunity



3. Current situation and potential benefits

Greater use of bioptics for driving can potentially deliver many benefits as highlighted by users' success stories



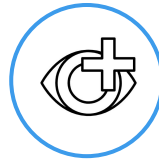
Currently, access to bioptics is typically limited due to unclear regulations, unfamiliarity and low awareness

Bioptic driving globally



Unclear regulation and no standards for bioptic driving

- Global guidelines may allow candidates to meet medical standards and qualify for conditional licences with corrective lenses, but may **not be clear as to how bioptic devices are included**
- Guidelines may or may not have **standards set for bioptic telescopes**
- **As a result, the ruling for bioptic driving is generally open to interpretation** by each state's driver licensing authority, **generating inconsistency in the assessment of potential bioptic users**



Unfamiliarity with bioptics in the eye health community

- Generally, guidelines recommend that potential users of bioptic devices be assessed by eye professionals with expertise in the technology
- However, **most eye health professionals are unfamiliar with bioptics and there are few bioptic experts globally**
- As a result, **few professionals prescribe bioptics** and potential users might need to travel to consult with specialists, making it an expensive and restrictive process



Low awareness amongst potential bioptic users

- **Many individuals with CVL assume that they will never drive** or are told so by their eye health professionals, especially those born with certain medical conditions (e.g. albinism)
- Also, many individuals with CVL **never have a chance to be comprehensively assessed** and demonstrate driving proficiency
- As a result, **most potential users of bioptic devices for driving are unaware of them**

Notable exceptions are USA, Canada and Netherlands, which have formalised bioptic driving frameworks

Enabling individuals with low vision to drive improves their independence, social connection, education & wellness

Social benefits



- **Greater inclusion** will occur as a result of a social model of disability
- A clear framework for bioptic driving can **enable a number of people to be assessed to drive**
- This will lead to **increased Independence in activities of daily living**
- **Greater ease of movement and reduced reliance on public transportation**, particularly important for those living in rural areas or who don't have access to formal or informal care
- **Stronger bonds with friends, family and the local community** due to greater connection



- Driving can **increase access to employment¹ and educational opportunities**
- **A number of potential bioptic driving users are of working or studying age**
- Individuals may also have **easier access to culture** (e.g. museums, theatres, etc.)



- Being able to drive independently can **increase social connections and facilitate access to healthcare & wellness**, for example attending doctors appointments or examinations
- This is particularly important for the **potential bioptic users who live outside major cities**, as they often have limited public transport options and may not live close to family and/or friends
- Increased social connection and greater independence **reduces the risk of depression that may occur as a result of stopping driving²**

Increasing the number of bioptic drivers can also enable economic benefits, such as potential govt. expense reduction

Economic benefits



- Reduced independence can **increase the need for medical care and social services**¹
- Expenditure can include: presentation and diagnostic costs, cost of treatment and monitoring, indirect costs for the treatment of anxiety and depression and the economic costs of rehabilitation¹
- Annual **healthcare sector costs and productivity losses associated with mental health** may be reduced



- Individuals finding employment thanks to bioptic driving could potentially:
 - Save the government in welfare
 - **Increase their revenue** closer to national averages



- A multidisciplinary bioptic driving framework is likely to **increase demand for specialist services**
- These may include:
 - eye health professionals
 - occupational therapists
 - rehabilitation specialists
 - driving instructors

Bioptic driving has the potential of changing lives, as highlighted by success stories from real users

Success stories

Rob thought he would never drive

- Robert Eaves has albinism, nystagmus and astigmatism and **was told all his life that he would never be able to drive**
- In 2016 he read an article about bioptic driving and **travelled from Adelaide to Sydney to meet a specialist**
- Rob underwent training with an OT at the suggestion of his optometrist, as it was thought that this **would teach him the best way to drive with the lens**
- Rob collected his bioptic in November 2016 but only got his licence in July 2018, after **extensive training & retaking his drivers' exam**

Rebecca was always told she wouldn't be able to drive

- Growing up with albinism, Rebecca was **always told that she would be unable to drive**
- She watched her **family and friends get their their licence and gain their independence** while she was still **reliant on public transport and lifts from others**
- Whilst she had known about bioptics in the 1990's it wasn't **until 2018 that Rebecca realised it was something within her reach**
- Working with a doctor in Sydney, Rebecca was prescribed a bioptic and gained her learner's permit in 2018, having **now completed all required training with just the final test and driving assessment remaining**
- Over this journey, Rebecca has **worked closely with a driving instructor and OT team to identify challenges and develop solutions** to ensure that she is a safe driver

Andrew has been driving for forty years

- Andrew **first got his driver's licence in his late teens**
- His vision was described as fine until his early forties when he was **diagnosed with Macular Telangiectasia (Mactel)**
- Whilst this did not cause too many problems at first for Andrew, he did **notice some deterioration in his ability to read things at a distance** (describing it as more annoying than a significant problem)
- Andrew **held a full unrestricted licence until 2019, where he fell just short of the minimum visual acuity**. He obtained a conditional licence with distance restrictions
- Andrew came across Bioptics when researching driving aids and after **several rounds of exams and consultations, he was fitted with a pair of bioptics and now uses them whenever he is driving**




4. Global cases and research safety

International examples show that a clear framework can increase access to bioptic driving and deliver appropriate candidate assessment and training, as well as address safety concerns as highlighted by extensive research



Global bioptic driving frameworks, none of which have been revoked, provide standardised access to bioptics

Lessons learned from global references in bioptic driving

	 USA	 Canada	 Netherlands
Framework in place	✓ <i>Legal in one state in 1971 compared to 45 states in 2020</i>	✓	✓
Bioptics situation	<ul style="list-style-type: none"> Bioptic driving was introduced in the 1970s and currently is regulated in 45 states^{1,2} 	<ul style="list-style-type: none"> Bioptic driving is allowed in Quebec and drivers from Manitoba, Northwest Territories, and Nunavut can also use bioptics to meet medical standards² Minimum VA of 6/15 is required from all drivers³ 	<ul style="list-style-type: none"> Bioptic driving is regulated and includes users with a VA between 6/12 and 6/48²
Key learnings	<ul style="list-style-type: none"> Bioptic driving rules vary across states and generate inconsistency,² e.g.: <ul style="list-style-type: none"> Different visual acuity requirements (most states require VA 6/12 to 6/20, but some allow 6/60 up to 3/60, often with restrictions) Whether bioptics can be used to meet standards and pass tests (some states allow it, some don't and some are unclear) Restrictions vary for similar cases in different states (e.g. daytime only, max. speed, etc.) 	<ul style="list-style-type: none"> Rules clearly define that candidates can use bioptics to meet visual acuity criteria³ Candidates are holistically assessed by a team of multidisciplinary professionals³ A comprehensive bioptic driving program is utilised to enhance training and safety, and includes pre-training on a simulator³ Bioptic drivers undergo periodic visual and driving re-evaluations³ 	<ul style="list-style-type: none"> A national bioptic driving framework was introduced in 2009⁴ based on USA rules adapted to the Netherlands' reality Candidates are holistically assessed by a team of multidisciplinary professionals⁵ Specific rules are used to assess night time driving and apply restrictions as needed
Takeaways for anew bioptic driving framework	<ul style="list-style-type: none"> A national framework should be introduced to increase consistency in candidate assessment and rules application 	<ul style="list-style-type: none"> Assessment guidelines should clearly define when bioptics can be used to meet criteria A multidisciplinary approach should be used to holistically assess candidates A structured bioptic training approach should be used to assess candidates throughout the process, enhancing safety Periodic reviews ensure bioptic drivers are maintaining visual and driving proficiency 	<ul style="list-style-type: none"> Countries should draw on international cases to elaborate national frameworks A multidisciplinary approach should be used to holistically assess candidates Restrictions might be introduced based on functional capability and local conditions

USA was the first country to regulate bioptics and rules vary by state



Case studies deep dives — USA



History

- Bioptic driving was introduced in the USA in the early 1970s¹
- 45 states allow this technology to be used for driving if individuals meet certain requirements²; Utah, Iowa, Connecticut, Maine, and Washington DC do not allow bioptic driving, and Minnesota permits them on a case-by-case basis²



Requirements

- Bioptic driving rules vary across states and generate inconsistency²
- For most unrestricted licences, drivers typically require a 20/40 (6/12) VA with a and 120–140° total visual field at a minimum²
- If using bioptics, a VA of 20/40-20/70 (6/12-6/20) is typically required
- Some states do not allow their use to pass the required driving examination, despite them being permitted for driving
- VA of 20/200 (6/60) and up to 20/400 (3/60) can legally drive in some states (often with restrictions)



Impacts

- Decades ago in the USA it would have been significantly difficult for someone with mild to moderate vision loss to drive
- It is estimated that 8,000-10,000 Americans now use bioptics to drive³
- Although many of these drivers are on restricted licences, they are able to learn how to drive safely with appropriate training and the help of eye health assessors³



Safety

- Almost all (96%) of bioptic drivers are rated as safe to drive by evaluators, with no differences compared to the control group in: pedestrian detection, ratings for scanning, speed, gap judgments, braking, indicator use, or obeying signs/signals⁴
- Previous driving experience is a strong predictor of collision likelihood, however this is consistent with first time drivers overall (especially young drivers)⁵



Key learnings

- **Consistency:** A national framework should be introduced (e.g. in the *Assessing Fitness to Drive* guidelines) to increase consistency in candidate assessment and rules application
- **Restrictions:** Restrictions on drivers (e.g. daytime only or speed restrictions) should consider the local context and impacts on the driver and community

Refer to pages 28-29 for details on safety research

Canada has a structured bioptic driving program with a focus on holistic evaluation and use of multidisciplinary teams



Case studies deep dives — Canada



History

- The INLB Bioptic Driving Program in Canada allows low vision patients to drive safely through the use of a multidisciplinary team approach¹
- The SAAQ allows individuals using bioptics to show that they have developed the 'necessary compensatory skills to drive safely'¹
- The program consists of three stages: preliminary admission, evaluation and rehabilitation¹



Requirements

- In Canada, bioptic use for driving is only permitted for those who live in Quebec, but is allowed to pass the vision test in Manitoba, Northwest Territories, and Nunavut²
- All individuals must meet the minimum VA acuity requirement of 20/50¹ to qualify for driving - even if they will use a bioptic whilst driving²
- There are a number of entry requirements for the INLB Bioptic Driving Program: a minimum VA of 20/200 (6/60) in the better eye, VF ≥ 100X80, stable visual condition and be able to attain a 20/50 (6/15) VA with ≤ 4X bioptic telescope power¹
- Once drivers undergo the program and successfully pass, a recommendation report is provided and the individual must complete the SAAQ driving test to receive their licence¹



Impacts

- The INLB program provides individuals with visual impairments the opportunity to increase their freedom of mobility¹
- The use of a multidisciplinary team allows bioptic drivers to integrate this new-found ease of travel into all aspects of their lives



Safety

- Bioptic drivers in Canada are required to produce an annual visual report and undergo re-evaluation every 2 years to retain their driving licence¹



Key learnings

- **Clear rules:** Assessment guidelines should **clearly define when bioptics can be used** to meet criteria
- **Multidisciplinary assessment:** A **multidisciplinary approach** should be used to properly assess candidates (e.g. ophthalmologists, optometrists, occupational therapists, etc.)
- **Specific training:** A **structured bioptic training** approach should be used to assess candidates throughout the process, enhancing safety (Canada employs a 4-month pre-driving training on a simulator plus a 12 month in-car driving program¹)
- **Periodic reviews:** Reviews are in place to ensure bioptic drivers are maintaining visual and driving proficiency

The Netherlands recently regulated bioptic driving and focus on multidisciplinary and inclusive assessments



Case studies deep dives — Netherlands



History

- Bioptic driving has been legal since 2009 in the Netherlands¹
- This legalisation occurred as a result of a 2006 demonstration project showing favourable patient outcomes after undergoing a bioptic training program²
- This project was based on the range of bioptic driving programs in the USA and adapted accordingly to fit into the Netherlands' driving training and assessment practices³



Requirements

- Based on the favourable results of the 2006 project, bioptic use was legalised in the Netherlands for patients with a VA between 20/40 and 20/160 (6/12 and 6/48)²
- Additional and specific requirements were also set for night time driving²



Impacts

- The pilot project demonstrated that some drivers with impaired vision are able to be trained to drive safely and proficiently using a bioptic telescope on the roads and conditions that are common to a European country³
- As the first bioptic driving project in Europe, there is the potential that this program and approach to formalisation could be used in other countries with similar driving conditions and requirements³



Safety

- The 2006 project showed that a number (25%) of people with moderately reduced visual acuity could be trained to be a proficient and safe driver using a bioptic telescope³
- Bioptic driving in the Netherlands has largely been restricted to the day time
- Studies have shown that some low vision drivers (33%) can drive safely at night with bioptics¹
- A practical fitness to drive test can be used as an accurate predictor of safety for nighttime driving¹



Key learnings

- **Case study:** Countries should draw on international cases to elaborate national frameworks
- **Multidisciplinary assessment:** A multidisciplinary approach should be used to properly assess candidates
 - Research highlight the importance of assessing individuals as a whole (e.g. optical, motor and behavioral issues, driving experience)⁴
 - There should be a focus on an individualised approach to assessment as it is not possible to rely on self-reported driving abilities or VA assessments only⁴
- **Restrictions:** Restrictions might be introduced based on functional capability and local conditions
- **Public awareness:** A uniform public information policy was utilised as a key enabler of bioptic driving in the Netherlands⁴

Authorities that commissioned bioptic driving research continue to permit its use; research shows its comparable safety

Research on bioptic driving safety

Authorities requesting initial research permitted their use following the release of the study findings (e.g. California)

- **Older research on bioptic driving showed higher collision rates for bioptic drivers** than the population average, e.g.:
 - 1.9x higher rates in California¹, according to a 1983 study
 - 1.34x in Texas², according to a 1988 study
 - 1.2x in Illinois³, according to a 1990 study

This slightly higher accident rate has been taken by some to mean that bioptic driving is not safe and should not be permitted. However, there are many groups with higher accident rates than the average population and bioptic driving frameworks in each of these states are still active to this day.
- **Other articles pointed additional challenges** with bioptics safety, e.g. potential hazards⁴, **ring scotoma** (e.g. seeing magnified image projected over central view)⁴⁻⁵, as well as **concerns that patients may use bioptics only to pass tests but not while driving**⁴
- Experts recognise that some of these **studies are dated, have limitations in research design** (including age matching as age is a key risk factor) and **did not involve training programs with technological advances**⁶

Recent research shows the comparable safety levels of bioptics users

- **Recent studies** considering modern technology and countries that recently regulated bioptics **indicate comparable safety for bioptic drivers** when appropriate training is completed, e.g.:
 - **Bioptic drivers have, at maximum, comparable performance to average drivers**⁷
 - **At a minimum, bioptic drivers have similar collision rates to many groups with higher collision rates than the average of the population (e.g. other physical and cognitive medical conditions, and younger drivers) that are permitted to drive:**
 - 1.9x for hearing impaired⁵
 - 18x for that of 16y/o drivers³
 - **Factors such as age and driving experience are more significant to predict accidents**, both for general and bioptic driving populations⁸⁻⁹
 - Bioptic drivers **demonstrate proficient on-road skills** when licenced through a bioptic driving program⁷
 - **Driving with bioptic telescopes doesn't increase citation /accident risk** when a bioptic training program is completed⁸
 - **The fellow eye is able to compensate for ring scotoma**, preserving peripheral vision¹⁰
 - The majority of **bioptic users continue to employ the device after obtaining their licences**¹¹⁻¹²

Experts recognise that bioptic driving should be allowed

“

Thus, one would not like to withhold driving privileges unless absolutely necessary. Interpretation of the *Americans with Disabilities Act* prohibits unjustified limiting of a driving licence as discrimination against the disabled.”

Dr. Eli Peli

Professor of Ophthalmology at Harvard University¹³

“

Drivers with central vision loss who are licenced to drive through a bioptic driving program can display proficient on-road driving skills. This raises questions regarding the validity of denying such drivers a licence without the opportunity to train with a bioptic telescope and undergo on-road evaluation.”

Dr. Joanne Wood

Professor at QUT School of Optometry & Vision Science⁷

1) Janke, *Accident rates of drivers with bioptic telescopic lenses*, J Safety Res (1983) 2) Lippmann et al. *Bioptic telescopic spectacles and driving performance: A study in Texas*, J Vis Impair Blind (1988) 3) Taylor, *Telescopic spectacles for driving: user data satisfaction, preferences and effects in vocational, educational and personal tasks: a study in Illinois*, J Vis Rehab (1990). 4) Fonda, *Bioptic telescopic spectacle is a hazard for operating a motor vehicle*, Arch Ophthalmol (1983). 5) Levin et al. *Driving with a bioptic telescope: an interdisciplinary approach*, Am J Optom Physiol Opt (1975). 6) Owsley, *Driving with bioptic telescopes: organizing a research agenda*, Optom Vis Sci (2012). 7) Wood et al. *Characteristics of on-road driving performance of persons with central vision loss who use bioptic telescopes*, Invest Ophthalmol (2013). 8) Vincent et al. *Driving Performance Among Bioptic Telescope Users with Low Vision Two Years After Obtaining Their Driver's License*, Assistive Technology (2012). 9) Dougherty et al. *Previous driving experience but not vision, is associated with motor vehicle collision rate in bioptic drivers*, Invest Ophthalmol (2015). 10) Bowers et al. *Detection of road hazards when viewing through a bioptic telescope*, Optom Vis Sci. (2018) 11) Bowers et al. *Bioptic Telescopes Meet the Needs of Drivers with Moderate Visual Acuity Loss*, Invest Ophthalmol Vis Sci. (2005). 12) Owsley et al. *Visually impaired drivers who use bioptic telescopes: self-assessed driving skills and agreement with on-road driving evaluation*, Invest Ophthalmol (2014). 13) Interview with Dr. Eli Peli, based on *Driving with low vision: who, where, when, and why*. In: *Albert and Jakobiec's Principles and Practice of Ophthalmology*, manuscript submitted for publication.

The detailed findings from recent research show comparable safety of bioptic drivers and suggest their inclusion

For a comprehensive review of literature by a medical expert, please refer to Harvard University's Prof. Eli Peli's "Driving with Low Vision: Who, Where, When and Why" (2008)¹

Research on bioptic driving safety — detailed findings

Topic	Previous research	Findings (initial dissent on bioptic driving)	More recent research	Findings (towards inclusion of bioptic drivers)
Collision rates	<ul style="list-style-type: none"> Janke (1983) and Clarke (1996) 	<ul style="list-style-type: none"> 1.9x higher collision rates in California, bioptic drivers added a total of 3 collisions to the 1.1 million collisions per year "When corrected for age, gender and invalid licenses, the difference was statistically significant in Clarke but not Janke"¹ 	<ul style="list-style-type: none"> Ivers et al. (1999) 	<ul style="list-style-type: none"> Rate of collisions in hearing impaired were similar to those patients with reduced acuity and higher than the rate previously reported for bioptic drivers
	<ul style="list-style-type: none"> Lippmann et al. (1988) 	<ul style="list-style-type: none"> 1.34x higher collision rates in Texas 	<ul style="list-style-type: none"> Vincent et al. (2012) 	<ul style="list-style-type: none"> The use of bioptics does not increase risk of accidents and offenses when a bioptic training program is completed
	<ul style="list-style-type: none"> Taylor (1990) 	<ul style="list-style-type: none"> 1.2x higher collision rates in Illinois 	<ul style="list-style-type: none"> Dougherty et al. (2015) 	<ul style="list-style-type: none"> Bioptic drivers have a mean rate of 0.13 collisions/yr Previously experienced drivers a lower rate of 0.077 and novice drivers have a rate of 0.20
Bioptic safety	<ul style="list-style-type: none"> Fonda (1983) 	<ul style="list-style-type: none"> Potential hazards with bioptics while driver is looking through telescope 'Blind' areas created in the peripheral field 	<ul style="list-style-type: none"> Wood et al. (2013) 	<ul style="list-style-type: none"> Bioptic drivers demonstrate proficient on-road skills when licenced through a bioptic driving program Bioptic drivers have comparable performance to average drivers
	<ul style="list-style-type: none"> Jose and Owsley (1984) 	<ul style="list-style-type: none"> Bioptics should be used no more than 10% of the driving time 		
Ring scotoma	<ul style="list-style-type: none"> Fonda (1983) and Levin et al. (1975) 	<ul style="list-style-type: none"> Ring scotoma occurs when using bioptics E.g. seeing magnified image projected over central view 	<ul style="list-style-type: none"> Bowers et al. (2018) 	<ul style="list-style-type: none"> The fellow eye is able to compensate for ring scotoma Peripheral vision is preserved
Bioptic use	<ul style="list-style-type: none"> Fonda (1983) 	<ul style="list-style-type: none"> Patients may use bioptics only to pass tests but not while driving 	<ul style="list-style-type: none"> Bowers et al. (2005) and Owsley et al. (2014) 	<ul style="list-style-type: none"> The majority of bioptic users continue to employ bioptic devices after obtaining their licence
Risk factors	<ul style="list-style-type: none"> Levin et al. (1975) 	<ul style="list-style-type: none"> Induced parallax, reduced reaction time, restricted visual field with magnification, and difficult use with mirrors 	<ul style="list-style-type: none"> Vincent et al. (2012) and Dougherty et al. (2015) 	<ul style="list-style-type: none"> Age and driving experience are more significant to predict accidents Both for general and bioptic driving populations

• "This slightly higher accident rate has been taken by some to mean that bioptic driving is not safe and should not be permitted. However, there are many groups with higher accident rates than the average population."¹

• California continues to allow, and never revoked, bioptic driving

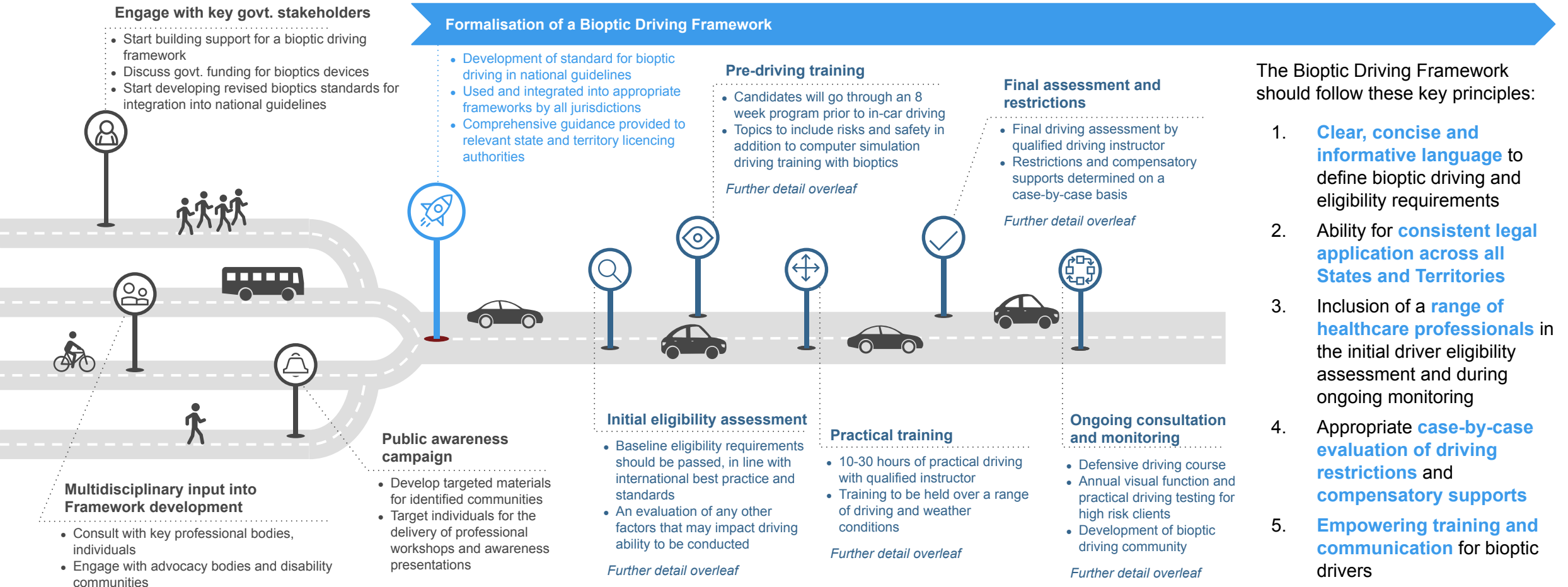
5. Key elements for a bioptic driving framework

A formalised bioptic driving framework should build on global cases and use a multidisciplinary and comprehensive approach to assess candidates



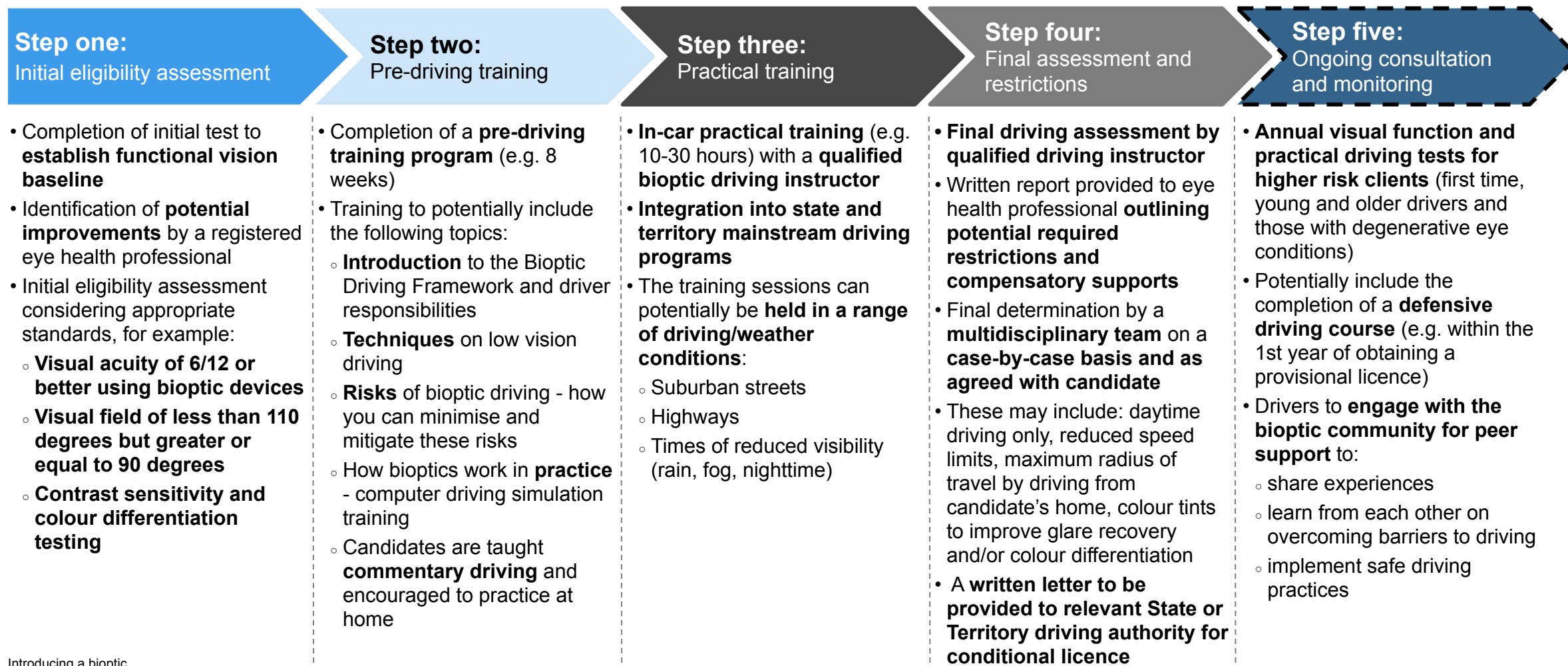
Based on global cases, a bioptic driving framework may include specific training and a multidisciplinary assessment

Potential bioptic driving framework (1/2)



A 5-step approach to assess and licentiate candidates for bioptic driving is proposed based on global examples

Potential bioptic driving framework (2/2)



Appendix

We interviewed experts from Australia and abroad

List of experts interviewed



Dr Sharon Oberstein
Optometrist & Deputy Clinic Director, UNSW Optometry Clinic.

Sharon has worked in private optometric practice and university low vision clinics in South Africa, the United Kingdom and Australia.

Her research area concerns driving with central visual impairment, the topic of her PhD.

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Bradley Williams
Director & Primary Occupational Therapist, Williams OT

Brad provides bioptic driver assessments and training in the Adelaide region of South Australia, opening Williams OT in 2011.

Prior to this, he managed Occupational Therapy driver assessments at the Repatriation General Hospital from 2008 to 2015.



Elizabeth Beals
President, Albinism Fellowship of Australia

Elizabeth has OCA and Nystagmus was diagnosed with Albinism at the age of 40.

Liz is passionate about empowering persons with Albinism and also creating an accurate and positive perspective of Albinism in the media.



Chuck Huss
*C.O.M.S.
Driver Rehabilitation Specialist, State of West Virginia*

Chuck Huss is a Certified Orientation and Mobility Specialist and Driver Rehabilitation Specialist in the United States.

Chuck has completed significant research on the effectiveness and use of bioptics for driving.



Eli Peli, MSc, OD
Professor of Ophthalmology, Harvard Medical School

Prof. Eli Peli specialises in AMD, Mobility Enhancement and Vision Rehabilitation at Harvard.

He is also the Co-Director of Mobility Enhancement & Vision Rehabilitation Center of Excellence.

Our findings are supported by the review of over 60 articles published in scientific journals and other research materials

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Thank you
