The role of Close Pass Indicators in Enhancing Road Safety: Cyclist Perceptions and Driver Behaviour.

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Contents

Abstract.

Cycling is a sustainable activity, advantageous for both the individual and the environment, therefore, encouraging cycling engagement should be an important research endeavour. Close pass events often discourage cycling. A close pass is an overtaking event where a driver leaves insufficient lateral clearance between themselves and a cyclist. This study examines the impact of a close pass indicator (CPI) on close pass events, and the subsequent effect on cyclists perceptions of safety and driver behaviour. A CPI is a device attached to the rear of a bike, acting as a visual indicator to drivers of the appropriate passing distance. This study, based in St Andrews, uses a mixed-methods approach of a cross-sectional and longitudinal design. A combination of surveys and interviews were used to assess participants self-reported perceptions of driving behaviour and cycling safety. Two participant groups were used. Firstly, cyclists engaged in surveys and interviews to examine their perceptions of road safety and driver behaviour and the subsequent effect a CPI has on these factors (Baseline survey N=75; Follow-up survey N=23; Interview N=5). The second participant group were drivers (N=28) who engaged in a survey to examine whether a CPI might impact their road behaviour. Cyclists suggested that the CPI impacted their perceptions of safety, but presented mixed effects. Some participants identified a CPI as beneficial in improving their confidence levels and drivers awareness of them on the roads. Alternatively, some cyclists suggested that a CPI heightened their awareness to the potential dangers on the road, negatively impacting their perceptions of safety. Drivers suggested that a CPI might encourage safer passing and greater visibility of cyclists on the roads. However, drivers currently see themselves as overtaking at safe distances prior to a CPI, therefore, are skeptical of the actual impact. No significant differences were found between CPI conditions. This suggests that whilst individuals do percieve changes, these effects do not translate into statistically significant impacts. The concluded findings suggest that CPIs might be beneficial at an individual level, impacting on specific concerns of cyclists, however, would likely be ineffective as a method of targeting driver behaviour and close pass events on a community-wide scale. In order to create meaningful change in cyclists perceptions of safety and driver behaviour, large-scale modifications are needed in infastructure and driver attitudes. Future studies might examine the observed impacts of CPIs on driver behaviour rather than relying on self-reported measures.

Structure of the Report.

This report has been divided into sections. The first section covers the background and exsisting literature of the study, adressing the aims and the topic of research. The following section highlights the methodologies adopted in the study, covering samples, ethics and materials used.

The results section follows, this unit is divided into qualitative and quantitative data, with a summary extending each section. Finally, the discussion section combines and interprets the findings, suggesting the limitations and the broader applications of the research.

Introduction.

Background.

Cycling is a sustainable mode of transportation. Cycling engagement can ease road congestion leading to a reduction in harmful pollutants like CO^2, beneficial to the environment (Cubbin et al., 2024, p.309). Cycling also benefits the individual, improving both health and cardiovascular fitness (Ege & Krag, 2010, p.1). Therefore, increasing cycling uptake will have widespread positive impacts and makes it a goal worth pursuing.

The experience cyclists have on the road is suggested to affect their willingness to cycle (Cubbin et al., 2024, p.309). In some perspectives, cycling is seen as a dangerous activity, for example 61% of people across the UK consider roads too dangerous to cycle on (Manton et al., 2016, p.139). Whilst cyclists are at a higher risk than most other modes of transportation, when incidents do occur, 87% of the cyclists were not responsible for the initiation of the accident, rather were engaging in safe and legal practices (Johnson et al., 2010, p.1). Therefore, it may be suggestive that cycling itself is not a dangerous behaviour, rather external factors to the activity cause cycling to become hazardous.

A close pass event is one of the most common on-road incidents between cyclists and vehicles (Cubbin et al., 2024, p.308). A close pass event occurs when a vehicle overtakes a cyclist leaving minimal lateral distance between the car and bike (Cubbin et al., 2024, p.308). It is suggested that 38% of road accidents involving drivers and cyclists occur from a close pass (Rubie et al., 2023, p.86). Close pass events can install fear or worry in a cyclist, potentially deterring them from the activity. Therefore, future research should endeavour to reduce the occurrence of close pass events to increase cycling engagement (Rubie et al., 2023, p.86). Much literature examines close pass events, with findings feeding into policies aiming at reducing the number of these incidents. The first section of this report examines the earlier literature on close pass events and the factors which influence their occurrence.

Literature Review.

This literature review expands on the current regulations of passing distances, providing examples of schemes used to reduce close pass events. Whilst beneficial, these regulations do not prevent close passes and therefore, changes in other aspects of the community have been found to impact upon the frequency of close pass events.

Passing distance laws have been implemented in the attempt to reduce close pass events and increase cycling uptake (Lamb et al., 2020, p.275). The Highway Code declares drivers must leave a minimum of 1.5 meters between the cyclist and the car when overtaking, with increasing distance with speeds above 30mph (UK Government, 2023). In the event that this distance cannot be achieved, the driver must wait behind the cyclist until a point of safe clearance occurs (UK Government, 2023). “Operations Close Pass” is an example of a scheme implemented to reduce these close pass incidents. This scheme used police officers, dressed as casual cyclists; the officers stopped vehicles who engaged in close passes to give a road-side education upon their driving behaviour (Lamb et al., 2020, p.278). This scheme had a positive effect, correlating with a 20% reduction in cyclists’ collisions within the area of operation (Lamb et al., 2020, p.278). However, these wide scale passing laws are often costly and potentially encourage a minimum value when overtaking, and thus, might encourage closer passing. Drivers may see this “1.5m” value as the appropriate passing distance when, in reality, this is the least amount of distance that should be maintained (Lamb et al., 2020, p.277). Therefore, passing distance laws may need to be combined with other mitigation strategies to prevent the occurrence of close pass events.

Changes in road infastructure are seen as a potential method to mitigate against close pass events. Hazards in the road (drain covers) often force cyclists into the centre of the road to avoid such hazards. Walker (2007) suggested that for every 1-meter cyclists strayed from the curb, the overtaking distance decreased by 27cm (p.417). Additionally, area's of road narrowing's, such as crossings, often lead to drivers increasing their speed to clear the cyclist prior to the junction (Rubie et al., 2023, p.86). Modifying infrastructure is therefore a potential method to mitigate against close pass events. Increasing the width of the road or the addition of segregated bike lanes are seen as positive ways to increase lateral overtaking distance (Haworth & Schramm, 2014, p.7). Once again however, these methods can be costly, involving large-scale changes of community structures, potentially not viable for implementation in every location (Bao et al., 2017, p.1377).

Literature has highlighted that drivers' attitudes should also be a target alongside structural change. Drivers are suggested to often hold negative attitudes towards cyclists, percieving them as taking up space from being an illegitimate road user (Cubbin et al., 2024, p.310). From this, drivers may behave unfavourably towards cyclists, for example, through reducing their overtaking distances (Davies et al., 1997, p.1). Not only do drivers attitudes impact the frequency of close pass events, but their perception of the cyclists is also an influencing factor. Research by Walker (2007) claims that cyclists who use protective gear (helmets) often experience decreased lateral overtaking distances, attributing this occurrence to drivers percieving the cyclist as safer or more experienced (p.417). Thus, a driver's perception and attitude towards a cyclist, whether conscious or unconscious, is also a determining factor towards close pass events. Furthermore, even with positive attitudes towards cyclists, drivers simply might struggle to interpret a correct passing distance (Haworth & Schramm, 2014, p.4). For example, Nilsson (2000) stated that, when driving, individuals often underestimate a safe passing distance and the gaps they leave at the front of their vehicles (p.1985).

Taken together, close pass events are a concern for cyclists. Whilst restrictions upon passing distances exsist, not all drivers follow these regulations. Research has suggested that potential changes in infastructure or implementation of initiatives to promote passing distances are beneficial, however, these often come with large expenses. Additionally, drivers' attitudes towards cyclists or their ability to interpret a safe passing distance may influence the occurrence of close pass events. From this, future research should target methods which are both in-expensive and impact upon driver behaviour. These methods may help drivers interpret a safe passing distance and boost cyclists' confidence on the roads. Following this, cyclists' safety may be increased leading to improvements in cycling engagement.

This Study.

This is an exploratory study to understand how cyclists' perceptions of safety and driver behaviour might be influenced by a close pass indicator (CPI). A CPI is a physical attachment, placed on the bike wheel, and protrudes from the right-hand side, extending the width of the cyclists. It is brightly coloured and contains a reflector.

Earlier research has assessed the impact of bike attachments into improving road safety. Zhao et al (2024) presented findings of the benefits of ReAR indicators (p.1). This device notifies cyclists on encroaching vehicles, preventing their attention being diverted away from the forward path; from this device, cyclists reported increased positive cycling experiences (Zhao et al., 2024, p.1). Similarly, the "Blaze Laser Light" projects an image of a bike five meters ahead of the rider to alert oncoming drivers of the cyclist's path. This device was shown to improve upon cyclists' perceptions of safety (Transport for London. & Future Thinking., 2015).

To the best of our knowledge, no academic research exsists on the usage of CPIs and their influence upon close pass events. The CPI acts as a visual reminder to drivers on the appropriate passing distances when overtaking, it aims to reduce close pass events. This study provides CPIs to participants and examines the self-reported perceptual changes in their road safety and driver behaviour as a response to the device. These devices aim to address previously stated concerns about mitigating against close pass events, in which, suggested methods are typically very costly (infrastructural change). Therefore, these devices might present an alternative method to reduce close pass events and encourage cycling within a community.

Research Question.

This study will examine the following research question:

"How do close pass indicators enhance percieved road safety of cyclists and influence driver behaviour?"

This study aims to answer the following questions:

1) What are the common cycling experiences in St Andrews?
2) How do close pass indicators impact cyclists perceptions of road safety?
3) How do close pass indicators impact drivers behaviours on the roads?
4) What do drivers and cyclists constitute as a safe passing distance?
5) Does a close pass indicator impact cycling engagement?

Methods.

Study Background and Setting.

The research for this study occurred in St Andrews, a local town in the North-East of Fife, Scotland, *figure one*. St Andrews is a golfing town, home to Scotland's oldest University and has a population of 18,000 (Hole & FitzRoy, 2005, p.2).

Figure 1: Maps showing the study location, St Andrews, North-East Fife, Scotland (Bing, 2025).

St Andrews has multiple cycle paths, bus networks and road systems, its nearest train station is in Leuchars, five miles away from the town (Hole & FitzRoy, 2005, p.3). Cycling has been suggested to be one of the most efficient ways to navigate St Andrews, despite this, the town experiences high congestion levels with low cycling engagement (Barke, 2017, p.3). A survey conducted within the University of St Andrews revealed that in 2017, 12% of university staff members cycled to work and 11.7% of students cycled between lectures (Barke, 2017, p.2). It is suggested that the apparent hazards across St Andrews prevents cycling engagement (Barke, 2017, p.2). The University aligns itself with the UN Sustainability goals, therefore endeavours to encourage sustainable transport to reduce carbon emissions (University of St Andrews, 2024, p.3). Additionally, Transition, University of St Andrews, operates multiple initiatives targetted at increasing cycling safety and engagement. For example, "bike pool" is a bi-weekly event aiding individuals in the maintenance of their bikes (Transition University of St Andrews, 2025). Thus, St Andrews is an area which might benefit from the implementation of CPIs to boost cycling engagement and promote safety.

Study Design and Procedure.

This research uses a mixed-methods design, involving both cross-sectional and longitudinal components across two participant groups. Across both groups, a combination of qualitative and quantitative data is collected. This study uses a within-subjects design assessing the impact of CPI usage. It aims to measure changes in cyclists perceptions of safety, driver awareness and engagement in cycling.

Cyclists.

The first group of participants were local cyclists in St Andrews. These participants engaged in two surveys. The first survey (baseline survey) explored their experiences cycling in St Andrews, their perceptions of safety and driver behaviour and their thoughts on CPIs. Following the completion of the baseline survey, participants bikes were fitted with CPIs. They used the devices on their traditional cycling routes for four weeks. After this period, participants engaged in the second survey (follow-up

survey) to explore how the CPI affected their perceptions of safety and driver behaviour. From the surveys, participants could indicate whether they wished to engage in interviews which allowed them to elaborate on their cycling experiences and the impact a CPI may have.

Drivers.

The second group of participants were local drivers in St Andrews. Drivers engaged in a singular survey (drivers survey) which examined their perceptions of road safety in St Andrews, their concern for cyclists and the potential effects a CPI may have on their driving behaviour.

Materials.

Surveys and Interviews.

All surveys were completed online, created on the software Qualtrics. Participants could access the surveys on their personal devices through links and QR codes.

Baseline survey.

The baseline survey consisted of 28 questions broken down into corresponding sections. The questions examined topics such as current cycling habits, their experiences in St Andrews, perceptions of safety and views on CPIs. The questions consisted of Likert Scales, rating scales and extended answers. Examples of questions included: “Do drivers in St Andrews overtake at safe distances?” and “Do you avoid certain areas when you cycle in St Andrews?”. This survey gave participants a unique ID code which they would use on the subsequent surveys to connect their answers across time.

Follow-up survey.

The follow-up survey consisted of 22 questions broken down into corresponding sections. The questions examined whether the CPIs had impacts upon their cycling experience, perceptions of safety or driver behaviour. The questions consisted of Likert Scales, rating scales and extended answers. Examples of questions included: “How effective do you think a close pass indicator is at improving your safety on the road?” and “Since using the CPI, how would you describe drivers’ awareness of cyclists?”.

Drivers Survey.

The drivers survey had a combination of 19 questions of Likert Scales, rating scales and extended answers. The driver survey was a one-time survey completed anonymously. Examples of the questions included: “Would you feel any differently if all cyclists used close pass indicators when riding?” and “How would you rate your awareness of cyclists while driving?”.

Interviews.

The interviews occurred online through Teams or Zoom, depending on participant preference. The interviews followed a semi-structured design involving 8 questions. Participants were able to explore any points they wished or not answer particular questions. The interview took 20 minutes to complete. The questions in the interview pertained to “How would you describe your overall perception of cyclists safety in St Andrews?” and “How would you describe drivers’ awareness of cyclists on the roads in St Andrews?”.

Close-pass indicators.

This study used a form of close pass indicator known as a horizontal/bike safety flag, *figure two*. These indicators were attached to the rear bike wheel. When cycling, the indicator can be folded outwards, extending the width of the bike. When not in use, the indicator can be collapsed back into the wheel. As this project aims to find inexpensive methods to reduce close pass events, this indicator was selected. This form of CPI costs £10 per device.

Figure 2: Images of the close pass indicators used within this study. The images show the functionality of the CPI, in which it can be extended outwards or folded inwards and it's overall position on a bike.

Participants.

Recruitment.

Participants were recruited through university mailing lists, social media posts and advertisements place around St Andrews. The advertisements provide participants with a QR code, giving them access to the study survey, general information and contacts for inquiries. Participants directly entered their answers into Qualtrics via their personal devices. At the end of the survey participants will be thanked for their time and asked if they would like to engage in interviews to expand on their thoughts.

Baseline Survey.

Ninety participants engaged in the baseline survey. Prior to analysis, 15 participants were removed as they didn't consent to data analysis or complete a sufficient number of questions. This created a total pool of 75 participants. Of these, 45 identified as female, 22 male, 8 as non-binary/third gender and 3 preferred to not answer. 18-29yrs had the largest category with 64 participants, followed by 30-49yrs (9), 16-17yrs (1) and 70+ (1). The majority of participants were students (57), followed by full time employment (2), part time employment (4) and retired (1).

Close pass indicators fitted.

Following from the completion of the baseline survey, 43 close pass indicators were fitted on bikes in St Andrews.

Follow-up survey.

A total of 29 participants who completed the baseline survey engaged in the follow-up survey. Prior to analysis, 6 participants were removed as they didn't consent to data analysis, producing a total of 23 participants. Of these participants, 16 were female, 2 male, 3 identified as non-binary/third gender and 2 preferred to not say. 18-29yrs had the largest age category (20) followed by 30-49yrs (3). The majority of these participants were students (21), followed by full time employment (1) and part time employment (1).

Driver Survey.

A total of 38 participants completed the drivers survey. Prior to analysis, 10 participants were removed as they didn't consent to data analysis or answer a sufficient number of questions. Of the participants, 21 were female, 6 male and 1 preferred not to answer. 18-29yrs had the largest age category (21), followed by 30-49yrs (4), 50-69yrs (2), 17yrs (1). The majority of these participants were students (22), followed by full time employment (6).

Interviews.

A total of 8 interviews were conducted. Prior to analysis, 3 transcripts were removed due to participants request to withdraw from the study or poor engagement with the questions. Participants were aged between 16-29, with 4 males and 1 female.

Ethics.

An ethics application was approved prior to undertaking this research. To address any potential concerns from participants, they were provided with the participant information sheets containing all information relating to the study, and contacts to direct any questions. Participants were informed their involvement was voluntary, having the option to skip over particular questions or withdraw themselves throughout the process. The surveys provided consent statements that participants could agree to prior to answering the questions and the interviews gave participants a consent form to fill out prior to their undertakings.

Data Analysis.

Data from surveys was collected in Qualtrics and exported to Excel. Once in this format, data was anonymised so no participant could be identified. When in Excel, the data was cleaned, removing participants who did not consent to data analysis or answer an appropriate amount of questions. Following this, data was exported to SPSS for further processing, establishing descriptive and inferential statistics. The interviews were recorded, after which were transcribed. The transcripts were exported to NVivo for further analysis.

Results.

Qualatative Analysis.

This study collected a range of qualatative data from both the interviews and extended answer questions within the surveys. Interviews were conducted on cyclists, inquiring about their experiences cycling in St Andrews, close pass events and perceptions of CPIs. Extended answer questions were included in all surveys.

The exploratory design used within this study was Thermatic Analysis. The interviews occurred online, lasting 20 minutes and adopted a semi-structured design. A total of eight questions were given to participants. Participants answered the questions and were able to expand on any thoughts they deemed relevant. The interviews were recorded and following completion were transcribed, the transcripts containing participants verbal responses. The extended answer questions from surveys were collaborated and both these and the interview transcripts were exported to NVivo for subsequent analysis. The researcher familiarized themselves with the transcripts and coded them inductively. Codes were established and were grouped into relevant clusters representing broader themes. For example, “emotions from close pass events” and “frequency of close pass events” were grouped under the theme of “Impact of Close Pass Events”. These themes were compared to the origional transcripts and modified to better encompass the data. Each defined theme was then linked to the research question and discussed within the context of the literature. To protect participants anonymity, all names used within this study are pseudonyms.

Theme One: Cycling experience in St Andrews.

Cyclists reflected on their experiences in St Andrews, highlighting the importance of cycling and their perceptions of safety. Participants regarded cycling as an important activity for themselves, in which it often acts as their primary mode of transportation. Due to this relevance in their lives, the safety of such activity is heavily important. Taken together, St Andrews was described as a relatively safe town to cycle in, especially in comparison with other locations participants have cycled, with specific reference to cities.

- “my main mode of transportation” – *Taylor.*
- “my experience in St Andrews is significantly safer than anywhere else that I have ridden on a bike” – *Baseline survey.*

Whilst St Andrews is understood as a relatively safe location to cycle, participants highlighted that they were still concerned about their safety. Participants often identified their experiences as “inconsistent” and hard to predict, this making it difficult to encompass their perception of safety.

- “hit or miss” – *Lucian*.

Participants elaborated on the specific concerns which impacted their cycling experience and perceptions of safety. The first concern raised was in heavy traffic areas, such as in the towns centre (Market Street, North Street). In these areas cars rarely pay attention to cyclists and the structural design of the streets makes navigating on a bike difficult. The vast quantities of parked cars can reduce cyclists sight lines and force them to move into the centre of the road to avoid the hazards. The second concern was pedestrians, who often step into the road with little consideration for their surroundings. As a result of these hazards, participants noted that they frequently avoid cycling in these areas.

- “People just stepping out sometimes onto the road in front of you and not looking before they cross” – *Noah*.

Taken together, participants across this study note that cycling is an important activity for them, allowing them to navigate around the town. Whilst St Andrews is regarded as relatively safe for cycling, especially compared to other locations participants have ventured, the associated risks in the town result in cyclists avoiding certain areas. This highlights that St Andrews might be a good study location for initiatives aimed at improving cyclists’ safety. The current hazards in the town negatively impact cycling experience and the scope of which participants can travel sustainably on their bikes.

Theme Two: The impact of Close Pass Events.

To tie into the research question, a main hazard impacting participants perceptions of safety, was their experiences of close pass events in St Andrews. Participants report experiencing these events often. When discussing close pass events, participants use terms such as “many” and “tonne” which showcase the common occurrence of these incidents. The frequency of such events, had led participants to express a sense of familiarity, stating that they had grown use to them and they no longer come as a surprise.

- “Many times, actually, one was really close it was about… a hands reach away from the handlebars” – *Lucian.*
- “I’ve had a tonne of experience where people just pass me really nearby” – *Mira.*

As a result of these experiences, participants highlight the negative effect they have on them. The events evoke distress and uneasy feelings in the participants, of which it can “take a minute to recover” from such.

- “so frightening” – *Mira.*
- “upset” – *Taylor.*

As a result of these distressing feelings, participants have described how they alter their behaviour in attempts to avoid close pass events. For example, increasing their speeds on roads to prevent cars from overtaking or avoiding the area’s where they have previously experienced a close pass event.

- “I just would never cycle down that road ever” – *Mira.*

Participants were asked to elaborate on the causes of close pass events. Research by Walker (2007), stated that for every 1-meter cyclists strayed from the curb, the overtaking distance decreased by 27cm (p.417). As previously mentioned, the abundance of parked cars and pedestrians often force cyclists into the centre of the roads, increasing the likelihood of a close pass event.

Additionally, participants suggested that drivers awareness might contribute to the occurrence of a close pass event. Drivers in St Andrews are described as not “being aware” of cyclists, often observing for other hazards such as cars and simply ignoring cyclists they do see. Cyclists describe themselves as being invisible on the roads.

- “a lot of them just appear to be ignoring cyclists” – *Lucian.*
- “[drivers] sort of look around for other cars as oppose to cyclists…and make sure they don’t hit other cars but they will not necessarily give consideration to cyclists” – *Lucian.*
- “I just don’t feel like I’m visible” – *Mira.*

Drivers are also discussed regarding their attitudes towards cyclists. Participants commonly use the term “ignore” when describing drivers attitudes towards them, potentially viewing them as illegitimate road users. Drivers are described as becoming angered when faced with cyclists and often direct hostility towards them.

- “cyclists as in a lots of them feel that there inconvenient and perhaps they shouldn’t be on the roads” – *Lucian.*
- “cars are typically more impatient when stuck behind a cyclists” – *Jordan.*

Cubbin et al (2024) stated that drivers commonly hold negative attitudes towards cyclists, viewing them as illegitimate road users (p.310). From this, drivers can often engage in close passes, potentially providing a reason for the frequency of close pass events experienced in St Andrews.

The participants in the drivers survey provided an opposing argument. Drivers in St Andrews highlight that cyclists are not visible on the roads. Rather than “ignoring” the cyclists, drivers state that they simply cannot see them, suggesting that they commonly wear dark colours and use dim lights. This implies a different perspective between cyclists and drivers in which drivers might not hold negative attitudes toward cyclists, rather their behaviour is based off cyclists invisibility. Enhancing this visibility might change this behaviour.

Taken together, cyclists identify close pass events as a frequently occuring concern in St Andrews. These events can create feelings of distress and impact participants engagement in cycling. Participants suggested that close pass events might occur from hazards on the roads (pedestrians, parked cars) or drivers attitudes towards them. Drivers suggested that their behaviour is influenced by cyclists visibility, in which cyclists are not visible enough in the town. This suggests that CPIs may have a positive effect by enhancing cyclists visibility on the road as they have an additional reflector and are brightly coloured, reducing the number of close pass events.

Theme Three: Close Pass Indicators: Their positive contributions.

Participants discussed their opinions of close pass indicators and whether they think they would provide value in St Andrews. Participants highlighted that CPIs are not common, therefore, were unsure of the exact effect they might have, thus, speculated about the potential benefits. Prior to CPI usage, these devices were regarded positively, potentially enhancing cyclists safety and drivers awareness in St Andrews.

- “the presence of CPIs can provide reassurance that their safety is being prioritized, potentially increasing confidence whilst riding” – *Baseline Survey.*
- “It would give a sense of safety and confidence knowing that there is a standard distance to be followed” – *Baseline Survey.*

CPIs are suggested to act as a “psychological safety net” in which cyclists believe their safety is a priority and not something to be “ignored” by drivers. This might lead to increased confidence levels, encouraging cycling in areas once believe to be hazardous. CPIs are also suggested to potentially alter driver behaviour. They act as a visual reminder to drivers of their passing distances, encouraging a wide berth when overtaking. Additionally, from the bright colour and reflector, they might increase cyclists visibility towards drivers, further boosting passing distances. From this, the frequency of close pass events might be reduced.

- “good for visibility since they are brightly coloured with a reflector” – *Drivers survey.*

- "I think they would influence a further gap" – *Baseline survey.*

Participants provided some insights into their experiences after using the CPI. Participants reported that they increased their confidence and perceptions of safety, allowing them to cycle more on the roads, especially at night.

- "At night I feel safer" – *Follow-up survey.*

Taken together, participants, prior to CPI usage, did regard CPIs as positive, in which they might encourage cyclists confidence, increase their visibility and make drivers aware of their passing distances. After usage, participants did report positive impacts on their cycling experience. Therefore, they may be a positive addition in St Andrews, influencing both cyclists and drivers.

Theme Four: Close Pass Indicators: Their Limitations.

Whilst CPIs were regarded positively, they were suggested to not be the "solution" to reducing close pass events and improving cyclists safety in St Andrews. Participants suggest that a CPI is unlikely to directly influence driver behaviour, especially if the driver has negative attitudes towards cyclists. Additionally, drivers who struggle to see cyclists will unlikely be able to see the small addition of a CPI.

- "people are reckless drivers do so because they care less. I don't know if a piece of plastic will change that" – *Driver Survey.*

Criticisms were also shared regarding the design of the CPI. The device is mounted low on the bike wheel, therefore, the view of such may be obstructed by car bonnets. Additionally, participants noted that the design of the CPI might be off putting to certain individuals, affecting the "aesthetic" of their bikes. Aldred & Woodcock (2015) noted that the current designs of protective clothing for cyclists can often deter people from wearing them, deeming them "uncool" (p.108). From this, participants simply might choose not to use them, reducing the effectiveness of CPI implementation across towns. Additionally, participants suggested that their design is often a hinderance that overshadows their potential benefits. For example, they might prevent cyclists from storing their bikes in tight bike racks. In addition to the design, participants noted that when using a CPI, they often moved about and making them stronger to cope with the demands of cycling would be beneficial.

- "I don't know if students would really do it if students would really put those on their bicycles" – *Mira*.
- "CPI might be too bulky for tightly spaced bike racks" – *Baseline Survey.*
- "Better fixing or material used so that people can fix it themselves" – *Follow up survey.*

Additionally, a CPI might encourage a "minimum passing distance". As suggested by Lamb et al (2020), the passing regulations often encourage minimum distances, interpreting the value as the target distance (p.277). A CPI might therefore encourage this minimum passing distance and lead to an increased occurrence of close pass events.

Finally, cyclists highlighted that a CPI might influence drivers perceptions of them and their subsequent behaviour. Walker (2007) noted that cyclists who use safety gear often experience more close pass events due to the false perception of their safety (p.417). A CPI might have a similar effect, in which drivers perceive cyclists as being increasingly "safe" or "experience" and negatively influencing their associated passing distances.

Participants who used a CPI in St Andrews suggested that it had the opposite of the intended effect. The CPI increased participants concern about their safety on the roads, potentially drawing their attention to the risks associated with cycling.

- "more close pass events I notice now because of the indicator." – *Follow-up survey.*

In summary, participants noted that a CPI, in it's current state, is not the solution to close pass events and cycling safety. A CPI might provide benefits, but on an individual basis. A CPI can impact drivers, but is dependent on whether it is visible to them and whether they interpret it's meaning correctly. In addition, the CPI might result in opposing effects, bringing cyclists attention towards the potential hazards on the roads and increasing their concern for their own safety.

Theme Five: Exploring Alternatives to Close Pass Indicators.

A CPI might be beneficial to helping individuals gain confidence, with participants highlighting increased confidence when cycling on the roads and at night. However, as a community wide scheme, CPIs are suggested to not be the solution to close pass events.

- "I think it depends who you are" – *Mira.*
- but its not the actual solution" – *Taylor*.

Participants highlighted the need for infrastructural change as a way of mitigating against close pass events. The need to create physical divisions between cyclists and drivers and increase connectivity between cycling routes.

- "these close pass indicators don't solve the underlying infastructure issues that make cycling dangerous in and around St Andrews" – *Baseline Survey.*
- "build out physical barriers between cyclists" – *Mira.*

Additionally, changing drivers attitudes towards cyclists might mitigate against negative road behaviour. For example, making drivers aware of what it is like to experience a close pass and the associated emotions.

- "more work should be done encouraging car drivers to have empathy with cyclists" – *Baseline Survey.*

To sum, participants highlighted that on an individual level, a CPI might be beneficial, but it is not the method of improving community wide cycling habits in St Andrews. Modifications are required in infrastructure and drivers attitudes in order to promote cyclists safety and reduce the occurrence of close pass events.

Summary.

This analysis highlights the experience of cyclists in St Andrews and the concerns regarding close pass events. These frequent events can often reduce confidence and discourage cycling. Close pass events are worsened through parked cars and pedestrians, often forcing cyclists to the centre of roadways, reducing the likelyhood of a car overtaking at a wide distance. Participants suggested that a CPI may be beneficial, and were encouraging in their potential implementation. However, participants concluded that CPIs might only be beneficial in adressing these concerns on an individual scale. In order to enhance road safety and reduce close pass events in St Andrews, large scale changes are needed in infastructure and driver attitudes.

Quantitative Analysis.

Baseline Survey.

The baseline survey assessed participants experience of cycling in St Andrews, the occurrence of close pass events and opinions of CPIs, prior to their usage.

Perceptions of safety and confidence when cycling in St Andrews.

In the survey, cyclists were asked to rate their levels of confidence and perceptions of safety when cycling in St Andrews, *figure three*. Many participants (54.7%) reported feeling somewhat or very safe when cycling in St Andrews. Some participants did identify feeling unsafe (20%) or very unsafe (2.7%) when cycling. Many of the participants (48%) identified themselves as not feeling confident when cycling in the town, with a smaller amount of participants feeling confident (38.6%). Therefore, whilst the majority of participants felt safe when cycling, many of such didn't have the greatest confidence.

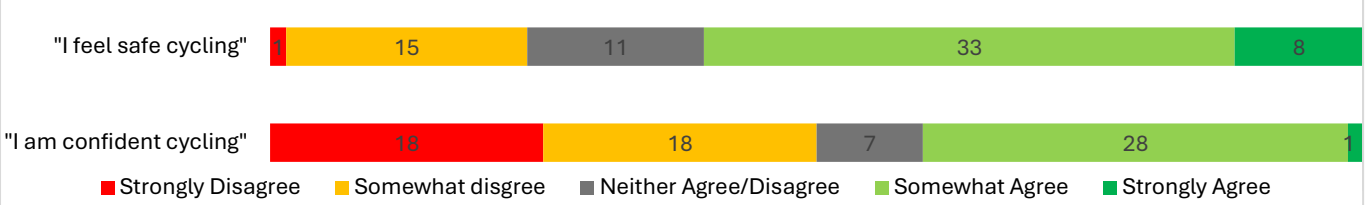

Figure 3: A graph displaying the Likert Scale responses of participants from the baseline survey, indicating their perceptions of safety and confidence levels when cycling in St Andrews, produced in Excel.

Perception of driver behaviour.

The baseline survey questioned participants about their experience of driving behaviour in St Andrews, *figure four*. Participants were first asked whether a drivers behaviour in St Andrews had a subsequent effect on their cycling engagement. From this, 30.7% of participants reported that drivers behaviour had influenced their cycling engagement, 50.7% had no experience of such an event and 13.3% unsure.

Participants were questioned about drivers awareness of cyclists on the roads, with 46.7% stating that drivers are aware of cyclists in St Andrews, 20% disagreeing with such statement and 26.7% remaining uncertain.

Participants were asked about their perceptions of drivers overtaking distances, indicating their agreement with the statement "drivers overtake at safe distances in St Andrews". From this, 45.3% somewhat or strongly agreed with this phrase, with 22.7% somewhat or strongly disagreeing.

From this, drivers are seen to have an impact on cycling in St Andrews, however many participants regard drivers behaviour as positive. The majority suggest that drivers have not impacted their engagement in cycling, are aware of cyclists on the roads and overtake at suitable distances.

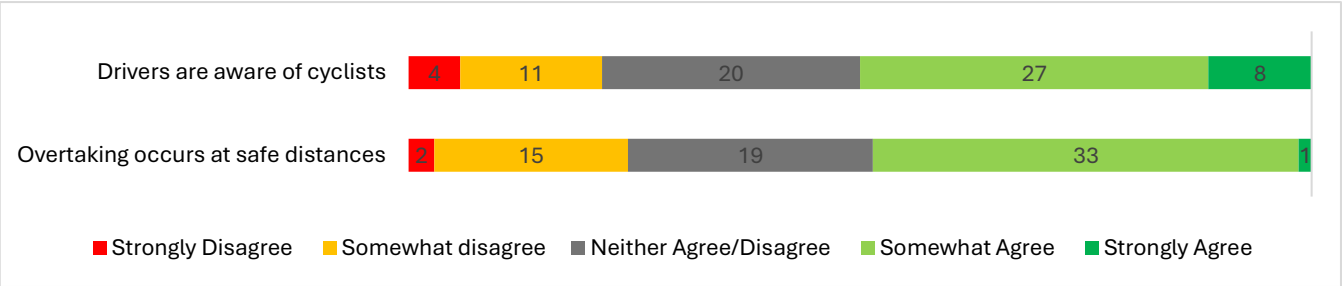

Figure 4: A graph displaying the Likert Scale responses of participants from the baseline survey, indicating their perceptions of driver behaviour in regard to their awareness of cyclists and overtaking habits in St Andrews, produced in Excel.

The Frequency of Close Pass events.

Cyclists were then questioned about close pass events. From this, 65.3% of participants had reported experiencing a close pass event in St Andrews, with 18.7% having not, leaving 12% uncertain. Following this, those who had experienced a close pass were asked about the frequency of such occurrences, *figure five*. Many participants (37.3%) stated that a close pass occurs occasionally (1-2 times a month), with 17.3% indicating they occur frequently (more than once a week) and a few stating they occur infrequently (10.7%) (once a year).

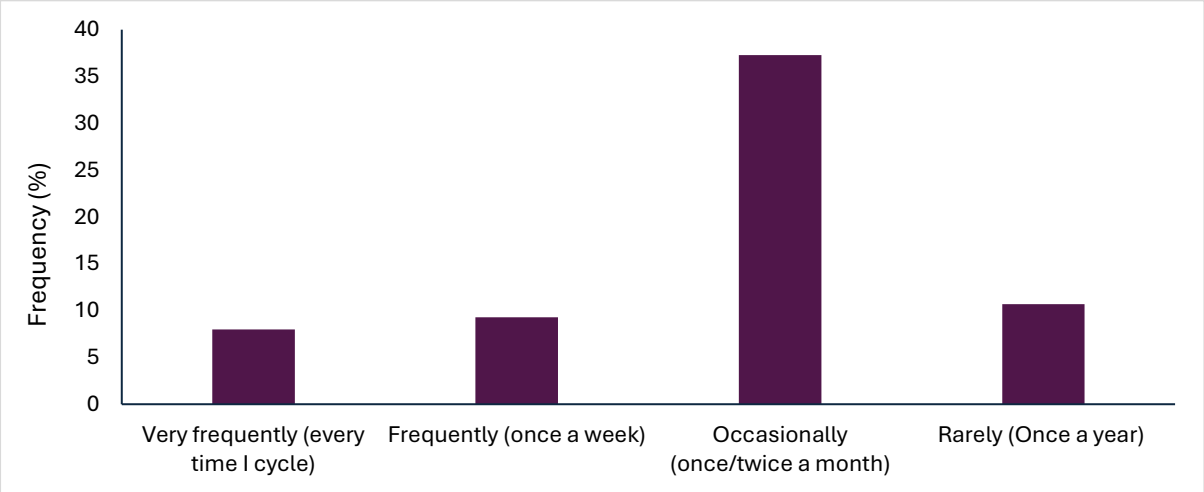

Figure 5: A bar graph displaying the frequency of close pass events experienced by cyclists in the baseline survey, produced in Excel.

Following this, participants were questioned about their concern regarding close pass events, rating this on a scale of 1-10, *figure six*. Participants had a varied rating, with 67.60% rating their level of concern above a 5.

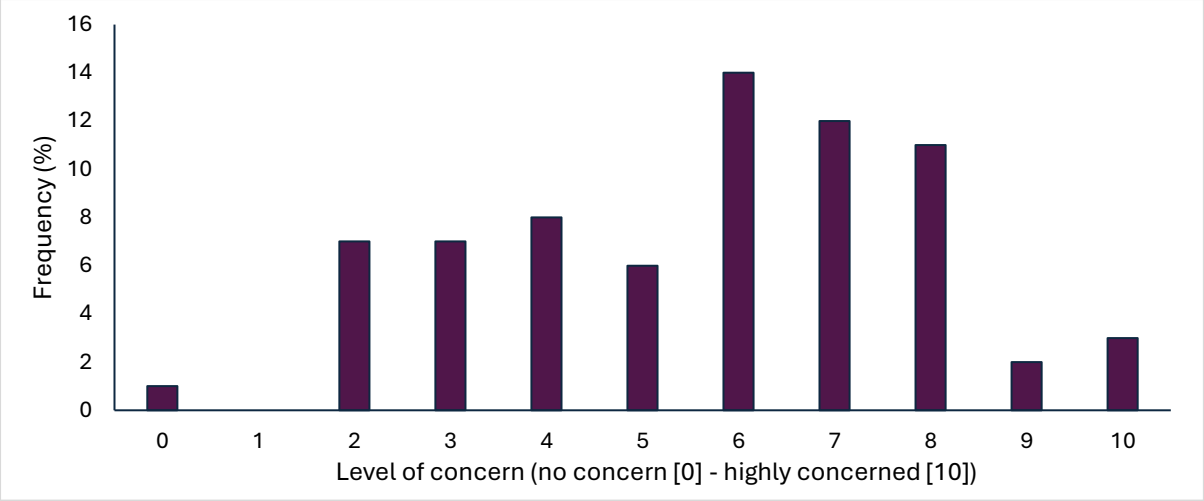

Figure 6: A bar graph representing the rated level of concern about close pass events from participants in the baseline survey, produced on Excel.

Close Pass Indicators.

To tie into the research question, participants previous awareness of CPIs was examined. From this, only 28% had previously encountered CPIs prior to the study. Participants were then assessed on their perceptions of the potential impact a CPI might have in St Andrews, *figure seven*. Firstly, 54.7% of participants stated that a CPI would have some improvement on their perceptions of safety when cycling, with 10.6% disagreeing with such statement, leaving a large number uncertain (21.3%). Additionally, 50.7% of participants indicated that a CPI might have a positive impact on driver behaviour, and 9.3% disagreeing with this. Many participants (28%) were once again uncertain about the potential effect.

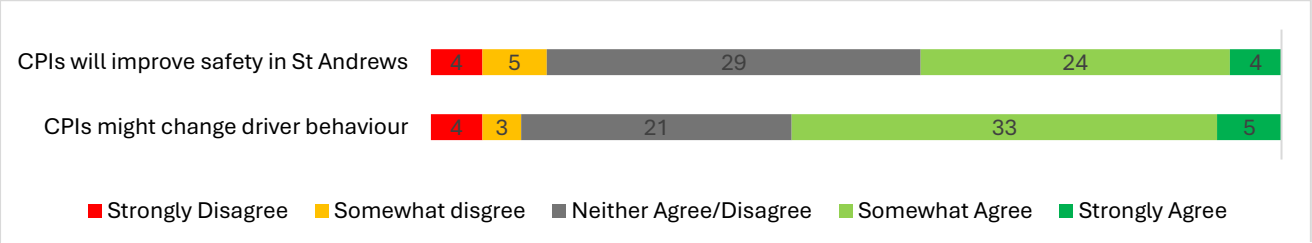

Figure 7: A graph displaying the Likert Scale responses of participants from the baseline survey, indicating their opinions of the impact CPIs might have in St Andrews, produced in Excel.

Increased Cycling Engagement.

Participants were then questioned about whether improving cyclists safety in St Andrews might lead to increased cycling engagement, *figure eight*. From this, the majority of participants (77.3%) somewhat or strongly agreed with such a statement, with only 4% suggesting that improved safety would have no effect upon engagement.

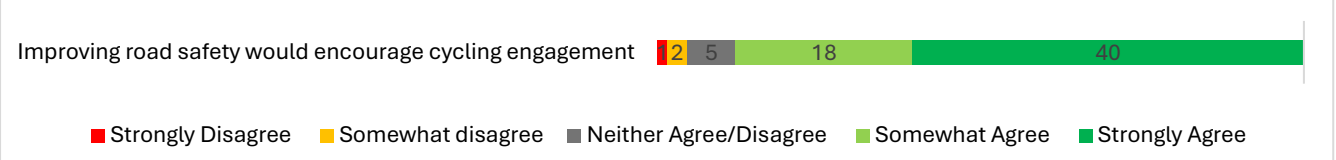

Figure 8: A graph displaying the Likert Scale responses of participants from the baseline survey, indicating their opinions of the impact improved road safety might have upon cycling engagement, produced in Excel.

A further analysis was conducted on the theme of cyclists safety and engagement. Firstly, the associated questions were examined for a potential factor analysis. A principle factor analysis was conducted on 6 measures assessing perceptions of road safety in St Andrews. The subsequent Kaiser-Meyer-Olkin measure of 0.562 suggested that these questions were unsuited for a factor analysis. This value indicated insufficient correlations among variables, and the determinate of 0.309 suggested multi-collinearity.

Following this, a single measure was used to understand perceptions of road safety. A Fishers Exact Test (expected frequencies less than 5) was used to determine whether perceptions of road safety influenced cycling engagement. This test revealed no significant association between the variables, indicating that perceptions of road safety doesn't have an association with participants frequency of cycling (X^2 (20) = 17.926, p=0.651).

Summary.

In conclusion of the baseline survey, participants highlighted their concerns when cycling in St Andrews. Whilst a majority of participants feel safe cycling on the roads in St Andrews, a large proportion do not feel confident to do so. Participants hold positive opinions of drivers, suggesting, on the majority, drivers are aware of them and overtake at safe distances. With this in mind, a large proportion have experienced a close pass event in St Andrews. Participants typically have not come across a CPI prior to the study and are often uncertain about the potential benefits they might have in St Andrews. A large majority of participants identify that improvements in cyclists safety in the town would encourage cycling engagement. However, when examining participants own perceptions of safety and their frequency of cycling, no significant association was found.

Follow-up Survey.

The follow-up survey assessed the same content as the baseline but occurred after using a CPI.

The Impact of a CPI on cyclists.

Following the usage of a CPI, participants were questioned about the impact they had upon their cycling experience, *figure nine*. Firstly, 37.5% of participants identified that a CPI reduced their concerns regarding road safety and 29.2% reported no change in this factor. However, 20.8% reported somewhat of an increase with 12.5% reporting a strong increased concern about their road safety. Additionally, from CPI usage, 54.2% reported increased awareness from drivers, with 16.7% reporting a strong increased awareness. This was followed by 4.2% suggesting that a CPI reduced drivers awareness of them on the road and 25% reporting a neutral view.

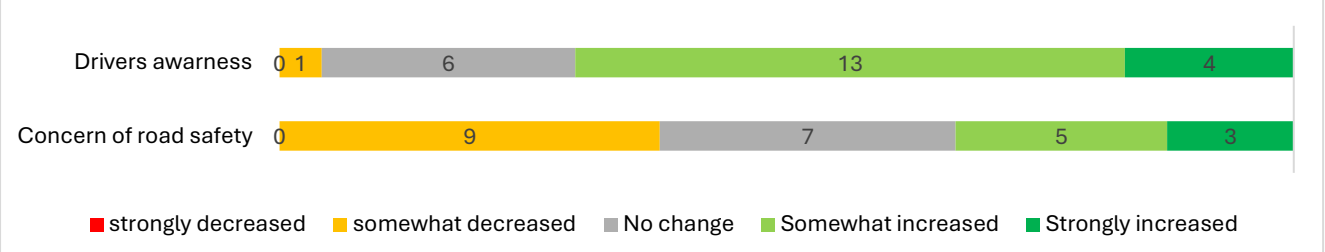

Figure 9: A graph displaying the Likert Scale responses of participants from the follow-up survey, indicating their perceptions of impact a CPI had on cycling experience, produced in Excel.

Following the usage of a CPI, 50% of participants reported improvements in their cycling experiences from the device, with the remaining 50% suggesting similar levels, *figure ten*.

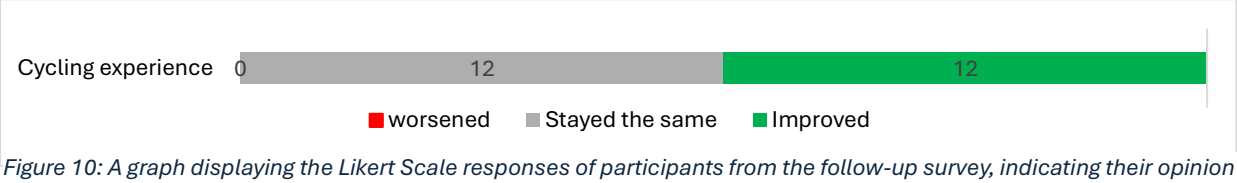

Figure 10: A graph displaying the Likert Scale responses of participants from the follow-up survey, indicating their opinion on their cycling experiences when using a CPI, produced in Excel.

Finally, participants were questioned about whether they would recommend a CPI for future use, with 66.7% agreeing with this statement, and 8.3% not recommending such a device. One of the aims of the CPI was the increased engagement in cycling, 37.5% of participants suggested a CPI might increase this in St Andrews, with 33.3% disagreeing with such statement.

The Impact of a CPI on drivers.

Participants were then further examined about specific driver behaviour. From this 50% of participants reported that drivers left more room when overtaking whilst using a CPI and 33.3% suggested drivers leave the same amount of room. The remaining participants were unsure about the changed passing distances, however, no participant reported that from using a CPI, passing distance reduced.

Summary.

Within the follow-up survey, participants reported positives from CPI implementation. Firstly, cyclists percieved drivers as being increasingly aware of them on the roads. A large proportion of cyclists reported improvements in their cycling habits and driver overtaking distances, leading to many participants recommending a CPI to others, potentially as a method of increasing cycling engagement. However, whilst there are positives, participants did highlight the negative impact of CPI usage. For example, CPIs were suggested as having a negative impact upon cyclists perceptions of safety, in regard to making them more aware of the potential risks on the road.

Comparing the differences between CPI conditions.

This section compared whether differences were seen among the two surveys, examining whether the CPIs had an impact on cyclists' perceptions of safety and driver behaviour.

Perceptions of safety and confidence.

Firstly, participants responses on their confidence levels were compared, *figure eleven*. Prior to CPI usage, 65.2% of participants agreed with the statement that they felt confident when cycling in St Andrews, this level remaining constant after CPI usage (65.2%). However, there was a change in the disagreement level, with those disagreeing that their confidence improved from the CPI by 4.3%. This highlights that the overall agreement in the statement remained level but there was a shift from neutral standpoints to negative ones.

A statistical analysis was conducted to see whether this change was significant. The data violated the assumptions of normality, therefore a Wilcoxon Signed Rank Test (Exact) was used to determine whether confidence levels changed as a result of a CPI. The findings concluded no significant change in self-reported confidence levels as a result of CPI usage ($Z = -0.040$, $p=0.999$).

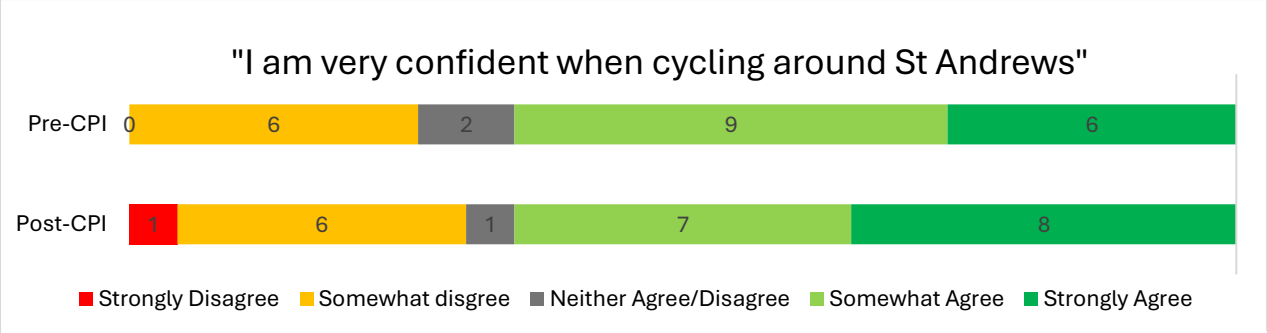

Figure 11: A graph displaying the Likert Scale responses of participants comparing across the baseline and follow-up survey. Participants indicated their confidence levels before and after using a CPI, produced in excel.

Similarly, participants indicated their level of agreement with the phrase "I feel safe when cycling in St Andrews", *figure twelve*. Prior to CPIs, 60.86% of participants agreed with the statement, 39.13% remained neutral, no participant disagreed with the statement. After using a CPI, there was a 34.78% increase in participants disagreeing with the statement.

To examine whether this result was significant, a Wilcoxon Signed Rank Test (Exact) was used to determine whether participants reported different levels of safety before and after using a CPI. This test was selected due to the ordinal data and violation of normality assumptions. It was found that there was no significant difference in participants perceptions of safety before and after CPI use ($z = -1.706$, $p=0.099$).

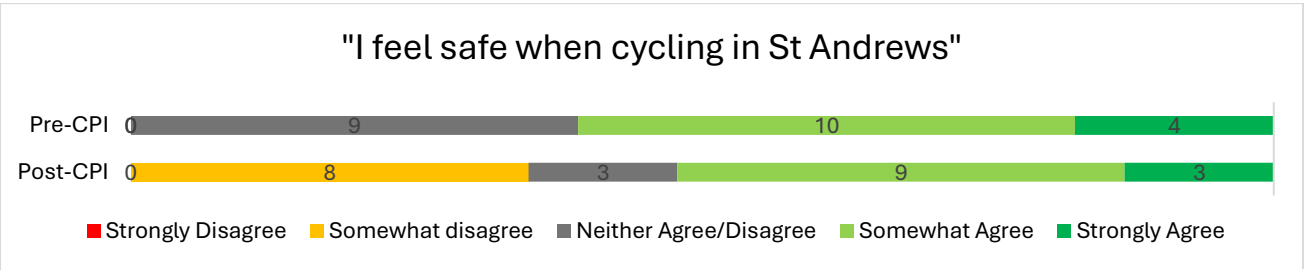

Figure 12: A graph displaying the Likert Scale responses of participants comparing across the baseline and follow-up survey. Participants indicated their safety perception before and after using a CPI, produced in excel.

Engagement in Cycling and frequency of close pass events.

Between CPI conditions, cycling frequency didn't appear to change, with levels remaining relatively identical, *figure thirteen*. As a result of the near identical findings, no inferential test was used to examine whether a difference exsisted.

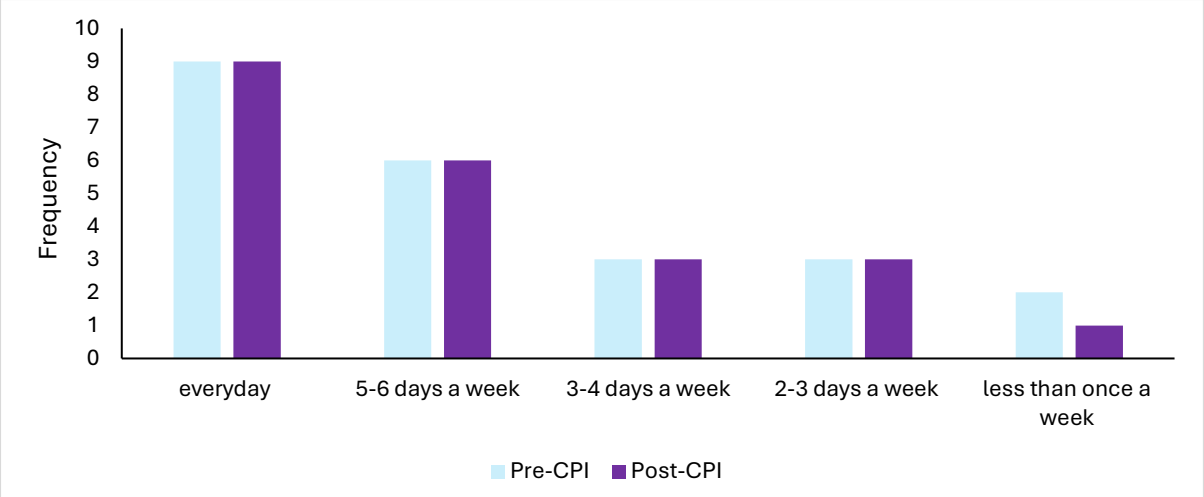

Figure 13: A bar graph representing the cycling frequency of participants across the baseline and follow-up survey. It attempts to assess whether CPI usage had impacts upon cycling engagement, produced in Excel.

Responses regarding the occurrence of close pass events were then examined, *figure fourteen*. Prior to CPI usage, participants who had encountered a close pass event mostly experienced them occasionally (35.7%), followed by frequently (28.6%), rarely (21.4%) and more than once a week (14.3%). After using a CPI, participants reported fewer close pass events, with more experiencing them occasionally than frequently (16% increase). A Wilcoxon Signed Rank Test (Exact) (violation of normality) was used to examine whether participants experienced a significantly different amount of close pass events between CPI conditions. From this, there was no significant change between close pass events and CPI usage ($Z=-1.027$, $p=0.354$).

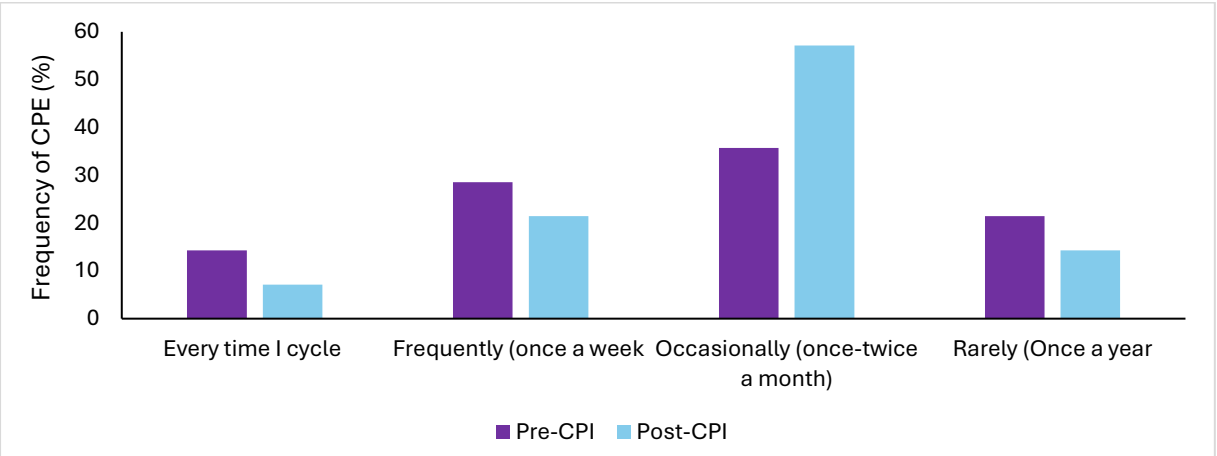

Figure 14: A bar graph representing the frequency of close pass events across the baseline and follow-up survey to assess whether CPI usage had impacts upon these experiences, produced in Excel.

The Impact of CPIs on driver awareness.

Prior to CPIs, 47.8% of participants held a positive regard for drivers awareness of them on the roads, with 34.78% holding a negative regard and 17.4% neutral positions. After CPIs, participants reported that drivers awareness had increased, *figure fifteen*.

A statistical examination was run to determine whether this change between driver awareness and CPI was significant. The data violated the assumptions of normality (Pre-CPI: ($W(23) = 0.772$, $p<0.001$); Post-CPI: ($W(23) = 0.597$, $p<0.001$)). Therefore, a Friedmans ANOVA (Exact) test was run. This test

revealed no significant differences between cyclists reported perceptions of driver awareness and CPI usage (X^2 (1) = 0.692, p=0.581).

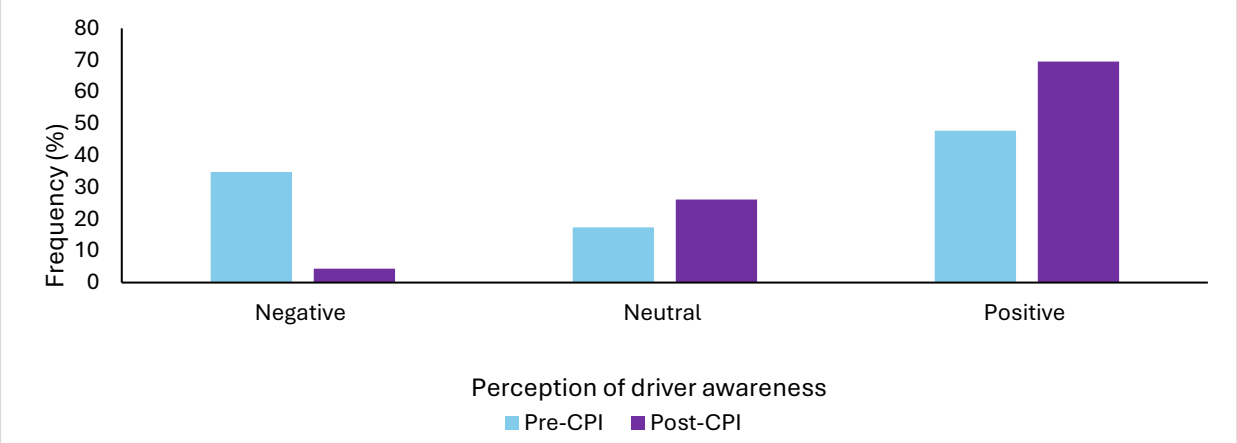

Figure 15: A bar graph representing the perceptions cyclists have towards drivers awareness of them on the roads between CPI conditions, produced in Excel.

Summary.

Taken together, CPIs, from the descriptive statistics were seen to be positive, decreasing the occurrence of close pass events and increasing driver awareness. However, CPIs were found to decrease confidence and perceptions of safety in cyclists and result in no change in cycling engagement. Whilst these findings are visible, there was no significant changes among any factors. This might suggest percieved changes at an individual level, but as a collective, CPIs did not influence cyclists perceptions of safety nor driver behaviour.

Drivers Survey.

Drivers concern about cyclists safety.

In the driver's survey, participants were asked to indicate their awareness of cyclists on the roads, using a 0-5 scale. All participants gave ratings above a 3, indicating medium-to-high awareness. Drivers were then asked about their concern regarding cyclists safety in St Andrews, of which 91.7% indicated that they were somewhat or very concerned about this issue, *figure sixteen.*

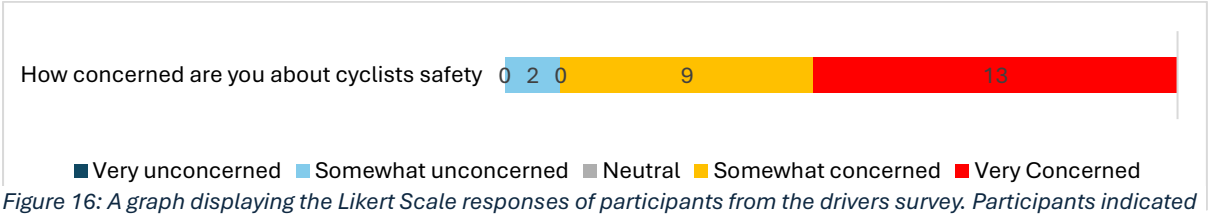

Figure 16: A graph displaying the Likert Scale responses of participants from the drivers survey. Participants indicated their concern about cyclists safety in St Andrews, produced in excel.

Drivers Overtaking Behaviour.

Drivers were then questioned about their overtaking behaviours, *figure seventeen*. A large proportion of participants (45.8%) indicated that they percieve themselves as always maintaining a safe passing distance, followed by frequently (37.5%), occasionally (12.5%) and rarely (4.2%).

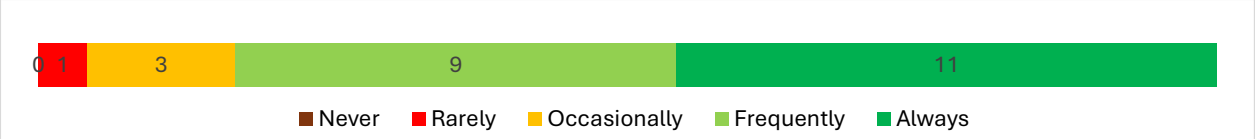

Figure 17: A graph displaying the Likert Scale responses of participants from the drivers survey. Participants indicated their personal views of their overtaking behaviour and how often they overtook at safe distances in St Andrews, produced in excel.

Participants followed this by ranking the roads in which they give increased lateral distance to cyclists, *figure eighteen*. Drivers showed that on rural and country roads, they give the widest lateral clearance, and the least amount on urban roads. This might imply that CPIs have different effects within different contexts.

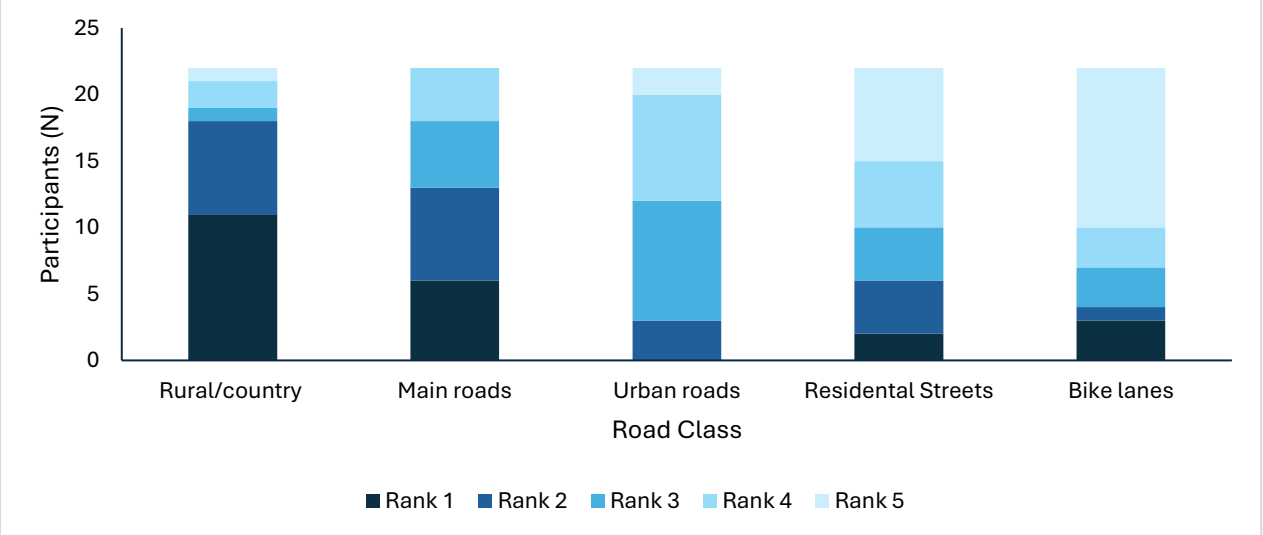

Figure 18: A bar graph showing the average ranked location of roads, with drivers indicating which road they give increased lateral distance. Rank one shows the most amount of distance between the cyclist and driver, rank 5 showing the least. Produced on Excel.

The Impact of CPIs on driver behaviour.

Drivers were examined regarding the impacts CPIs might have on their road behaviour. Half of the participants (50%) suggested that a CPI would make the driver more aware of the cyclists position on the road, followed by 12.5% stating they would give more space to the cyclist and 8.3% suggesting they would likely approach the cyclist more cautiously. A total of 29.1% suggested that CPIs would have no impact upon the drivers subsequent behaviour.

Following this, an examination was run to determine whether drivers who have previously encountered CPIs on a bike reported different levels of awareness of cyclists on the roads. The majority of drivers (60.7%) indicated they had never come across a CPI, 21.4% stating they are aware of them, and 3.6% remaining uncertain. Additionally, 60.7% of cyclists stated that a CPI would improve drivers awareness of cyclists, followed by 7.1% disagreeing with such a statement.

A Mann-Whitney U test (violation of normality and ordinal scaled data) was selected to examine whether prior knowledge of CPIs influenced drivers reported awareness of cyclists. Participants who were aware of CPIs prior to the study did not differ in their level of percieved awareness of cyclists ($U = 36$, $z=-1.279$, $p=0.224$; Yes Mdn = 4.5, No Mdn = 4.0).

Summary.

From the drivers survey, it can be seen that participants are very concerned about cyclists safety in St Andrews. Drivers report themselves as overtaking commonly at a safe distance, and giving the most lateral clearance on country and rural roads. Drivers report that CPIs are likely to change their behaviour on the roads. However, drivers who have previously encountered a CPI report no significant differences in their levels of awareness than those unaware of the devices.

Drivers and Cyclists perceptions on safe passing distances.

An examination was run to determine whether cyclists and drivers have different perspectives upon what constitutes a safe passing distance. Participants were asked to indicate what they believed the recommended distance a vehicle should maintain when overtaking a cyclist, *figure nineteen*. In this examination, two participant data sets were excluded, giving values of 10m and 20m, suggesting impossible overtaking scenarios. This dataset violated the assumptions of normality, (Cyclists: $W(69) = 0.792$, $p<0.001$; Drivers: $W(24) = 0.753$, $p<0.001$) as well as homogenity of variance. From this, a Mann-Whitney U Test (Exact) was used to determine whether cyclists and drivers suggest different measurements as a safe passing distance. Findings concluded that drivers suggest a significantly higher lateral distance when overtaking than cyclists. ($U=480.50$, $z=-3.131$, $p=0.001$, $r= -0.077$; Drivers Mdn = 2, Cyclists Mdn = 1.5).

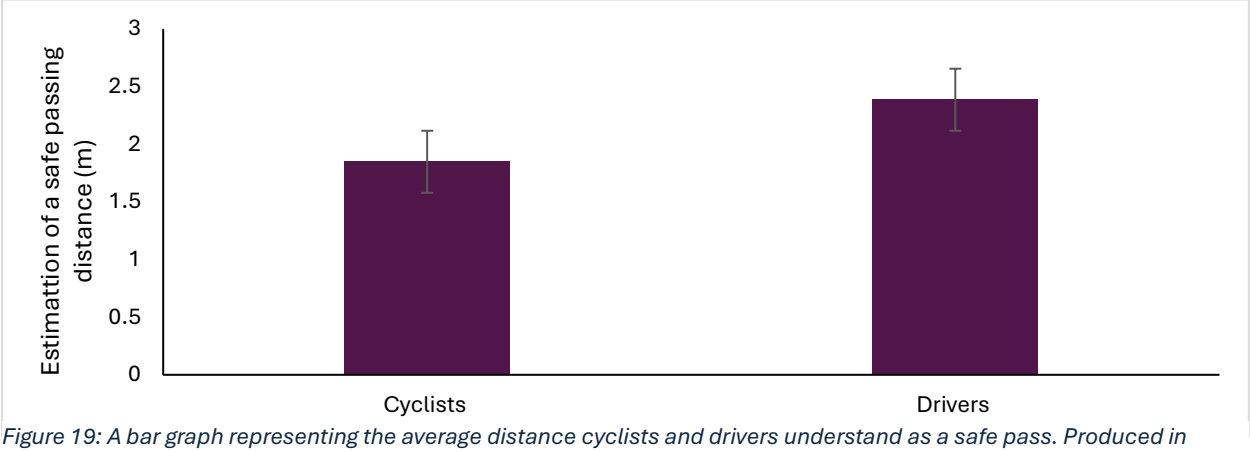

Figure 19: A bar graph representing the average distance cyclists and drivers understand as a safe pass. Produced in Excel.

Summary.

In conclusion, cycling is regarded as somewhat of a safe activity in St Andrews, however, cyclists often lack confidence on the roads. Participants highlight that drivers, on average, are aware of cyclists and overtake at safe distances, with this in mind, close pass events still occur. Drivers and cyclists are opposed in their perspective of what constitutes a safe distance, with drivers proposing significantly larger values. After using CPIs, participants were still positive about them, suggesting they improve drivers awareness of them, this was also concluded in the driver survey, in which participants indicated that CPIs might increase cyclists visibility. CPIs are also suggested by drivers and cyclists to improve the passing distances. However, CPIs have been highlighted as potentially increasing cyclists awareness of the risks on the roads, decreasing their confidence levels. Additionally, whilst the descriptive statistics highlight these notions, no significant findings were examined on the impacts of CPIs on cyclist safety perceptions and associated driver behaviour.

Discussion.

Summary of the key findings.

This study aimed to answer the following research question:

"How do close pass indicators enhance percieved road safety of cyclists and influence driver behaviour?"

Data was collected through a combination of interviews and surveys. Firstly, the qualatative analysis examined interview transcripts and the surveys assessed extended answer responses. Participants responses were analyised, producing themes, which encompassed the main topics in the content. Following this, the quantitative analysis reviewed the participant responses to survey questions. The subsequent findings were combined to produce an overall conclusion to the stated research question.

What are the common cycling experiences in St Andrews?

Overall, these results indicate that cycling is percieved as somewhat of a safe activity in St Andrews. With consideration to this, cyclists are seen to lack confidence on the roads and feel powerless to control their safety, aligning with findings by Aldred (2016, p.79). Drivers are percieved to have good awareness of cyclists and commonly overtake at a safe distance, with this in mind, close pass events still occur. These events are understood to negatively impact upon cyclist experience, inducing feelings of distress. These incidents were said to stem from frequently occuring road hazards (parked cars, pedestrians) as well as drivers attitudes towards cyclists. Following close pass events, participants drew attention to changes in their cycling behaviour, often avoiding areas which these incidents can occur. As a result of these experiences, participants suggest that St Andrews is a location which can benefit from improvements, aimed at reducing the frequency of close pass events. This might boost cyclists confidence and engagement. In sum, St Andrews is somewhat of a safe cyclist town but one which would benefit from the implementation of mitigation strategies to improve upon cyclists safety and driver behaviour.

How do close pass indicators impact cyclists' perceptions of road safety?

Cyclists suggested that a CPI might improve their perceptions of road safety in St Andrews. CPIs are recommended as a potential way to boost individuals' confidence. Some participants reported that from CPI use, their confidence increased, allowing them to cycle in area's they once avoided. Additionally, from CPIs, participants percieved drivers as giving them greater lateral distance when overtaking. Overall, participants did regard CPIs positively, encouraging the implementation of any scheme that targets road safety. CPIs might therefore be a feasible method of improving cyclists perceptions of safety on the roads in St Andrews. On that note, whilst CPIs were regarded positively, they were also suggested to cause the opposite effect than the one intended. Participants suggested that CPIs heightened their awareness to the potential risks associated with cycling. In addition to this, participants noted that CPIs do not address their main concerns affecting their perceptions of safety. When examining for a statistical difference between CPI conditions, no such findings were concluded. Thus, CPIs might have impacts upon an individual, however, such impacts might vary, with some individuals experiencing increased safety perceptions and others decreased. CPI implementation in St Andrews might be useful in singular cases to address individual-level concerns about cycling safety. However, due to the potential negative impact associated with heightened risk awareness and the lack of significant differences within the results among CPI conditions, they are unlikely to be beneficial at targeting cyclists perceptions of safety as a community wide scheme.

How do close pass indicators impact drivers behaviour on the roads?

Drivers frequently directed attention towards cyclists invisibility on the roads and the need to improve on this. A CPI was suggested to increase cyclists visibility, from the bright colours and additional reflector making them more apparent. If drivers are able to see cyclists more easily, their subsequent behaviour might change, for example, giving wide lateral clearance when overtaking. However, drivers currently perceive themselves as frequently giving wide clearances when overtaking. Therefore, a CPI might make cyclists more visible to drivers but not impact close pass events, as from drivers standpoints, they currently demonstrate correct overtaking without a CPI. To further this, a significance test demonstrated that drivers who have encountered CPIs prior to the study reported no significant difference in levels of awareness of cyclists than drivers unaware of CPIs. Following this, additional research is needed to examine the exact effect CPIs have on driver behaviour, potentially through direct observations. Interestingly, drivers indicate that on rural/country roads, they often give wider distances than other roads such as those in urban environments. Following this, it might also imply CPIs have varying effects in different contexts, potentially enhancing lateral clearance in urban environments but not rural. To conclude, more research is needed to examine driver behaviour following CPIs. This study found that through self-reported measures drivers would likely give cyclists increased lateral clearance from CPI use, however, already percieve themselves as giving appropriate clearance levels. Future research needs to examine direct measures of clearance as a result of CPI usage.

What do drivers and cyclists constitute as a safe passing distance?

An intresting finding in this study pertained to cyclists and drivers interpretation of a safe passing distance. The findings concluded that drivers indicate significantly larger values than cyclists when discussing what constitutes as a safe overtaking distance. This might suggest that drivers are aware of safe passing distances, and interpret a larger lateral clearance as safer, however the road structures might prevent them from maintaining this distance. This might imply that CPIs will not be effective in St Andrews as drivers are aware and can identify safe passing distances, with these being larger than cyclists' interpretations. Changes in the road structures might be the only methods to increase the lateral clearance to reduce close pass events.

Does a CPI impact cycling engagement?

Participants highlighted that improving cyclists safety would likely increase cyclist engagement, aligning with findings in Cubbin et al (2024, p.309). CPIs might not be the method to improve such safety. It was seen that participants experienced no significant changes in their cycling habits as a result of CPI usage. Whilst being regarded positively, CPIs might not be the best driver for cycling engagement. Large scale infrastructural changes are suggested to be the most effective method at increasing cycling in St Andrews. This was a conclusion also stated by Walker et al (2014, p.417) that infrastructural change is needed to enhance cyclists road safety and engagement.

Summary.

This study was able to demonstrate the safety concerns of cyclists in St Andrews. The road hazards and close pass events often result in cyclists becoming apprehensive or avoiding certain areas. CPIs were suggested to be a potential cost-effective method of reducing close pass events, modifying driver behaviour resulting in improved levels of cyclists safety and engagement.

In summary, CPIs are seen as potentially beneficial at influencing individual-level cycling safety perceptions but will likely be ineffective as a community-wide scheme. The impact of CPIs is mixed, some participants felt that CPI usage made an impact whilst others, they heightened their concern to potential hazards on the roads. Participants did report that drivers had increased levels of awareness, but no significant effect was found between any factors as a result of CPI use. CPIs have some value, but they do not address broader safety issues. In order to create meaningful change in these factors, large-scale modifications are needed in infastructure and driver attitudes.

What are the limitations of these findings?

Whilst this study provides valuable insights, the limitations of such still need consideration.

Data collection and material design.

Firstly, the self-reported data gathered in the survey might not reflect participants true belief's. Participants often suffer social biases, giving answers which make them appear more favourable. For example, drivers are unlikely to state that they do not overtake at safe distances and will choose a more socially desirable option. Additionally, this study is limited by the design of the questions used. The common Likert Scale questions used throughout all surveys often suffer biases. Participants are unlikely to select the most extreme categories (e.g. strongly agree) even if it goes against their strength of opinion. Therefore, it might be useful for future research to assess observed impacts rather than self-reported behavioural change from CPIs. For example, measuring the physical distance drivers leave when overtaking a bike, with or without a CPI.

Furthermore, errors were present in some of the questions given to participants. For example, the question assessing the frequency of cycling had overlapping categories (2-3 days per week/3-4 days per week). Proofing of questions is therefore required in future studies. Additionally, drivers were asked to rank road types in order, demonstrating the amount of lateral distance they give when overtaking. The common answer to this question was the order in which the options were originally presented in, and it was uncertain whether participants simply agreed with this order or didn't engage with the question. Changing this response to allow participants to drag and drop their options will allow the researcher to gage whether this question was answered.

Finally, participants were given ID codes which connected their responses across time to track the impact of CPIs. However, participants often entered these codes incorrectly, and resulted in their responses not being connected. Using simpler codes or gathering more identifiable information might reduce the amount of participants removed from the analysis.

The Close Pass Indicators.

Firstly, the CPIs might not be used. Participants have to remember to fold the CPIs out prior to cycling. Additionally, the design of the CPI was suggested to struggle under the pressures of cycling. The aesthetic of the design was also criticised. Changing the design slightly so CPIs are aesthetically pleasing, ready to function when cycling and able to withstand pressures might increase their impacts.

An intresting concept surrounding CPIs is the moth effect. This theory suggests that drivers often pay attention to flashing lights they see along the road and typically move towards the object (Terry, 2018, p.3). Whilst the CPI used in this study didn't have a flashing light, it is something not commonly occuring and might draw drivers attention towards it. This might impact drivers, with them potentially altering their trajectory towards the cyclist, focusing on the device, rather than away.

Sample Selection.

This study was advertised to participants as a research project examining cyclists' safety in St Andrews. As participant involvement was voluntary, this study was unlikely to attract participants

who hold negative attitudes towards cyclists. As stated by Rubie et al (2023), drivers who hold negative attitudes toward cyclists often engage in more negative road behaviour (p.93). Therefore, the drivers within this study likely reflected individuals who were concerned about cyclists in the town, potentially presenting a biased viewpoint.

Additionally, there was poor engagement in the follow-up survey, examining the impact of CPIs. This reduced the sample size, potentially inhibiting the detection of an effect. From this, participants might require greater encouragement to continue their participation in the study.

Future directions.

This study highlights the importance of cycling in St Andrews and the need to improve cyclist safety on the roads. CPIs are useful but are not the sole driver in changing perceptions of safety and driver behaviour. Future research could build upon these findings. Firstly, the examination into the psychological effect CPIs have on perceived road safety. From this, findings could inform future initiatives within the community. Additionally, drivers indicated that they provided increased lateral distance in rural/country roads than in urban areas. This might imply that CPIs impact are context dependent. Future research should look at the impact of CPIs within different environments. Finally, direct observations are needed to confirm the impact of CPIs on driver behaviour. This research concluded that CPIs could be beneficial on an individual scale, but are not the fix to cycling safety in St Andrews. Future directions should target infrastructural change and driver attitudes.

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Figure List.