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## Strategic and tactical choices as a basis for understanding motorcyclists

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### Abstract

This study examines the risks motorcyclists face in traffic, focusing on intersections and curves, through in-depth interviews with 62 motorcyclists. It investigates how knowledge of multi-vehicle accidents influences motorcyclists' behavior and information gathering.

The motorcyclists were divided into three groups: Group 1 (less than 3 years of riding experience), Group 2 (more than 3 years of riding experience), and Group 3 (professional connection to motorcycling). Group 3 expressed more consistent strategies compared to Groups 1 and 2, which often had unclear assessments.

Interaction and preventive riding are crucial in motorcycle training. Group 3 was more proactive and better prepared for conflict situations. Regarding curve riding, Group 3 showed a better understanding of normal positioning and maneuvering space, while Groups 1 and 2 had greater trust in other road users and were less consistent in their strategies.

In terms of speed choices, Group 3 showed greater awareness of speed reduction in curves and had a better tactical repertoire. Groups 1 and 2 described strategies with increasing speed through curves but showed the ability to adjust speed when necessary.

Braking in curves was seen as a risk factor by Groups 1 and 2, while Group 3 viewed it as a tactical tool. Group 3 had a more nuanced understanding of braking in curves and used it as part of their tactical repertoire. These findings highlight the importance of riding experience and training to improve motorcyclists' safety and reduce accident risk. The research question was: "To what extent will different levels of experience influence self-awareness and stated descriptions of tactical and strategic choices?"

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**Keywords:** Motorcyclists, self-awareness, tactical choices, strategic choices.

### 1. Introduction

In the White Paper on the National Transport Plan (NTP) 2022-2033 (Norwegian Ministry of Transport 2021), it is stated that targeted efforts against high-risk factors and vulnerable road user groups highlight that, in light of the development of motorcycle and moped accidents, a

revitalization of the work for increased motorcycle safety is required. Motorcyclists represent a significant high-risk group in road traffic, as reflected in both accident statistics and research literature. Iversen and Njå (2022) highlight that motorcyclists are particularly vulnerable in traffic situations involving intersections and curves. This report aims to

examine the various risk factors motorcyclists encounter, as well as the strategic and tactical choices they make to prevent conflicts and reduce risk.

Navigating intersections is one of the most challenging situations for motorcyclists. In such scenarios, the motorcyclist must exhibit heightened vigilance towards other road users and potential hazards. Iversen and Njå (2022) emphasize the necessity for motorcyclists to develop effective strategies to prevent conflicts and risks when approaching and traversing intersections. This includes being prepared for unforeseen events and having the readiness to respond swiftly to dangers. Furthermore, motorcyclists must make deliberate strategic and tactical decisions to navigate safely through intersections and combinations of turns.

Riding through curves represents another significant risk factor for motorcyclists. Roads with varied curvature are often popular among motorcyclists due to the experiences they offer, but they also account for a large proportion of motorcycle accidents. Iversen and Njå (2022) indicate that a substantial portion of motorcycle accidents are run-off-road accidents in curves. To reduce the risk in such situations, the motorcyclist must make carefully considered speed choices before and through curves, as well as strategic and tactical decisions that take into account the road design and traffic conditions.

To achieve a deeper understanding of motorcyclists' experiences and attitudes, this study employs in-depth interviews as one of the primary methods. The in-depth interviews provide valuable insights into the riders' perspectives and experiences and help to elucidate the factors that influence their safety and accident susceptibility. Through these interviews, a better understanding can be gained of how motorcyclists perceive risk and what measures they consider necessary to improve safety.

The development of motorcycle accidents poses a challenge to road safety and the Vision Zero initiative. Iversen and Njå (2022) report an increase in the number of registered medium and heavy motorcycles, as well as an increase in the number of accidents involving such vehicles.

Previous studies have shown that rider skill, experience with the vehicle, and riding experience are crucial factors influencing accident risk (Høye, 2017; Høye et al., 2016). To achieve a reduction in the number of accidents, targeted efforts against high-risk factors and vulnerable road user groups are therefore necessary. In 2024, Nord University, in partnership with SINTEF and under the commission of the Norwegian Public Roads Administration, executed a research project examining motorcyclists' decision-making processes to promote safe riding.

## **2. Theoretical framework**

The thematic analysis of serious accidents involving ATVs, mopeds, and motorcycles from 2015 to 2020 (Iversen, T., Njå, O. 2022) reveals an increase in the number of registered medium and heavy motorcycles during this period, with a total of 2067 accidents involving these vehicles. Of these accidents, 32% are Vision Zero accidents, which involve fatalities and serious injuries to drivers or passengers. Previous analyses have highlighted differences in accident factors between motorcycle accidents and those involving other vehicle types (Høye, 2017; Høye et al., 2016). In motorcycle accidents, driver competence encompassing traffic competence, vehicle experience, and riding experience is crucial. This underscores the importance of the relationship between driver competence and road design, as well as between driver competence and traffic situations. For both run-off-road and head-on collisions, accidents involving sharp curves have increased over time, necessitating further examination of the relationship between changes in road alignment and crossfall (Sagberg et al., 2020). Men are disproportionately represented in accidents involving medium and heavy motorcycles, with 1822 men and 245 women involved in accidents from 2015 to 2020 (Iversen, T., Njå, O. 2022). Regarding age groups, Table 1 shows that individuals aged 45-54 are overrepresented (37.4%) among those killed in motorcycle accidents during this period (Iversen, T., Njå, O. 2022).

| Age Group         | Under 16 | 16-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65-74 | 75-84 | Total |
|-------------------|----------|-------|-------|-------|-------|-------|-------|-------|-------|
| Slightly Injured  | 0.9%     | 12.3% | 18.8% | 16.7% | 28.3% | 17.6% | 4.7%  | 0.8%  | 100%  |
| Seriously Injured | 0.4%     | 10.9% | 17.6% | 16.9% | 28.2% | 19.7% | 6.0%  | 0.4%  | 100%  |
| Killed            | 0.0%     | 14.1% | 12.1% | 16.2% | 37.4% | 15.2% | 5.1%  | 0.0%  | 100%  |

Table 1: Proportion of riders and passengers killed and injured on medium and heavy motorcycles from 2015 to 2020 (N=2065). Source: (Iversen and Njå, 2022)

Motorcycle riding is seasonal, with accidents occurring more frequently from April to September, peaking in June (Iversen, T., Njå, O. 2022). It is currently not possible to determine to what extent traffic competence or riding experience can explain accidents involving drivers in the 45-54 age group. The thematic analysis does not describe the riding experience of the deceased or seriously injured or how much these drivers used their motorcycles throughout the year.

The thematic analysis of serious accidents involving ATVs, mopeds, and motorcycles from 2015 to 2020 (Iversen and Njå, 2022) identifies a potential issue with motorcyclists' attention. It questions whether brief lapses or ongoing attention deficits could lead to fatal accidents. Run-off-road accidents in curves are particularly common among motorcycle accidents. We have extensive knowledge about these incidents from detailed analyses and studies. These studies (Høye, 2017; Høye et al., 2016; Sagberg et al., 2020; Njå and Iversen, 2022) explore factors such as accident types, timing, lighting conditions, road conditions, purpose, helmet use, etc., but they do not fully capture all aspects of the accidents.

### 3. Methods

#### 3.1. Participants

The project was conducted with 62 riders divided into three groups: Group 1: Riders with less than three years of riding experience who use the motorcycle for leisure and utility riding. This group consists of individuals who have had a license for three years but may not have ridden much during this period. Although they have had their license for three years, they may lack practical experience and routine on the road. This could be due to not riding regularly or only riding

under limited conditions, such as in good weather or on familiar roads. The group also includes those who have gained good experience over the three years. Group 2: Riders with more than three years of riding experience who regularly use the motorcycle for leisure and utility riding. Riders in this group have had a license for more than three years but can be both experienced and inexperienced. Some have ridden regularly under varied conditions, while others have ridden less frequently. Even though they have had their license for a long time, a lack of frequent riding or exposure to different riding situations may mean they have not developed the same skills and confidence as more active riders. Group 3: Riders with extensive professional experience on motorcycles, such as police officers, riding test examiners at the Norwegian Public Roads Administration, riding instructors, and instructors at driver development courses for track/road. The police have internal training that ensures motorcycle competence at all levels. Examiners at the Norwegian Public Roads Administration participate in internal courses and gatherings to maintain their competence. Instructors at riding development courses train frequently on tracks to maintain their skills. Experienced riding instructors have broad competence under various weather and road conditions as well as traffic situations. All these groups are expected to have higher competence compared to both Group 1 and Group 2.

#### 3.2. Interview guide

Prior to conducting the interviews, a semi-structured interview guide was developed. This guide was organized around key themes such as the interviewee's background and experience. Additionally, questions were asked about their tactical and strategic thoughts when approaching and navigating various intersection situations, as well as their considerations when entering and negotiating curves and curve combinations. An example of a question is: "What criteria do you base your speed choices on when approaching and navigating curves?"

#### 3.3. The article authors

The authors of the article are all involved in the education of Norwegian motorcycle riding instructors (Nord University, 2024). They also have extensive experience in training within real

educational settings. Additionally, two of the authors have worked as examiners for practical motorcycle tests.

3.4. The interviews

A total of 62 interviews were conducted. The in-depth interviews were carried out as semi-structured interviews (Kvale, 1996) in the fall of 2023. The interviews took place after each participant had driven the designated route. The interviews lasted between 35 and 45 minutes. They were then transcribed before analysis.

3.5. Analysis

The methodological framework for the analysis is Braun and Clarke's (2006) thematic analysis. However, this method does not provide clear guidelines for analysis involving multiple researchers. Therefore, we applied Helga Eggebo's (2020) "collective qualitative analysis," which builds on Braun and Clarke's (2006) method but provides a framework for collaborative analysis. The analysis process began with each of us (the two interviewers) familiarizing ourselves with the interview data independently. The collective parts of the analysis were further structured through six working meetings, where different interpretations of the transcribed interviews and relevant themes were discussed and revised. By critically evaluating each other's interpretations and demanding clear substantiation of individual interpretations, the collective qualitative analysis has contributed to the reliability and validity of the presented findings.

3.5. Ethics

All study participants were comprehensively informed about the project's objectives and potential risks. Each informant was provided with a written consent form prior to their participation. The project received approval from Sikt: Norwegian Agency for Shared Services in Education and Research (SIKT, 2023), previously known as the Norwegian Centre for Research Data (NSD), in compliance with GDPR principles.

4. Results

In this study, we have selected two main sections from the in-depth interviews. Both sections address areas where motorcyclists are highly prone to accidents. One main section is the motorcyclist's accident susceptibility in various intersection situations, and the other main section is the motorcyclist's accident susceptibility in curves, particularly curve combinations.

Table 1 Results of In-depth interviews

| Factors related to<br>Motorcyclists' explicit<br>tactical and strategic<br>choices |  | Illustrative explanation                                                                       |
|------------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------------------|
| 1 Intersections                                                                    |  | Tactical and strategic choices when approaching and navigating various intersection situations |
|                                                                                    |  |                                                                                                |
| 2 Curve combinations                                                               |  | Tactical and strategic choices when approaching and navigating in curve combinations           |
|                                                                                    |  |                                                                                                |

4.1. Intersections

The informants in group 1 and 2 were asked about their strategies to avoid intersection accidents. Many stated that intersections were a high-risk area for motorcyclists. They expressed concern about this issue, but when describing their information gathering, strategies, and tactical choices, many struggled to specify preventive measures to minimize risk. This applied to both their actions approaching and passing through intersections. In roundabouts, several were concerned about yielding to the left, and although cars from the right were also mentioned as a risk factor, there was significant trust in traffic from the right. This trust was largely extended to intersections on rural roads with higher speed limits. The majority stated that eye contact was crucial to determine if the intersection was safe, while a minority remained on alert through the danger zone. The general perception was that eye contact could confirm that other road users had

seen them, and they believed this could be determined well before approaching the intersection. The minority pointed to tactical choices such as speed and lateral positioning to maintain distance.

All informants in group 3 expressed awareness of the motorcyclist's particular vulnerability and risk when riding through intersections. Compared to groups 1 and 2, informants in group 3 provided a more concrete description of their strategy for gathering information, approaching and passing through intersections. However, this was not a universal trait for the group, as some gave shorter and less clear descriptions of their information gathering strategies. In contrast to the other two groups, informants in group 3 described specific strategic and tactical choices to reduce the risk of intersection accidents. Examples include lateral positioning to create distance from other traffic and speed adjustment to avoid meeting other traffic in the intersection. They seemed to set higher criteria for clearing the intersection and expressed lower trust in other road users than informants in groups 1 and 2.

#### **4.2. Curve combinations**

Several informants described their line choices in curves as outlined in the curriculum and relevant literature. They focused on normal positioning and the straightest possible line. Descriptions of their actions before and through the curve were articulated by the group. An interesting finding in this group, compared to groups 2 and 3, was the concept of visibility, which was never used as a strategic or tactical choice in curve riding.

When choosing speed approaching and through curves, many in group 1 preferred to adjust speed before and increase speed through the curve, with the majority avoiding braking in the curve. They believed braking could cause the motorcycle to straighten up, making it difficult to control and potentially dangerous. When asked about their vision, many focused on looking far ahead but also used quick glances to gather references. They were not precise in describing what they looked for but expressed that lifting their gaze improved the curve.

In curve combinations, many aimed for the straightest possible lines but struggled to describe a concrete strategy. Descriptions of their vision use

were often unclear. Most were skeptical of cracks and holes in the road, associating them with danger.

Informants in group 3 described their line choices in alignment with the curriculum's definition of normal positioning in curves. They often adjusted their line based on visibility conditions. The majority delayed the turning point in blind left-hand curves to create more distance from oncoming traffic. When asked about speed choices in curves, they described adjusting speed before the curve and maintaining or increasing speed through it. However, fewer had a precise strategy for speed choice, often relying on a "gut feeling."

Only three informants in the group expressed that braking in curves posed a risk, as it could reduce the motorcycle's ability to turn and make it harder to control. The majority found braking in curves unproblematic, using it mainly for correction if they felt their speed was too high or encountered obstacles. Most informants focused on looking as far ahead as possible, with some scanning closer to the motorcycle for hazards. Despite this, all informants stated that small cracks or holes in the asphalt had little impact on their riding.

In curve combinations, all informants in group 3 provided precise descriptions of their strategy, contrasting with groups 1 and 2. They described planning the first curve based on the next, treating them as a unit. Many emphasized the need to look as far ahead as possible.

## **5. Discussion**

### **5.1. Intersections**

Motorcyclists face a high risk of accidents in various traffic situations, particularly when navigating intersections. This report examines how knowledge and understanding of multi-vehicle accidents influence information gathering and behavior when approaching and traversing intersections. It also explores how motorcyclists prevent conflicts and risks at intersections and their preparedness when in danger from other road users.

All groups recognized their vulnerability as motorcyclists. However, Groups 1 and 2 were unclear about their information-gathering processes and struggled to articulate when an intersection was deemed safe. In contrast, Group 3 provided more consistent explanations of their strategies for navigating intersections, although

variations in tactical choices were still observed. This inconsistency suggests that theoretical knowledge may not always translate into practical decision-making.

The motorcycle curriculum (NPRD, 2016) emphasizes interaction and efficient traffic flow, which can be contradictory, as motorcyclists are expected to be both defensive and efficient. The concept of preventive riding, highlighted in the report "Safe Motorcycle Riding" (Wigum et al., 2023), is part of defensive riding. Preventive riding involves positioning and speed choices to avoid encounters with other road users at intersections.

Groups 1 and 2 had difficulty describing how they converted information gathering into concrete risk prevention measures, often reacting to situations as they arose. Group 3, however, expressed a more proactive approach, anticipating potential conflicts and being better prepared when they occurred.

Trust in other road users varied, with Groups 1 and 2 expressing greater reliance on eye contact to confirm that other drivers had seen them. Group 3, while also using eye contact, relied on additional observations such as speed reduction and vehicle positioning to assess situations more accurately.

The concept of "action space," as defined in the motorcycle curriculum, refers to the safety margin motorcyclists create by maintaining distance from potential hazards. Groups 1 and 2 appeared to have more trust in other road users, often not creating sufficient action space, whereas Group 3 emphasized creating physical space to enhance cognitive readiness. There was a varying degree of risk awareness among the groups concerning driving through intersections. Group 1 was aware of a general risk, while Group 2 was aware of the specific risk associated with driving through intersections. Thus, we can say that there were varying degrees of risk awareness among Group 1, Group 2, and Group 3

## **5.2. Curve combinations**

Group 1 exhibited an unclear strategy for lane positioning, generally adhering to the curriculum guidelines. Participants in Group 1 had held their licenses for less than three years, suggesting that recent training might explain their adherence to standard positioning in curves. This finding aligns with Group 3, predominantly composed of

motorcycle instructors. For most participants in Group 2, visibility was a crucial factor in navigating curves. While some in Group 1 mentioned oncoming traffic in left-hand curves, this varied significantly within the group. Group 2 more frequently cited the risk of oncoming traffic in left-hand curves, though less so than Group 3.

The concept of standard positioning has been debated in various forums, and qualitative findings suggest it remains a topic of interest among motorcyclists. Group 2 stood out regarding standard positioning in curves, frequently using the term "visibility." This group aimed to achieve visibility before entering a curve, justifying the need with information gathering about the road ahead. This strategy may conflict with the curriculum's intentions, which emphasize the importance of maintaining an action space for safe riding. Delaying entry into a curve to gain visibility can increase the risk of encountering oncoming vehicles, particularly in right-hand curves where vehicles tend to position near the centerline, reducing the distance between the motorcyclist and oncoming traffic. This can lead to risky situations where the motorcyclist may react impulsively with limited action space.

Conversely, there may be a need to deviate from the curriculum's guidelines on standard positioning in right-hand curves. The curriculum specifies that motorcyclists should be to the right of the lane's center by the curve's midpoint, allowing for tactical adjustments. Deviating from standard positioning can provide early information about the road ahead, enabling motorcyclists to detect intersections and other road users sooner and be seen earlier. Some participants used the concept of the vanishing point as a strategy to assess how a curve will develop. The vanishing point, though not mentioned in the curriculum, was used by some informants to make tactical decisions.

The different groups employed various strategies and rationales for their choices, and multiple factors may influence the outcomes.

The curves used in the study were not among the sharpest or most challenging for motorcyclists. Additionally, many participants were familiar with the route, likely having a strong experiential basis and mental map. This theory is supported by several informants who indicated that familiarity with the area and curves influenced their strategic choices. The surprising number of Group 2 participants using "visibility" as a strategic term, compared to the few in Group 3, may be due to the evolution of motorcycle training over time. Previous training emphasized different positioning strategies, with visibility being a key factor. The term "visibility" may also have varied meanings, such as waiting to see the curve's exit or waiting to enter until oncoming traffic is clear. The concept of the vanishing point may also be linked to visibility.

## **6. Validity**

An interview that focuses on the interviewee's own knowledge related to motorcycle riding cannot capture all the forms of knowledge the interviewee possesses. This is particularly true for tacit knowledge – the skills and insights that the interviewee takes for granted and therefore finds difficult to articulate (Polanyi & Ra, 2000). Furthermore, the interview may not necessarily illuminate all dimensions of situated knowledge, which is strongly tied to specific contexts and practices (Kvale & Brinkmann, 2021). Consequently, the knowledge generated by the interviews has limited validity for the participant's overall riding competence. However, the interviews do provide insight into how the participants think and reason about their own riding style, the concepts they use, and the factors they consider important for safe riding.

## **7. Implications**

Training programs should place a strong emphasis on the practical application of theoretical knowledge. This includes real-world scenarios where motorcyclists can practice and refine their tactical and strategic decision-making skills. Given the observed differences in self-awareness and decision-making between experienced and less experienced riders,

continuous training and periodic refresher courses should be implemented.

Training should prioritize proactive riding strategies, encouraging motorcyclists to anticipate potential hazards and make informed decisions before encountering dangerous situations. This can be achieved through scenario-based training and simulations. Additionally, training programs should include components that help riders develop greater self-awareness. This can involve reflective practices, self-assessment tools, and feedback from instructors to help riders understand their strengths and areas for improvement.

Training programs should be tailored to the experience levels of the riders. Novice riders may require more foundational training, while experienced riders can benefit from advanced courses that challenge their skills and enhance their strategic thinking. Training should also address the importance of visibility and positioning in various riding scenarios, including intersections and curves. Riders should be taught how to use concepts like the vanishing point to make informed decisions about their positioning.

Testing should go beyond theoretical knowledge and assess practical skills in real-world scenarios. This can include on-road tests that evaluate a rider's ability to apply tactical and strategic choices effectively. Both training and testing should incorporate mechanisms for providing feedback to riders. Constructive feedback can help riders understand their mistakes and learn how to improve their decision-making processes.

By implementing these implications, training and testing programs can better prepare motorcyclists to navigate complex traffic situations safely and effectively, ultimately reducing the risk of accidents.

## **8. Conclusion**

The extent to which different levels of experience influence self-awareness and stated descriptions of tactical and strategic choices is considerable. Experienced motorcyclists, such as those in

Group 3, tend to exhibit higher self-awareness and provide more consistent and detailed descriptions of their tactical and strategic decisions. Their advanced training and extensive riding experience enable them to anticipate potential hazards and make proactive decisions, enhancing their overall safety.

In contrast, less experienced riders, like those in Groups 1 and 2, often expressed lower self-awareness and struggle to articulate their decision-making processes. Their recent training may not yet have fully translated into practical application, leading to reactive rather than proactive riding behaviors. This discrepancy highlights the importance of continuous training and experience in developing a motorcyclist's ability to accurately assess and describe their tactical and strategic choices.

Overall, the findings suggest that experience plays a crucial role in shaping a motorcyclist's self-awareness and ability to make informed, strategic decisions, ultimately impacting their safety on the road.

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