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Comparison of bend-taking on thermal and electric motorcycles: qualitative studies.

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1 Research approach

Powered two-wheelers (PTWs) riders are overrepresented in road accidents. In France, although PTWs riders make up less than 2% of traffic, they account for 22% of those killed and 34% of those seriously injured (ONISR 2023). As a result of environmental concerns and the announced ban on the sale of thermal vehicles in the European Union from 2035, the number of electric vehicles (EVs) in road traffic, particularly of electric motorcycles (EMs), is set to increase. However, EVs have specific features regarding dynamics and sensory feedback, which influence vehicle control. This raises the question of the transition from thermal to electric vehicles and the necessity for drivers to adjust how they control their vehicles, which could be problematic, especially for experienced drivers of thermal vehicles.

Difficulties drivers and riders encounter when transitioning to EVs could be linked to changes in environmental information gathering, leading to changes in driving behavior. Indeed, the differences between thermal and electric vehicles are numerous. EVs are silent, generally have no gearbox, vibrate little, and have different dynamics due to high engine torque from the first seconds of acceleration (Toman, Svoboda, and Pinkas 2021). The dynamic of EVs could be problematic during re-acceleration out of bends, with the risk of losing grip. The absence of engine noise also raises questions since studies have shown that when car drivers were entirely deprived of auditory feedback, their perceived driving speed was lower than their actual speed (Evans 1970). When drivers were partially deprived of auditory feedback, their driving speed increased (Horswill and Plooy 2008; Knowles, Scott, and Baglee 2012).

The “electric” rider would have fewer sensory cues available to her/him. During the transition from thermal motorcycles (TMs) to EMs, control difficulties could thus appear and put her/him in danger (for example, over-speed on a bend approach).

The eMC² project examines the safety implications of switching from TMs to EVs. It focuses on two main concerns: the impact of quieter EMs on road users’ perception and

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the differences in driving characteristics between EMs and TMs, emphasizing the need for appropriate measures to ensure road safety during this transition.

2 Methodology

The two exploratory studies we present aimed to investigate the differences between riding an EM and a TM when taking bends. The two studies were carried out on the La Ferté-Gaucher race track, where eight men, who were all expert riders (instructors at the French Gendarmerie Nationale), drove both a TM and an EM. All motorcycles ridden by the participants were instrumented specifically for the needs of these experiments, based on the instrumentation work carried out in a previous work (Smaiah et al. 2018).

Four riders participated in the first study: two had experience riding an EM, and the other two were novices at EM. They rode a TM (sport bike type, RSV4, Aprilia) and an EM (roadster type, SR/F 2020, Zero Motorcycles) using three different riding styles (free, soft, and dynamic). The mixed factorial experimental design was therefore composed of a between-subjects factor, "level of experience" (novice or confirmed), and two within-subjects factors: "motorisation" (thermal or electric) and "riding style" (free, soft or dynamic). The instructions for the "soft riding style" modality were to minimize acceleration and braking and to ride calmly without trying to perform. For the "dynamic riding style" modality, the instructions were to adopt active, sporty, and energetic riding.

Four other participants, all novices to EM, took part in the second study by riding a TM (roadster type, ER6, Kawasaki) and an EM (roadster type, SR/F 2020, Zero Motorcycles). The experimental design was composed of two within-subjects factors with two modalities: the "motorisation" factor (thermal or electric) and the "riding style" factor (soft or dynamic).

During these two studies, we collected subjective data (workload with the NASA-TLx, questionnaires, and interviews on the feelings (sensations, emotions, sentiments) of riding experience) and objective data (GPS location, speed, acceleration, braking, ...).

3 Results of the study

Preliminary analysis of the collected data (from the two studies) showed that the participants rapidly adapted to the EM. They also highlighted differences in riding for the two motorisation types. The participants perceived a lower speed than their practiced speed when riding the EM. They stated that the EM, not having a gearbox, was easier to control on the inside of bends but was more challenging to control when they approached bends due to an underestimation of perceived speed. Finally, the workload assigned to riding the EM was considered more important by the participants than the workload assigned to riding the TM.

We identified a difficulty in generalizing our results due to the high level of expertise demonstrated by our participants, all French Gendarmerie Nationale riding instructors. We hypothesize that their professional and daily experience in riding motorcycles allowed them to quickly adapt their control actions and riding behavior to the motorisation changes.

4 Perspectives

These first results support the presence of a rider behavior adaptation during the transition from a TM to an EM due to the motorisation specificities'.

In-depth subjective data analysis is underway to qualify the participants' feelings about transitioning from a thermal to an electric vehicle. We will attempt to correlate the results of these analyses to measured behavioral differences: control actions implemented by riders and motorcycle trajectories when taking bends.

In the future, as part of the eMC2 project, similar studies on our riding simulator will be conducted to verify whether the results obtained on the track will also be obtained on

our riding simulator. Finally, other studies will be conducted to continue investigating the transition from TM to EM.

The presentation will discuss the method implemented for the two exploratory studies carried out in October 2023 and the results obtained.

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