Emergency braking training for motorcyclists: instructors' preferences and new technologies application in a perception-action task

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Motorcycle and mopeds, called powered-two-wheelers (PTWs), represent an affordable, fast, and reliable mode of transport that is more space-efficient than other private vehicles, helping to reduce congestion in cities. PTWs can improve the sustainability of transport systems, mainly when deployed as shared mobility alongside electrification, but their most critical aspect is the increased risk of injury and death for their riders. The behavioural qualities relevant for safe riding have been widely accepted and frequently has become the base of the national training programs. However, the tests to obtain the riding license are limited to simple tests that examine part of the program. Since higher order skills take longer to be assimilated and the main goal of users of driving schools is to get the license, driving schools are frequently committed to train the motorcycle riders to perform properly the test, without time and budget to explore in more depth all the levels. New approaches, including new technologies and data analysis, are essential to improve understanding of driver behaviour and capabilities, and thus to enhance safety through driver training.

The objectives of this study are twofold: to collect the preferences and requirements of a sample of instructors to teach the most frequent emergency manoeuvre; (ii) to develop a method by reproducing a real emergency braking scenario with perception-action components capable of identifying with data from an instrumented vehicle the difference between the use of brakes by experts versus less skilled riders.

In a first stage, 19 instructors from different regions of Italy were consulted with surveys to understand the braking training procedure and the instructor preferences to define a procedure able to assess the performance of the riders in a realistic scenario using new technologies. The survey was fully completed by 11 riding instructors and we present the most relevant results. Only 3 instructors thought the license test for emergency braking reflects the skill level that riders need to have in real-world riding. When asked about the two most important features when evaluating practice attempts, instructors mostly look for balanced front and rear brake use (72.7%), followed by other secondary features such as the coordination and control of body movements (36.4%), the stopping at a specific place and stability of PTW at completion of braking (both 27.3%). At the same time most of the instructors indicated that the hardest task

for the trainees is finding the right balance front and rear brake use (63.6%) and coordinating the body movements (54.5%). Many instructors noted the importance of scanning the environment and keep the look straight ahead during the exercise. Concerning the type of feedback used, there is not a clear consensus, instructors selected mainly the description of what could happen as a result, and the practical demonstration of how to correct the error. Asked about tools for teaching, most instructors (55%) considered PTW instrumented as one of the most important tools for teaching.

In a second stage, a field experiment was conducted in a real-world controlled environment to identify the differences among 13 riders with different skill levels in an emergency scenario. The test scenario was built in a parking lot with a car driven by one investigator turning in front of the rider representing one of the most frequent crash scenarios with motorcycles (Left Turn Across Path- LTAP), where the perception-action task associated to emergency braking is critical. Thirteen participants experimented 12 emergency braking events with an instrumented 278cc scooter-style motorcycle (including brake pressure sensors). The test identified the competencies in perception and control. Concerning perception skills, intermediate skilled riders reduced in a significant way the response time in the last part of the test. Riders more advanced in perception skills detected the key cue (car starting to turn) quickly from the beginning and kept the level for the rest of the test. The novice rider did not experience any significant improvement during the whole experiment as the rider's cognitive load was fully focused on actions related to the control of an unknown vehicle. Regarding control skills, lack of use of the maximum front brake capacity was the difference identified that separated the less skilled riders from the more skilled ones. As a demonstrator, it was designed a user interface tool that classify the skill level of the rider and provide prescriptive feedback to support learning process. By providing riders with objective feedback on such elements as disparity from target stopping distance and with expert riders, riders are aware of their own limitation.

The work highlighted the need to understand the behaviour of the riders in emergency manoeuvres, and specifically braking, to define strategies based on new technologies that increase their safety. The literature on learning and skill acquisition has noted that there is evidence of gradual and steady improvement in performance given: a well-defined task; detailed and immediate feedback; and the opportunity for learners to perform the same or a similar task repeatedly to improve their performance progressively. The study presented has set the first two components with a well-defined emergency braking task coupling perception and action and with a tool to provide visual feedback of the performance.