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Review

Emotion behind the Wheel: Unravelling the Impact of Emotional (dys)Regulation on Young Driving Behaviour—A Systematic Review

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Abstract: Young people engage in a variety of behaviours that can have an impact on their health and safety, including driving and road accidents, which represent a major health issue today. Emotions, and in particular emotional regulation (ER), interact significantly with key elements of driving behaviour, such as risk perception, decision-making, and attention. We carried out a systematic review considering the presence of an association between emotional (dys)regulation and driving behaviour of young adults (18–25 years). A total of 1849 records were selected for screening and, finally, eight full-text articles were included. Two main findings were found: on the one hand, driving anger, unlike other emotional patterns, emerged as a well-defined cause of impairment among young drivers. On the other hand, drivers' risky behaviour seems to be influenced by a heterogeneous set of factors, such as using specific ER strategies or personality traits (e.g., impulsivity). Expressing one's emotions adaptively, improving the ability to accept and be aware of negative emotions, and controlling impulsive behaviour could reduce driving risks in young drivers.

Keywords: road safety; emotional regulation; affective states; young drivers; driving behaviour; personality traits

Citation: Pizzo, A.; Lausi, G.; Burrai, J.; Quaglieri, A.; Mari, E.; D'Alessio, I.; Barchielli, B.; Cordellieri, P.; Giannini, A.M.; Cricenti, C. Emotion behind the Wheel: Unravelling the Impact of Emotional (dys)Regulation on Young Driving Behaviour—A Systematic Review. *Sustainability* **2024**, *16*, 3384. https://doi.org/10.3390/su16083384

Academic Editors: Stewart Barr and Jesús-Nicasio García-Sánchez

Received: 22 February 2024
Revised: 4 April 2024
Accepted: 15 April 2024
Published: 18 April 2024

1. Introduction

Road accidents represent a major health issue today, especially due to the consequences on direct and indirect victims [1] and related social costs. The risk of being involved in a traffic accident is associated with young age and male gender [2–6]: in fact, the mortality rate is three times higher for males between the ages of 15 and 20 [7–10]. In Italy, the main causes of road accidents in 2020 included distracted driving (or "indecisive course") in 15.7% of cases, failure to yield or respect traffic lights in 14.5%, and high speed in 10% of cases, followed by failure to observe a safe distance and the implementation of irregular manoeuvres, both in 8.7% of cases (ACI and Istat: https://www.istat.it/it/files/2022/07/REPORT_INCIDENTI_STRADALI_2021.pdf; accessed on 12 September 2022). These findings are consistent with global evidence; indeed, road accidents can be caused by several factors, but 55–60% of them are due solely to the human factor, which occurs, along with other variables, in about 90% of cases [11–14]. As reported by the Highway Safety Manual [7], road crashes can be attributed to the human factor (93%), the environment (34%), or the vehicle (13%), which may also overlap and concur in the causation of the

accidents (in fact, the proportion only apparently exceeds 100 percent). Within the human factor are the effects produced by emotional states: anger, stress, worry, or excitement can have the same impact on driving as phone use or driving under the influence of alcohol or drugs [15–17].

1.1. Emotion and Driving Behaviour

Emotions interact significantly with key elements of driving behaviour, such as risk perception, decision-making, and attention [17–22]. The association between positive-valence emotion and attention has important effects on driving behaviour, as experiencing positive emotions extends the attentional field, leading to increased interference from other stimuli, which may distract the drivers, slowing their reaction time [22,23]. However, in the presence of emotion with positive valence, there is greater cognitive flexibility [22,24], and information processing occurs more easily and carefully. In contrast, the presence of a negative emotion highlights a potentially threatening situation, which requires more effort to process information [9]. Moreover, negative emotions seem to increase the chance of engaging in dangerous driving behaviours and being involved in accidents [24].

By assuming a connection between emotions, decision-making, and risk perception [25–28], it is possible to refer to two main approaches [29]. The first perspective is based on the positive or negative valence of emotions, whereby positive emotions decrease risk perception while negative emotions increase it [29–31], without clarifying the specific effect of two different emotions with the same valence (e.g., anger, fear). Instead, based on the second perspective [29,32–34], every emotion differs based on the evaluation of certain dimensions (e.g., certainty, control, pleasantness, attention, expected effort, responsibility). For example, while anger and happiness are associated with certainty and individual control and negatively affect risk perception, fear is associated with uncertainty and situational control, and thus increases risk perception. In addition, it is important to consider how young people under 25 tend to engage in more risky behaviours, exhibiting higher levels of impulsivity and arousal, also related to a level of cognitive development that is still in progress [35].

Emotions also have significant effects on driving speed [21,36,37], safe distance [37–40], and increased collisions [37,41].

Emotions are also found to be especially relevant in the propensity to make errors or violations. Reason and colleagues [42] described these risky behaviours as two distinct psychological constructs: errors refer to the inability to perform a series of actions aimed at achieving a goal, whereas violations are behaviours performed to violate traffic rules. In addition, errors can be divided into slips (i.e., lack of attention), lapses (i.e., lack of memory), and mistakes (i.e., lack of intention). In turn, violations can be "aggressive" when they contain a component of interpersonal aggression or "ordinary", as deliberate deviations from safe driving without the intent to harm [43,44].

1.2. Emotional (dys)Regulation and Driving Behaviour

Emotional regulation (ER) refers to the "processes by which we influence which emotions we have, when we have them, and how we experience and express them" [45].

Gross [46] defined ER as the set of "conscious and nonconscious strategies we use to increase, maintain, or decrease one or more components of an emotional response" and conceptualized an ER model that distinguishes two classes of mechanisms based on the moment in which they are activated. The first group addresses antecedent-focused regulation strategies, because they are employed before the emotional response is fully activated, for example, shifting attention away from a stimulus that could generate negative emotions. The second group includes response-focused regulation strategies, which are employed when the response has already been generated, for instance, through modulation or suppression. Antecedent-focused strategies reduce both the expression and the experience of negative emotions and do not require a high level of cognitive load; in contrast,

response-focused strategies require a greater amount of cognitive effort and only influence the reduction in emotional expression [46].

Individuals with difficulties in ER are more likely to behave aggressively, display impulsiveness, and, consequently, reveal a tendency to engage in risky behaviours and driving errors. In contrast, those who use more adaptive ER strategies experience less stress under intense emotional conditions such as, for example, in heavy-traffic situations [47]. ER abilities while driving would seem to increase not only with age but also with driving experience: in particular, Carver [48] pointed out that if negative emotions are experienced, the ER system engages in restoring emotions to a neutral level, which leads the individual to ignore activities that are not directly related to the regulatory action. As a result, while driving, the attention paid to the road will represent a small part of the attention involved in the regulation process. For instance, drivers who experience anger but do not express it exhibit speed-increasing behaviours, while drivers who express anger engage in much more dangerous behaviours that are correlated with more accidents [49]; moreover, when the individual experiences a state of frustration while driving, their emotional state can dangerously escalate [50].

1.3. Young Drivers and Driving Behaviour

Young people engage in a variety of behaviours that can impact their health and safety in several contexts (e.g., drinking frequency, general delinquency, sexual behaviour), including driving [51–57].

Specifically, changes in driving behaviour and decreases in driving performance are often detected when drivers experience a range of emotional states [58,59]. For example, Lansdown and Stephens [60] found that young drivers distracted by emotional conversations via smartphone experience more problems than those who have non-emotional conversations, with an increase in driving distraction [61].

Moreover, the young are not inclined to risky behaviours in general but rather are more willing to take risks in particular circumstances, such as in the presence of peers [21,62]. Peers may serve as role models to emulate, thus encouraging risky driving, since from a developmental point of view, young novice drivers are vulnerable to negative peer influences and need social approval from peers [63].

This finding introduces the relevance of social influences for young drivers who, in the presence of friends, drive faster than when they are alone, especially when their emotional state is positive, probably due to an "emotional contagion" [9,64].

1.4. Aims

The preceding literature, as highlighted in the Introduction, has demonstrated that emotions can have a significant impact on driving behaviours, increasing the likelihood of violations and errors, and that difficulty in their regulation is associated with engaging in risky behaviours [42]. This systematic review aims to provide an overview of the current scientific knowledge regarding the relationship between emotional regulation and driving behaviours in young adults, who represent the population with the highest mortality rate due to road accidents [2–6] and are more prone to engaging in risky behaviours, partly due to their lower emotional maturity [35]. Two objectives are outlined: (1) to identify the emotional regulation strategies used during driving behaviour; (2) to verify whether studies confirm a relationship between maladaptive or adaptive driving behaviours and specific emotional regulation strategies, such as cognitive reappraisal or emotion suppression.

2. Methods

This systematic review was based on the framework of Arksey and O'Malley [65] and was performed according to the recommendations of the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses"—PRISMA [66,67]. The study was registered in the "International Prospective Register of Systematic Reviews" (PROSPERO) in August 2021 (CRD42021251474), and the detailed protocol is available upon request.

Given the complexity and importance of the phenomenon, a thematic synthesis was performed to provide an initial overview of the current state of research on the topic [68].

2.1. Eligibility Criteria

In this study, the criteria were measured using PCC, which stands for:

- Population: young adult drivers (18–25 years);
- Concept: the presence of an association between emotional (dys)regulation and driving behaviour of young adults;
- Context: addressing emotional (dys)regulation in driving contexts.

Several online databases were screened on 22 April 2021: PubMed/MEDLINE, PsycINFO, Web of Science, Scopus, Secondary Documents of Scopus, and CINAHL. In addition, a manual search of reference lists of the retrieved relevant articles was performed. The keywords used were related to emotional regulation and dysregulation ("emotion* regulation" OR "emotion* dysregulation") and driving context ("driv*" OR "traffic" OR "road").

Screening resulted in 3925 papers published from 1999 to 2021. After the removal of duplicates, a total of 1849 records were selected for screening. Selected articles included English, Italian, French, and Spanish languages and had to meet the following criteria: (1) the articles were qualitative/quantitative/cross-sectional/cohort/non-report studies; (2) the study target population included young adults (18–25 years; [69]); (3) the article considered any vehicle (e.g., car, bicycle, truck); (4) the presence of the construct of emotional (dys)regulation; (5) the presence of an association between emotional (dys)regulation and driving behaviour.

The exclusion criteria were systematic/non-systematic reviews, mini-reviews or meta-analyses, clinical study samples, focus on stress/distress, or study involving individuals other than drivers. A number of 1806 records were excluded based on the title and abstract, and a total of 43 articles were assessed for eligibility. Of these, 34 studies were excluded for the following reasons: incorrect focus (N = 5), incorrect research design (N = 5), incorrect population (N = 21), or other (N = 3), resulting in a total of 8 records reviewed.

The review procedure was the following: titles and abstracts were screened by two authors independently (AP and CC) and potentially eligible studies were collated using Microsoft Excel, version number 16.82, Microsoft Corporation, Redmond, Washington, United State). The potentially eligible studies and discrepancies were discussed among the research team. Then, the authors reviewed the full texts based on the inclusion and exclusion criteria outlined, with the emerging discrepancies being discussed and resolved within the research team.

2.2. Risk of Bias

Two authors (AP and CC) also performed a risk of bias assessment using the NIH Quality Assessment Tools for observational, cohort, and cross-sectional studies (https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools; accessed on 20 September 2022), and a third author (GL) performed a final review to ensure the adequacy of the assessment procedure. An overall quality assessment was performed to identify the risk of general bias: studies were rated as "Good" if they showed a $\geq$75% positive response rate to the NIH instrument questions (N = 2); they were rated as "fair" if they showed a 50–75% positive response rate to the NIH instrument questions (N = 6); finally, studies showing a 25–50% positive response rate to the NIH instrument questions were rated as "Poor" (N = 1). Following the NIH guidelines exclusion criteria, studies rated as "Poor" were excluded; thus, a final number of 8 studies were reviewed (see Figure 1; Table 1).

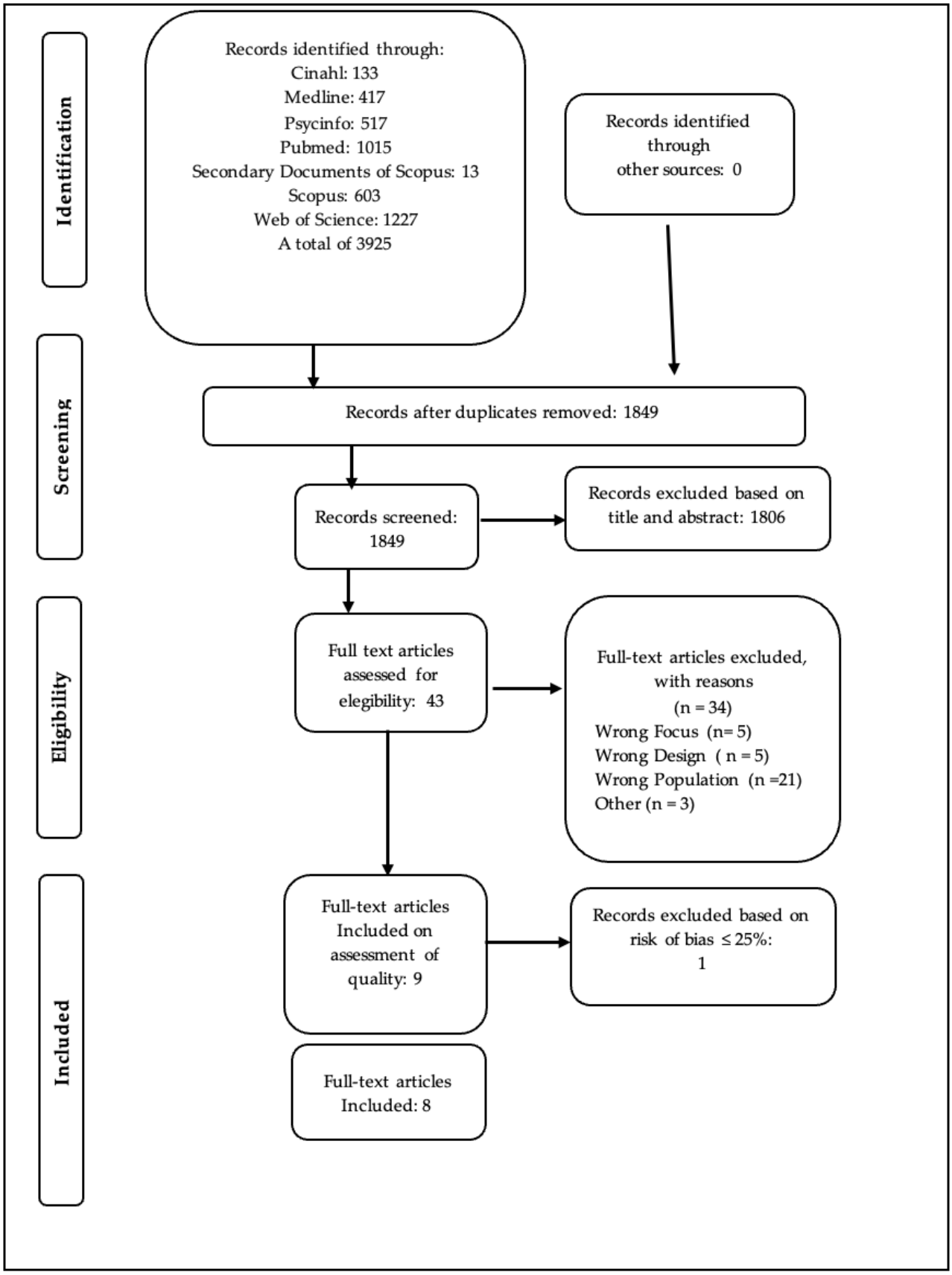

Figure 1. Flow Chart.

Table 1. Assessment of risk of bias.

	Q1.	Q2.	Q3.	Q4.	Q5.	Q6. *	Q7. *	Q8. **	Q9.	Q10. ***	Q11.	Q12.	Q13. ****	Q14.	Quality Rating
Harris and Nass, 2011 [50]	Y	Y	Y	N	N	N	N	Y	Y	NA	CD	CD	NA	N	Poor
Harris, 2011 [70]	Y	Y	Y	N	N	N	N	Y	Y	NA	Y	NA	NA	Y	Fair
Jeon, 2012 exp2 [71]	Y	Y	Y	Y	Y	N	N	N	Y	NA	Y	NA	NA	N	Fair
Jeon et al., 2015 [72]	Y	Y	Y	Y	N	N	N	N	Y	NA	Y	CD	NA	N	Fair
Watling et al., 2020 [73]	Y	Y	Y	Y	N	N	N	Y	N	NA	N	Y	NA	Y	Fair
Biassoni et al., 2016 [74]	Y	Y	Y	Y	Y	N	N	N	Y	NA	Y	NA	NA	N	Fair
Lazuras et al., 2019 [75]	Y	Y	Y	N	CD	N	N	Y	Y	NA	Y	Y	NA	Y	Good
Parlangeli et al., 2018 [76]	Y	Y	Y	Y	N	N	N	Y	Y	NA	Y	Y	NA	Y	Good
Van der Zwaag et al., 2013 [77]	Y	Y	Y	N	Y	N	N	Y	N	NA	Y	CD	NA	N	Fair

Note. The quality of included studies was assessed using the National Institutes of Health (NIH) Quality Assessment tool for Observational Cohort and Cross-Sectional Studies (https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools; accessed on 20 September 2022). Q1. Was the research question or objective in this paper clearly stated? Q2. Was the study population specified and defined? Q3. Was the participation rate of eligible persons at least 50%? Q4. Were all the subjects selected or recruited from the same or similar populations (including the same period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants? Q5. Was a sample size justification, power description, or variance and effect estimates provided? Q6. For the analyses in this paper, were the exposure(s) of interest measured before the outcome(s) being measured? Q7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed? Q8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as a continuous variable)? Q9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? Q10. Was the exposure(s) assessed more than once over time? Q11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? Q12. Were the outcome assessors blinded to the exposure status of participants? Q13. Was the loss to follow-up after baseline 20% or less? Q14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)? Q: question; CD: cannot determine; NA: not applicable; N: no; Y: yes; *: For cross-sectional analyses, the answer to Questions 6 and 7 should be "no"; **: If there are only two possible exposures (yes/no), then this question should be given an "NA", and it should not count negatively towards the quality rating; ***: Cross-sectional studies do not assess the exposure(s) more than one time, because of their nature; ****: Cross-sectional studies do not require a follow-up.

3. Results

Most studies were cross-sectional and observational cohort designs and were conducted in different countries: Italy (N = 2), USA (N = 3), UK (N = 1), Australia (N = 1), and the Netherlands (N = 1). The following measures were used to assess ER while driving: ad hoc questionnaires (studies = 4) [70–73] and validated instruments (studies = 4) [74–77].

3.1. The Role of the Affective State and Emotional Regulation on Driving Behaviour

Lazuras and colleagues [75] applied a dual-process model (System 1 and System 2) to the driving performance of young drivers: System 1 traits regard higher-order cognitive processes correlated with impulsiveness and sensation-seeking related to deviant driving behaviour; System 2 traits regard individual differences in self and emotion regulation associated with a positive attitude toward safe driving. The results showed that impulsivity was associated with driving violations and errors, whereas sensation-seeking was directly associated with errors. Furthermore, both elements showed significant indirect effects on committing errors through self-regulation. In particular, the mediation results would suggest that System 1 inputs increase the risk of being involved in road accidents, whereas System 2 self-regulatory processes may mitigate this risk.

Parlangeli and colleagues [76] investigated correlations that existed between unsafe driving behaviour and certain variables such as impulsivity, risk perception, and emotion regulation strategies: cognitive reappraisal and suppression. Impulsivity was positively correlated with suppression strategies and not with reappraisal, showing how exhibiting dangerous driving behaviour before reappraisal of emotions makes the use of suppression strategies more likely. This is expressed by a relationship between cognitive reappraisal and increased risk perception for all investigated dangerous behaviour (i.e., intentional acts—violations—and unintentional errors—errors, i.e., wrong actions that are a result of incompetence, and lapses, i.e., errors resulting from attentional malfunction), whereas the suppression strategy appears to be associated only with increased risk perception for violations.

Another strategy to regulate the emotional state was investigated by van der Zwaag and colleagues [77], who specifically focused on the effect of music in attenuating a driver's emotional response by measuring some physiological parameters (e.g., skin conductance, facial muscle tension). Participants listened to positive (happy)-valence music of their choice, after which the experiment consisted of a gradual or abrupt music change towards more calming music. The results showed that the abrupt way of changing music type led to more physiological calmness and improved driving performance and was thus safer and more effective.

Studies on Driving Anger Regulation

Concerning driving anger, the results showed that when this emotion is involved, young drivers commit a greater number of violations and errors. Biassoni and colleagues [74] investigated the relationship between driving anger, risky behaviour, and how drivers express and regulate anger while driving. The authors assessed verbal and acoustic expressions of driving anger and examined whether emotion regulation strategies, (e.g., cognitive reappraisal) effectively reduced this emotional pattern. Using a simulated driving scenario, a neutral and angry emotional state was induced in participants by recording their behaviour and reactions: one group received instructions to re-evaluate anger-inducing events, while a control group received no instructions. The results showed that in the anger-inducing scenario, participants committed violations, honked, and swore more frequently, although the emerging acoustic profile of anger expression resembled that of "cold anger" [78], characterized by lower levels of arousal and intensity. Cognitive reappraisal, however, is effective in reducing the number of violations committed.

Harris [70] examined the effect of cognitive reappraisal strategies on driving behaviour and, specifically, how these strategies can help to minimize the negative emotional response to frustrations while driving. Three variables were assessed: the ER strategy (i.e., reappraisal, suppression, or none), the time at which it was introduced (i.e., before or while driving), and the source of regulation (i.e., internal or external). Some individuals were asked to self-regulate by generating their reappraisals or suppressing thoughts and emotions, while others received concrete suggestions from a voice assistant to reappraise what was happening during the driving scenario. The results showed that those who received external support in the use of regulation and/or suppression strategies before or during the driving task performed better than participants who self-regulated or suppressed, but also compared to those who did not implement any strategies and those who received instructions during the simulation. Specifically, the use of reappraisal strategies significantly reduced negative emotions, in contrast with the use of suppression strategies or the absence of any type of regulation.

Similarly, Jeon [71] and Jeon and colleagues [72] explored how interaction with an on-board voice agent can improve a driver's psychological state and increase driving safety. The authors specifically explored the use of the on-board software to mitigate the effects of anger on driving behaviour. Again, an angry or neutral emotional state was induced in participants who received two types of prompt from a voice assistant during the driving simulation: "ER" (Emotion Regulation) or "SA" (Situation Awareness). The results showed

that both types of voice prompts improved both the driver's context awareness and driving performance, while also reducing anger level and perceived workload.

3.2. Sleep-Impaired Emotional Regulation on Driving Behaviour

The consequences of emotional dysregulation on driving behaviour have also been investigated through its effect on sleep levels in young drivers [73]. Sleep deprivation leads to lower ER and impulse control abilities, but also to impaired cognitive function [79]. Thus, research by Watling and colleagues [73] examined the relationship between sleep level, sleep quality, sleep-related impairment of ER skills, and impaired cognitive functioning, as well as increased risk propensity in a sample of young drivers. These relationships were specifically investigated about two frequent behaviours among young people: the tendency to keep driving while sleepy and the experience of having a sleep-related close call. The results showed that more than 15% of the participants were at risk of being involved in a road accident due to sleepiness. In addition, both age and impaired ER due to sleepiness were associated with the two risky behaviours investigated, as well as shorter sleep duration and higher levels of impaired cognitive function.

The coding of all articles is shown in Table 2.

Table 2. Coding.

Authors, Year	Country	Sample Details	Assessment of ER	Assessment of Other Variable	Results		
	N	Mean Age (SD)	Gender				
Harris, 2011 [70]	USA	112	20.9 (1.7)	50% F	AdHoc_Q	-	The use of reappraisal strategies significantly reduced negative emotions, in contrast with the use of suppression strategies or the absence of any type of regulation.
Jeon, 2012 [71]	USA	30	20.9	46.66% F	AdHoc_Q	NASA—TLX SA Questionnaire	Angry drivers committed more errors and violations than those in a neutral state and also showed higher speeding, overconfidence risk underestimation, and lower levels of context awareness.
Jeon et al., 2015 [72]	USA	60	20.2 (1.2)	40% F	AdHoc_Q	NASA-TLX	ER or SA voice prompts improved both the driver's context awareness and driving performance and reduced anger and perceived workload.
Watling et al., 2020 [73]	Australia	137	19.75 (2.89)	58.39% F	Adhoc_Q	ESS ISI CASQ STQ	Both age and impaired ER due to sleepiness were associated with risky behaviours, as well as shorter sleep duration and higher levels of impaired cognitive function.
Biassoni et al., 2016 [74]	Italy	44	23.32 (1.91)	54.5% F	POMS	-	Angry participants committed violations, honked, and swore more frequently, but cognitive reappraisal decreased the number of violations.
Lazuras et al., 2019 [75]	UK	409	21.18 (2.12)	65.5% F	ERQ	ABIS NEO-PI (5 items) SSRQ DBQ	Impulsivity is associated with driving violations and errors, while sensation-seeking is directly associated with errors. Both have significant indirect effects on committing errors, but self-regulation has a protective effect in this regard.

Table 2. *Cont.*

Authors, Year	Country	Sample Details	Assessment of ER	Assessment of Other Variable	Results		
	N	Mean Age (SD)	Gender				
Parlangeli et al., 2018 [76]	Italy	490	-	46% F	ERQ	DBQ (13 items) M-DBQ (4 items) ImpSS Scale	Impulsivity was positively correlated with suppression strategies and not with reappraisal; females engage in safer driving behaviors and have poorer sensation-seeking compared with males, but they do not differ in impulsive behaviours; sensation-seeking and impulsivity were positively correlated with dangerous driving behaviors and negatively correlated with hazard perception. Females tend to use reappraisal strategies to manage emotions while driving, but males prefer emotional suppression strategies, also preferred by younger drivers, while, as age increases, a greater use of reappraisal emerged.
van der Zwaag et al., 2013 [77]	Netherlands	28	21.7 (1.3) M 21.3 (0.4) F	50% F	UMACL	RSME	Music change has a positive effect on the driver's mood by dampening its intensity. Abrupt music change is associated with a lower skin conductance (less activation), greater facial corrugator muscle tension (sad expression), and fewer crashes in the simulation and seemed to be more functional in regulating mood while driving, improving driving performance, and promoting safer behaviours.

Note. ABIS: Abbreviated Impulsiveness Scale; AdHoc_Q: Ad Hoc Questionnaire; CASQ: Cleveland Adolescent Sleepiness Questionnaire; DBQ: Driver Behaviour Questionnaire; ER: Emotion regulation; ERQ: Emotion Regulation Questionnaire; ESS: Epworth Sleepiness Scale; F: Female; ImpSS: Impulsive sensation-seeking; ISI: Insomnia Severity Index; M: Male; M-DBQ: Modified Driver Behaviour Questionnaire; NASA-TLX: NASA Task Load Index; NEO-PI: NEO Personality Inventory; Ot: Other; POMS: Profile of Mood States Scale; RSME: Rating Scale for Mental Effort; SA: Situation awareness; SSRQ: Short Self-Regulation Questionnaire; STQ: Sleep Timing Questionnaire; UMACL: UWIST Mood Adjectives Checklist.

4. Discussion

This systematic review aimed to investigate the association between ER and driving behaviour, with a specific focus on young adults. Research on this topic has been concerned with investigating how specific ER strategies affect risky behaviours; the effect of ER on anger and on driving behaviours; and the effect of impairment of ER strategies associated with sleepy driving states. Two main results emerged: on the one hand, driving anger, differently from other emotional patterns, arose as a well-defined cause of impairment among young drivers. On the other hand, drivers' risky behaviour seemed to be influenced by a heterogeneous set of factors, such as using specific ER strategies or personality traits (e.g., impulsiveness).

Specifically, about the effects of emotional regulation on driving behaviour, the results showed that impulsivity and sensation-seeking are associated with an increased risk of road crashes and that emotional regulation, especially emotional reappraisal, is a protective factor. Specifically, emotional reappraisal increases the perception of risk for both intentional behaviours (such as violations) and unintentional behaviours (such as errors and

lapses), while otherwise, suppression may be a risk factor [75,76]. Beyond the specific strategies mentioned above, one external component that has emerged as a tool for emotion regulation is music; specifically, relaxing music can lead to better driving performance [77]. In line with these results, personality traits, such as impulsivity and sensation-seeking [80], seem to influence the relationship between ER and risky driving. Oppenheim et al. [81] found that higher sensation-seeking scores suggest a greater likelihood of being high-violation-rate individuals, consistent with the previous literature [82–85]. Apparently, the higher the score on such traits in the drivers, the greater the difficulties in emotion regulation, making them more likely to engage in risky driving behaviours, rather than positive driving behaviours [86].

Out of all the studies included in the literature review, particular interest was given to the study of driving anger. In this context, the role of the emotional regulation strategy of reappraisal emerges again as a protective factor for the enactment of risky behaviours, such as the number of violations [74]. Several authors [70–72] aimed to investigate the presence of differences between self-regulation and hetero regulation (i.e., instructions given by voice commands on ER strategies to be implemented). The results showed that hetero regulation is more effective in reducing anger, frustration, and the enactment of risky driving behaviours than self-regulation or no emotional regulation. In addition, the authors found that the instruction to participants to use the reappraisal strategy rather than suppression was more effective. These results are in line with several studies that have highlighted the link between aggression and risky driving behaviour [47,87–91], specifically in young drivers [92–96]. Indeed, adolescents and young adults up to 25 years are still in a cognitive development stage; hence, they are more likely to show strong impulsive reactions and physical arousal toward risk [35]. Drivers who are more able to use ER strategies (e.g., cognitive reappraisal) may experience less distress in traffic situations, as they may have the ability to enact desired behaviours when experiencing negative emotions, to remain calm in situations where others would feel overwhelmed or out of control, and to concentrate and focus on driving in a stressful situation [47,97]. A systematic review conducted by Bjureberg and Gross [98] confirmed these results by examining the implications of using different ER strategies on driving behaviour, especially when the driver experiences anger. While cognitive strategies (e.g., repurposing or reconstrual) consistently decreased road rage outcomes, attentional strategies (e.g., focus shifting) or response modulation strategies (e.g., suppression) were found to be equivalent or, in some cases, to increase aggressive driving.

How we regulate our emotions can also have a significant impact on indirect driving behaviour through the relationship between this ability and certain key factors, such as sleep. The review results showed that impairment of ER resulting from sleepy states emerged as associated with risky behaviours such as the tendency to keep driving while sleepy and the experience of having a sleep-related close call [73]. Sleep-related impairment of ER is supported by Motomura and Mishima [99], suggesting that sleep loss, besides causing daytime sleepiness and psychomotor impairment, may affect emotional stability and emotion regulation mechanisms (e.g., interfering with the functional regulation of the amygdala by the ventral anterior cingulate cortex). In addition, although age and driving sleepiness are negatively correlated in the literature [100–103], Watling's study [104] found a positive relationship between these factors in a sample of young drivers (aged 18–25), probably due to their limited driving experience concerning sleepiness and overnight driving. Accordingly, several studies have reported a higher prevalence of sleepiness-related vehicle crashes for youths and young adults [105,106] and a higher propensity towards risky driving behaviours [107].

Limits

This study has limitations that should be considered for the interpretation and generalization of the results: firstly, all studies were conducted in Western contexts, while none

of them addressed driving in Asian or, more generally, Eastern contexts, a reason that could bias the analysis of the driving behaviours observed.

In addition, the measures used are very different: some studies employed simulated driving scenarios, others used questionnaires, and others employed both types of assessment tools. Moreover, ER was mostly assessed with ad hoc measures (sometimes consisting of few items), while only two studies used the ERQ [75,76]. In addition, the focus of the studies is not homogeneous: despite there being some consistency in the research on road rage, other studies are more heterogeneous, examining several different issues (e.g., mood induction, impulsivity and sensation-seeking, and sleepiness levels).

Finally, the study population is restricted to car drivers, while there are no studies investigating ER or dysregulation in other drivers (e.g., bicycles, public transportation, trucks, and electric scooters).

5. Conclusions and Future Perspective

This systematic review confirmed the importance of emotional regulation in young people's driving activity. One of the key findings that emerged in the studies that dealt with this issue related to the different effects between the use of the cognitive reappraisal strategy and suppression. Within the theoretical framework of reference is the model of Gross [46], who indicated how these two strategies are situated at two different levels of emotional response generation. Cognitive reappraisal, intervening before the generation of the emotion, decreases the intensity of the emotion without any cognitive load; while suppression intervening, on the contrary, following the generation of the emotion has an effect exclusively on reducing emotional expression and requires more cognitive load. Emotions interact significantly with the cognitive processes essential for good driving performance, such as risk perception, attention, and decision-making. In this sense, the results of this review are consistent with findings from studies conducted by Gross and colleagues [108–110] showing that adaptive strategies, such as reappraisal, can improve cognitive performance, while suppression can have a negative effect.

Based on the present findings, recommendations could be made. Young drivers could reduce driving risks and adaptively express their emotions by improving their ability to accept and be aware of negative emotions and control their impulsive behaviour. In addition, a specific recommendation for young drivers may be to use cognitive strategies such as reappraisal and reconstruction while driving, which can be effective in dealing with difficulties in impulse control and goal-oriented responses [97]. To the authors' knowledge, this is the first systematic review that explicitly investigated ER and driving behaviour specifically in young drivers.

Our results highlighted the relevance of including ER skills in the assessment of driving candidates, suggesting potentially useful intervention pathways to decrease unsafe driving, but should be considered precautionary considering the limitations that emerged. Future investigations are needed to examine young drivers' attitudes and abilities to better understand possible implications for road safety education. Moreover, another study could focus on other age groups (e.g., how ER affects driving ability in the elderly) or could consider other emotional competencies (e.g., emotional intelligence).

Author Contributions: Conceptualization, A.P., G.L. and C.C.; methodology, A.P. and C.C., formal analysis, A.P. and G.L.; data curation, A.P., G.L. and C.C.; writing—original draft preparation, A.P., G.L., J.B., A.Q., E.M., I.D., B.B. and C.C.; writing—review and editing, J.B., A.Q., E.M., I.D., B.B. and C.C.; supervision, A.M.G. and P.C.; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflicts of interest.

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