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Review article

Driving anxiety and anxiolytics while driving: Their impacts on behaviour and cognition behind the wheel

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ABSTRACT

Introduction: The interaction between road safety and drivers' mental health is an important issue to take into consideration on transportation and safety research. The present review deals specifically with the link between anxiety and driving activity from two complementary points of view.

Method: A systematic review into primary studies, following the PRISMA statement, was carried out in four databases: Scopus, Web of Science, Transport Research International Documentation and Pubmed. A total of 29 papers were retained. On the one hand, we present a systematic review of research articles exploring the cognitive and behavioural effects of driving anxiety, regardless its onset, when concerned people have to drive. The second goal of the review is to compile the available literature on the influence of legal drugs, which are used to fight against anxiety, on actual driving tasks.

Results: Eighteen papers have been retained for the first question, whose main findings show that exaggerated cautious driving, negative feelings and avoidance are associated with driving anxiety. Most of the conclusions were drawn from self-reported questionnaires and little is known about the effects in situ. Concerning the second question, benzodiazepines are the most studied legal drugs. They affect different attentional processes and could slow reaction times down depending on the population and treatment features.

Conclusions: The two standpoints included in the present work allow us to propose some possible lines of research to study certain aspects that have not been explored in depth about people who either feel apprehensive about driving or who drive under the effects of anxiolytics.

Practical applications: The study on driving anxiety may be crucial to estimate the consequences for traffic safety. Furthermore, it is relevant to design effective campaigns to raise awareness about the issues discussed. To propose standard evaluations of driving anxiety and exhaustive research works to find out the extent of anxiolytics use are also important to be considered for traffic policies.

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1. Introduction

Nowadays, mobility is one of the core issues to guarantee the well-functioning of industrialised societies. Most of the citizens have to interact with the driving activity every day for different reasons and in numerous contexts. Sometimes, users take a passive role as passengers in public transport or carpooling and other times they are obliged to take an active role as drivers. Although some people enjoy driving or just drive for need, there is a non-negligible percentage of the population who not only is uncomfortable to drive but who experiences veritable anxiety and suffers to cope with this activity [1,2]. Furthermore, in the last few years, the prevalence of anxiety due to diverse reasons is increasing and at times people draw upon anxiolytics to cope with it and go on doing their daily activities, including driving. Both situations raise the issue of the link between mental health and the guarantee of safe transportation when concerned people drive.

On the subject of driving anxiety, there is no consistent operational definition. In general, it consists of fear of driving-related stimuli that are perceived as threatening or dangerous [3]. Hence, the intensity of driving anxiety can vary greatly from one person to another, leading to different consequences. Some people seem to have specific anxiety about driving, whereas for others the anxiety does not seem to be limited to the driving domain, but spreads to a wider scope [4]. Drivers with moderate or extreme driving anxiety have reported that it affects their mental health, their quality of life as well as their quality of work [5–7]. Driving-related anxiety has also been associated with high levels of shame, both for experiencing anxiety as well for the associated avoidance behaviour [6]. Indeed, one of the major consequences of driving anxiety is the restriction of driving activity. Depending on the intensity of this anxiety, it can range from avoiding certain stressful situations (e.g., tunnels, highways, or bad weather conditions) to avoiding driving in general. Consequently, this avoidance may prevent drivers from developing automatic driving skills and can reinforce driving anxiety through a deterioration in self-confidence and self-efficacy.

The first studies on driving anxiety were mainly conducted in the context of the follow-up of people who had been victims of a road accident, and more specifically in people with post-traumatic stress disorders [8,9]. However, it is not necessary to have been involved in a crash to experience driving anxiety. For instance, in a recent survey in France, only 57% of respondents could recall a specific event that could be considered the trigger for their driving anxiety. The top three sources were panic attacks, followed by criticism from a passenger or driving instructor and only in the third place, a road accident [10]. Overall, understanding the origin of anxiety is important as different anxieties may require different treatments and therapies. While those associated with post-traumatic stress disorder (PTSD) or generalised anxiety disorders (GAD) are better suited to clinical support, other anxieties can be managed within the driving network and be addressed and/or prevented by road safety practitioners through better awareness and education for drivers.

Driving is an activity involving a wide range of cognitive processes and attentional mechanisms [11], which can be altered by emotions [12,13]. The driver must demonstrate adequate sustained and selective attention to be able to discriminate useful information for decision-making while remaining ready to react satisfactorily to unexpected events. Yet, anxiety is characterised by high physiological arousal and a negative affective state, which interact with attentional biases [14] and increase sensitivity to errors and negative feedback, impacting the attentional control of goal-directed inhibition [15]. For instance, it has been shown that individuals with high levels of anxiety allocate their attention to a target less efficiently than individuals with lower levels of anxiety [16]. On the other hand, there is some evidence that anxiety can enable rapid responses to potential hazards. However, the disengagement from attention allocated to threatening stimuli appears to be more difficult and the ability to inhibit distractors also appears to be less effective [17]. Finally, some work has highlighted a degradation of perceptual-motor performance in anxiety-provoking situations [18].

Knowing these interactions between cognitive functions and driving performance on one hand, and between cognitive functions and anxiety on the other hand, it is interesting to study the particularity of driving anxiety in order to determine its consequences on cognition and, consequently, on driving skills and behaviour from a transportation standpoint. In this way, it would be possible to tailor suitable countermeasures. Hence, the first research question of this review consists in searching for scientific evidence on the impact of driving anxiety on driver cognitive process and performance.

One of the solutions to fight against anxiety consists of medication, mainly anxiolytics or sedatives. It is known that this kind of medication may decrease individual's alertness level with possible consequences on driving safety [19–21]. Nonetheless, these conclusions are mainly drawn from retrospective studies after the crashes happen, and, consequently, it is not possible to assess causality. Thus, it is crucial to better understand the effects of legal drugs against anxiety on the psychological processes and behaviour while driving experimentally. Therefore, the second research question consists in searching for updated scientific evidence on the impact of taking anxiolytics on driver cognitive process and performance.

2. Methodology

Guidelines and recommendations contained in the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement [22] have been considered. The parameters extracted from papers to analyse were based on the PICO structure (Population, Intervention, Comparisons and Outcome), especially for the question about legal drugs.

2.1. Eligibility criteria

The inclusion criteria concerning the content of the contributions to be included in the reviews were.

- Papers dealing with the influence of driving anxiety on cognitive or behavioural processes, not only based on subjective feeling expression;
- For the first objective, only the research where an explicit driving anxiety measurement was included;
- Papers dealing with the effects of medication (legal drugs only) that could be used to fight against any type of anxiety, or stress, on any driving activity.

The exclusion criteria for the first objective were mainly established in order to avoid confounding factors that could modulate severely the specific effects caused by driving anxiety.

- Specific populations who can present particular cognitive or emotional characteristics affecting attentional resources and their management, such as attention-deficit/hyperactivity disorder (ADHD), general anxiety disorder (GAD), chronic stress or depression;
- Neurological or motor troubles that could influence the cognitive process and the anxiety in diverse situations, such as epilepsy, parkinsonism or multiple sclerosis;
- Older people, for whom the source of driving anxiety may be linked to driving retirement or natural cognitive and motor declines;
- Research dealing with post-traumatic stress disorder (PTSD) after a motor vehicle collision where a cranial trauma occurred or other severe health repercussions as well as research on PTSD after driving in extremely violent contexts (e.g., soldiers in a war);
- Research focused only on driving anger, aggression or supposed anxious driving styles without explicating the feeling of driving anxiety potentially associated;
- Research focused on punctual stressful situations on road where the anxiety is not really linked to driving activity (e.g., range anxiety, travel phobia, fear in public transport).

The publication dates considered were between 1990 and 2021. The search was limited to English contributions. Concerning the type of contributions, research articles, book chapters, brief reports, and conference proceedings were included. The types of contributions excluded were: books, reviews, meta-analyses, theses, press articles, editorial letters, patents, and authorless contributions.

2.2. Information sources

Four electronic databases were consulted.

- Scopus (https://www.scopus.com/)
- Web of Science (https://clarivate.com/webofsciencegroup/solutions/web-of-science/)
- Transport Research International Documentation (https://trid.trb.org/)
- Pubmed (https://pubmed.ncbi.nlm.nih.gov/)

2.3. Search strategy

In order to conduct an exhaustive systematic search, we first identified the main concepts linked to the aims of the study: “driving”, “anxiety” and “cognition”. Then, various keywords that could be linked to each concept and which were expected to appear in the titles or in the abstracts of studies regarding driving anxiety were defined. The search token “*” was used to expand our research to all derivative words from the same semantic family. The retained research equation is depicted in Table 1. When possible, we excluded research fields not relevant to the research question (e.g., Chemistry, Microbiology) to limit the number of false positives.

The combined search in Scopus, Web of Science, TRID, and Pubmed, performed on August 06, 2021, provided a total of 16,273 records. The screening and study selection described in Fig. 1 were performed by two researchers independently. The Cohen’s kappa score for agreement between both of them for the full-text screening phase was $\kappa = 0.853$. According to Ref. [23], this is a strong agreement value. When a disagreement existed, a third opinion was solicited from another researcher from the research team. A total of 7 articles required the third opinion, 5 and 2 for the first and the second research questions, respectively.

Table 1
Equation of research.

Driving		Anxiety		Cognition
driv* OR rid* OR travel OR road	AND	anxi* OR apprehension OR reluctance OR worry OR fear OR fright* OR panic OR phobi* OR post-traumatic	AND	cognit* OR attent* OR percept* OR inattent* OR executive OR memory OR behav*

3. Results and discussion

3.1. Impact of driving anxiety on behaviour and cognition

After the record screening and considering all the inclusion and exclusion criteria described in the previous section, 18 articles have been retained corresponding to the first research question. The selected studies, based on surveys or focus groups (n = 17) and on-road experiment (n = 1) are depicted in Tables 2 and 3, respectively. Of note, cognitive processes are scarcely examined.

Few papers reported studies about anxiety and driving on simulators, and when it is the case, they did not deal with driving anxiety but about driving situations which induced an anxiety state and consequently they were not included (e.g. Ref. [38]).

The selected articles were published after 2004, although the time period considered begins in 1990. Almost a half of them (n = 8) were published recently, in 2020 or 2021. Several countries are represented, including European countries, USA, Australia, and, particularly, New Zealand (n = 5).

Concerning the participants in the studies, overall the number of women and men was comparable, except on particular cases where the recruitment focused specifically on people concerned by driving anxiety, e.g. Refs. [6,7], where a higher proportion of women took part. All ages were considered within the different studies, without making groups according to these factors, just two studies focused on only young people [28,33]. In general, licensed drivers were included. In only three studies, the sample was constituted by people with motor vehicle accident history [25,29,33].

The research works presented in Table 2 are exclusively based on self-reported measures including a variety of validated questionnaires, such as the Driving Behaviour Questionnaire (DBQ), the Driving Behaviour Survey (DBS), the Driving Cognitions Questionnaire (DCQ), or the Driving and Riding Avoidance Scale (DRAS), according to the scope of the paper. Driving anxiety has been measured either by one-item driving anxiety scale (n = 5) or by one of the mentioned questionnaires measuring driving attitudes, behaviours and cognitions, specifically DBS, DCQ or Driving Situations Questionnaire (DSQ). Note that, sometimes, the same questionnaire can be used as the score of driving anxiety in one study and as a measure of the impact of such anxiety in another study, e.g., DBS. The score of this questionnaire can be interpreted by different points of view, mainly when it refers to anxious driving styles [28,30,31]. Thus, it would be desirable to determine which dimension of the anxiety manifestations (e.g., behaviours, feeling, psychophysiology responses …) should be privileged to measure it.

Globally, the findings agree concerning the behavioural impact. The most common driving behaviours that have been linked to driving anxiety are related to exaggerated caution, anxiety-related performance deficits, i.e., a higher number of lapses, errors or

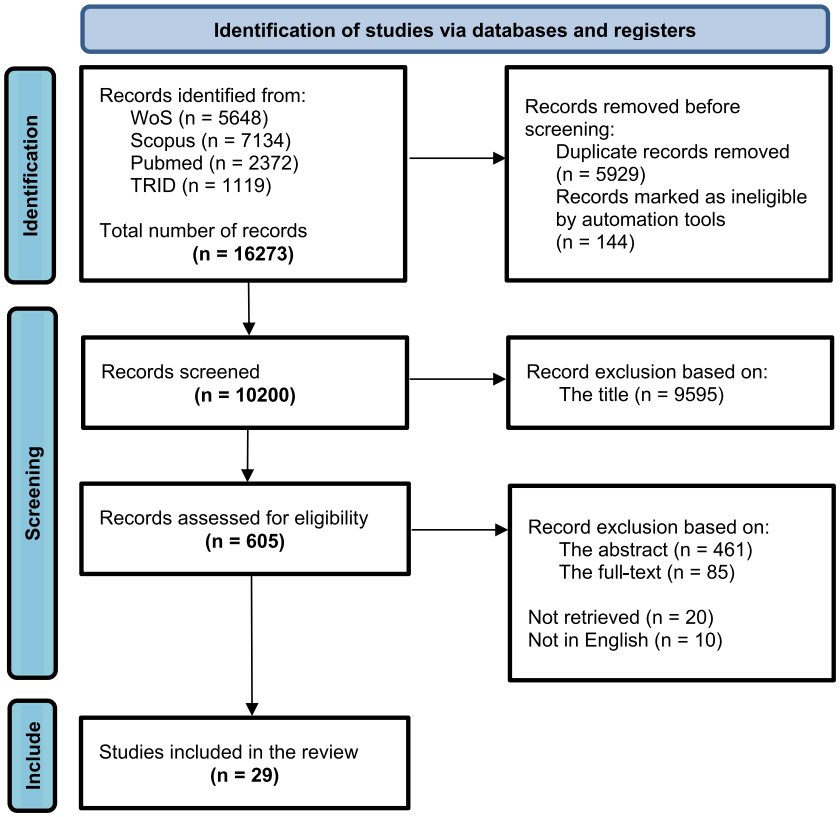

Fig. 1. PRISMA flowchart.

Table 2
Description of the papers reporting impacts of driving anxiety through surveys and focus group.

Study	Country	Participants				Questionnaires Driving Anxiety	Other Questionnaires	Main results on behavioural impact
		N	age rang (mean ± SD)	Gender Female/ Male	Characteristic			
Barnard & Chapman (2018) [24]	United Kingdom	227	17 to 81 (35 ± 18.4)	65.6% F 33.4% M	Licensed drivers	- Modified version of State-Trait Inventory of Cognitive and Somatic Anxiety while driving (STICSA) - Driving Cognitions Questionnaire (DCQ)	- Driving Behaviour Survey (DBS)	Driving anxiety predicts anxiety-based performance deficits, exaggerated safety-cautious behaviours and total DBS scores
Clapp et al. (2014) [25]	USA	3 groups **A**: 40 **B**: 515 **C**: 316	**A**: (40.8 ± 13.3) **B**: (19.1 ± 1.7) **C**: (19.5 ± 1.8)	**A**:62.5% F 37.5% M **B**: 45.6% F 54.4% M **C**: 47.6% F 52.4% M	**A**: Crash related post traumatic stress disorder (PTSD) **B**: Students **C**: Students involved in crash	- Driving Behaviour Survey (DBS)	- Driving and Riding Avoidance Scale (DRAS) - Clinical Administered PTSD Scale (CAPS) - Beck Depression Inventory (BDI)	In group A, medium correlation between CAPS and hostile/aggressive driving. Greater level of safety and caution behaviour and of anxiety based performance deficits in PTSD
Dula et al. (2010) [8]	USA	1121	17 to 55 (21.23 ± 5.61)	67.4% F 32.6% M	Licensed drivers	- Negative Emotional Driving subscale of Dula Dangerous Driving Index (3DI-NCE)	- 13 relevant traffic safety variables - 3DI-Risky-driving and 3DI-Aggressive-driving subscale - Propensity for Angry Driving Scale - Beck Anxiety Inventory	Mean-13 measure, which is an indicator of dangerous driving, was significantly and positively correlated with 3DI-NCE (and the other variables)
Fort et al. (2021) [6]	France	304	18 to 77 (36.96 ± 13.6)	79.9% F 20.1% M	Individuals concerned by driving anxiety	- Driving anxiety scale (11 point Likert scale)	- Driving and Riding Avoidance Scale (DRAS) and Total avoidance - Driving Cognitions Questionnaire (DCQ) - Impact on quality of personal and occupational life	The more intense the driving anxiety, the stronger the avoidance (by DRAS)
Gwyther & Holland (2014) [26]	United Kingdom	48	18 to 75 (33.89 ± 20.5)	83.3% F 12.7% M	Licensed drivers	- General feelings about driving (enjoyment/dislike) - Confidence when driving - Vulnerability feelings	- Coping behaviours	Qualitative data: avoidance and over-regulation type behaviours were employed by anxious drivers to manage feelings of vulnerability
Kontogianni (2006) [27]	Greece	714	7.6% < 25 52% > 55	33% F 67% M	Workers	- Driving Behaviour Inventory (DBI)	- Driver Skills Inventory (DSI) - Reduced version of Driving Behaviour Questionnaire (DBQ)	People scoring high in dislike of driving reported more mistakes and lapses (by DBQ)

(*continued on next page*)

Table 2 (*continued*)

Study	Country	Participants				Questionnaires Driving Anxiety	Other Questionnaires	Main results on behavioural impact
		N	age rang (mean ± SD)	Gender Female/ Male	Characteristic			
Lucidi et al. (2010) [28]	Italy	1008	18 to 23 (18.33 ± 0.7)	43.2% F 56.8% M	Licensed drivers	- NEO-Personality Inventory-Revised - Normlessness Scale - Driving Anger Scale - Locus of control orientation in driving	- Coping behaviour - Driving Behaviour Questionnaire (DBQ) - Attitudes toward traffic rules - Accident risk perception	Identification of 3 groups: risky, worried and careful drivers. Worried drivers showed intermediate scores on driving violations and errors (by DBQ), more positive attitudes toward traffic safety than risky drivers, but a similar number of lapses
Mairean (2020) [29]	Romania	162	19 to 57 (29.37 ± 9.52)	37% F 63% M	Crash survivors	- Travel Phobia Questionnaire for driving (12 items)	- Driving Behaviour Questionnaire (DBQ) - Post Traumatic Stress Disorder (PTSD) Scale	Positive correlation between PTSD symptoms and slips and lapses, and with errors (by DBQ). Positive correlation between fear and avoidance and slips and lapses, and with errors
Nees et al. (2021) [30]	USA	601	18 to 75 (35.27 ± 13.6)	53.6% F 46,1% M	Licensed drivers	- Multidimensional Driving Style Inventory (MDSI) - Accident Concern Scale	- Driving Skill Self-rating - Driving Speed Questionnaire - Desirability of Control Scale - Illusion of Control Scale - Accidents, Violations, and Close Calls questionnaire	Anxious driving style is associated with more self-reported accidents, violations and close calls (MDSI)
Nordfjaern & Rundmo (2013) [31]	Norway	1731	18 to 65 (47.22 ± 11.8)	48.1% F 51.9% M	Licensed drivers	- Road traffic relates worry	- Driver, perceived safety skills behaviours - Attitudes towards road traffic safety - NEO-Personality inventory	People who scored high anxiety and reported low normlessness and sensation seeking traits had the safest behaviours related to road traffic
Przepiorka et al. (2020) [32]	Poland	310	18 to 51 (24.4 ± 6.1)	51% F 49% M	Licensed drivers and learners, mainly students	- Driving Behaviour Survey (DBS) - Driving Cognitions Questionnaire (DCQ)	- Driving and Riding Avoidance Scale (DRAS) - State-Trait Anxiety Inventory.	Positive correlations between anxiety-based performance deficits and exaggerated safety/ caution behaviours (by DBS) and avoidance (by DRAS)
Stephens et al. (2020) [7]	Australia	535	18 to 67 (24.96 ± 9.7)	93% F 7% M	Individuals concerned by driving anxiety	- Driving anxiety scale (11 point Likert scale)	- Driving and Riding Avoidance Scale (DRAS) - Driving Cognitions Questionnaire	Higher driving anxiety, higher avoidance for traffic, driving under certain weather conditions and certain types of roads as well as riding a car (by DRAS)

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Table 2 (*continued*)

Study	Country	Participants				Questionnaires Driving Anxiety	Other Questionnaires	Main results on behavioural impact
		N	age rang (mean ± SD)	Gender Female/ Male	Characteristic			
Steward & St. Peter (2004) [33]	USA	118 (study 3)	range not specified (19.9 ± 1.8)	67.8% F 32.2% M	Crash survivors, mainly students	- Fear Survey Schedule-II (FSS-II, subscale)	- Reported impact on quality of personal and occupational life - Driving and Riding Avoidance Scale (DRAS) - Mobility Inventory (subscale) - Accident fear questionnaire - Fear questionnaire	According to the study 3 of the article greater overall level of fear (FSS-II) was related to increased driving and riding avoidance (by DRAS)
Taylor & Paki (2008) [34]	New Zealand	99	15 to 69 (38.8 ± 15.3)	57.6% F 42.4% M	No specified	- Driving anxiety scale (11 point Likert scale)	- Driving Situations Questionnaire (DSQ) - Driving Cognitions Questionnaire (DCQ) - State Trait Anxiety Inventory (STAI)	Moderate avoidance, more pronounced in women than men
Taylor (2018) [2]	New Zealand	441	18 to 87 (54 ± 17)	66% F 44% M	No specified	- Driving anxiety scale (11 point Likert scale)	- Driving and Riding Avoidance Scale (DRAS) - Driving Behaviour Questionnaire (DBQ) - Driving Situations Questionnaire (DSQ) - Driving Cognitions Questionnaire (DCQ) - Driving Behaviour Survey (DBS) - Driver Social Desirability Scale (DSDS)	Those with high driving anxiety did not have more driving-related incidents, accidents, or injuries than people with no driving anxiety, but they report more frequent anxiety-based performance deficits, exaggerated safety/ caution, and hostile/aggressive behaviours
Taylor et al. (2020) [35]	New Zealand	437	18-87 (54 ± 17)	66% F 44% M	No specified	- Driving anxiety scale (11 point Likert scale)	- Driving and Riding Avoidance Scale (DRAS) - Driving Situations Questionnaire (DSQ)	General and traffic avoidance and weather and riding avoidance were both moderately positively related to increased anxiety and avoidance of driving situations measures (by DSQ and DRAS)
Taylor et al. (2021) [36]	New Zealand	420	18 to 87 (54 ± 17)	66% F 44% M	Licensed drivers and learners (random sample from electoral roll)	- Driving Situations Questionnaire (DSQ) - Driving Cognitions Questionnaire (DCQ) - Driving Behaviour Survey (DBS)	- Driving and Riding Avoidance Scale (DRAS) - Driving Behaviour Questionnaire (DBQ)	The level of lapses and errors (by DBQ) as well as avoidance (by DRAS) were positively related to all anxiety variables

violations [28,30,24,27,32] or even aggressive/hostile behaviours [25,39] resulting sometimes in dangerous driving [8] and sometimes in safer driving [31], probably influenced by driver personality. Arguably, the most relevant impact on driver behaviour is the avoidance either total or partial avoidance of specific driving contexts or situations [6,7,26,35,36,40]. Avoidance seems higher for women [34].

The only study selected that deals with anxiety driving on road is detailed in Table 3. The conclusions drawn by Ref. [37] are in line with the self-reported measures presented above. Driving anxiety impairs driving performance in several situations according to an expert evaluation. Nonetheless, in this study, the real situations could have made its replicability difficult to assure comparable conditions for every participant and, therefore, hampered the generalisation of the results, based on 40 min of driving in a female sample. Furthermore, the two experimental groups were distinguished from each other marginally by one-item scale (DAS).

3.2. Gaps in the research on driving anxiety effects

The first goal of the present review was to show an exhaustive overview of the studies dealing with the effects of driving anxiety on cognition and behaviour during the driving activity. As can be seen within the set of selected articles, driving anxiety is a current attention-grabbing topic for journals with different aims and scopes, since it can be examined from different points of view involving transportation, clinical, social or even technical/ergonomics approaches.

However, the review has allowed finding out the gaps in the research linked to cognitive psychology. Of note, as mentioned previously, most of the papers about driving anxiety are based on self-reported questionnaires to estimate its consequences or they are interested only in the feelings associated with this problem, while the quantification of the detrimental effects while driving is scarce. Actually, the behavioural measures presented in the studies are subjective or drawn by accident reports with diverse levels of detail, and are mainly related to the extent of driving avoidance in different situations. Only one article dealing with people suffering from driving anxiety in real driving has been found [37]. As mentioned, in that study, the behaviour evaluation was provided by an expert instructor and no objective measures from the vehicle were considered. Consequently, the replicability could be compromised in this kind of studies as it is based on the subjective judgment of the instructor.

Therefore, studies incorporating objective measures from the driving activity, similarly to the measures employed in the protocols to evaluate the impact of drugs on driving, such as the ones shown below (e.g., the standard deviation of the lateral position, the steering wheel reversal rate, speed and acceleration variations or braking behaviour) are missing. These objective measures together with the use of other techniques to evaluate driver personal behaviour (e.g., eye tracking to verify the visual strategies, posture, peripheral measures such as the heart rate to quantify the stress response, amongst others) would let possible to examine basic attentional and cognitive processes as well as elaborated strategies and executive functions. To this aim, simulated environments or virtual reality could be suitable alternatives as they show an adequate trade-off between safety, generalisation and experiment replicability. Furthermore, it could allow incorporating neurophysiological measures to examine the underlying neural activity

Table 3
Description of the paper reporting the impact of driving anxiety on road.

Study	Country	Participants				Control group	Questionnaire Anxiety	Other Questionnaires	Driving task	Main results on behavioural impact
		N	age	Gender Female	characteristics					
Taylor et al. (2007) [37]	New Zealand	50	(43.6 ± 15)	100% F	Licensed drivers, driving fearful, at least 3 on the driving anxiety scale	N = 50, ≤2 on driving anxiety scale	- Driving anxiety scale (11 point Likert scale)	- Driving Cognitions Questionnaire - Driving Situations Questionnaire - Advance Driver Assessment - Test Anxiety Inventory - State Trait Anxiety Inventory (STAI) - Fear questionnaire - Beck Depression Inventory-II	40 min of on-road driving, with at least 20 min of which in medium to heavy traffic conditions	Higher number of errors in the fearful group than in the control group, mainly in search techniques at intersections, but also in other situations (entering the traffic flow, holding on the road and maintaining position in the traffic stream). Driving instructor rated control group as having better driving skills than fearful group. Control group had more minor incidents and was charged with more traffic offences.

involved in the anxious situations before passing to the study of unpredictable situations on road.

3.3. Driving and the legal drugs to fight against anxiety

Regarding the second research question, 11 articles were included in the review (Table 4). Ten out of the 11 studies were carried out in Europe, 4 of them in the Netherlands. The publication dates were from 1995 to 2019.

In general, given the particularities of the clinical experimentation, small sample sizes were considered when experimental settings were required (between N = 8 and N = 51, in the latter when including several groups). In contrast, higher sample sizes are found when the study is based on surveys [47]. Whereas experimental controlled settings give insights on behaviour and cognition, surveys provide information about the increased risk to have an accident after legal drug consummation.

When using a driving task, the main driving situations investigated were a driving test on the highway (n = 6), car-following maintaining a safe distance (n = 2), or braking in a delimited area (n = 2). When questionnaires were used, no standard questionnaires seemed to be used. Most of the studies (n = 8) did not present a control group and the comparisons were made intra-group. In every study, the effects of benzodiazepines (mainly employed as anxiolytics) in different forms: alprazolam [42,44,49,51], lorazepam [43,46], diazepam [41,46,48]; were examined. Usually, other medications were taken in consideration (e.g., hypnotics or other antidepressants) that could be prescribed also to fight against anxiety. The dosage was always moderate.

Globally, the results show that anxiolytics can affect cognitive and behavioural components involved in driving. Specifically, the standard deviation of lateral position was increased after taking the drugs (n = 6) and it reached an explicit clinical relevance in Ref. [50]. From a cognitive level, an increase in reaction times and a decrease in alertness (usually measured by self-report) are shown in several studies (n = 4), but some discrepancies can be found, since, for instance, reaction times were shorter to respond to auditory stimuli in Ref. [45].

Some limitations of the studies should be pointed out. In Ref. [47], the conclusions are drawn from self-reported measures based on retrospective memories, it is a cross-sectional study without control groups who do not take medication, and the dosage and medication time are unknown. In some research, (e.g. Ref. [45]), the participants are healthy volunteers and therefore it is not possible to determine the effects of therapeutic treatments taken on longer periods and interacting with the pathology treated. In Ref. [50], the measures are based on patients who estimated themselves whether they felt fit to drive and the anxiolytic and hypnotic users formed a heterogeneous sample due to the diversity in benzodiazepines, daily dosages, time since last dosage, and co-medication. Finally, the impact on very precise driving tests, may not be generalizable to the actual impact in complex driving situations.

3.4. Cautions when interpreting the effects of anxiolytics on driving anxiety

Although anxiolytics can be a solution to fight specifically against driving anxiety, in the present review, we have kept all the studies dealing with these legal drugs regardless of their application. Actually, the participants in most of the studies were healthy people who take the legal drugs only for the experimental purpose. Therefore, we have to be cautious to extract conclusions about the effect of medication since the individual differences can modulate them (e.g., occasional users vs. long-term consumers or people suffering from psychological disorders needing anxiolytics every day).

Either way, it is important to point that, unlike the studies mentioned in the previous section about driving anxiety, the experiments concerning legal drugs included both subjective feelings and objective behavioural measures from driving activity (either in simulators or on road contexts) that permit to examine more precisely the cognitive processes. This is helpful in order to discuss whether the use of some type of anxiolytics is compatible with safe driving and how to classify them in terms of potential risks [20,52].

Nonetheless, no conclusions can be drawn about the efficiency of anxiolytics to fight against driving anxiety, since no specific research on it has been found. In contrast, other therapeutic approaches have been tested, such as cognitive behaviour therapy (CBT) or virtual reality exposition therapy (VRET) among others, as shown in Ref. [53].

3.5. Limitations

This systematic review may have some limitations that have to be mentioned. First, the selection criteria used may have led to missing some relevant studies. For instance, to allow replicability of this review, it was conducted in only 4 electronic databases, “grey” literature has been put aside from the review as well as no English papers. Besides, neither specific populations were included into the selected articles, to avoid confounding factors, nor specific medical terms, e.g., benzodiazepines or beta blockers, were considered as keywords. In addition, publication bias has to be taken into account when considering the conclusions of every systematic review. Thus, considering the lack of experimental studies assessing the objective impacts of driving anxiety on cognitive processing while driving, we may ask ourselves if this is because these studies do not exist or if negative or not statistically significant results relative to our initial questions have not been published.

3.6. Future directions

This current literature review on driving anxiety effects highlights the lack of conceptual and methodological guidelines to allow comparisons between studies. It also shows the lack of controlled studies based on objective indicators of the cognitive impact of driving anxiety while driving. Consequently, several future research lines can be interesting to develop to better understand this issue and design proper intervention as well as anticipating new contexts.

Table 4
Description of the papers assessing the impacts of legal drugs against anxiety on driving performances.

Study	Country	Participants			Control group	Legal Drugs (anxiolytics)	Driving task/Survey	Impact Behaviour (BEH) Impact Cognition (COG) Risk of crash (RISK)
		N Sample	age rang (mean ± SD)	Gender Female/ Male				
Boucard et al. (2007) [41]	France	36 Licensed drivers	18 to 35	52.8% F 47.2% M	yes	- Benzodiazepine (0.1 mg/kg) (0.3 mg/kg)	Streams of 15 real-world scenes displaying a road were presented for 50 m s each	**COG:** Diazepam at a therapeutic dosage affects attentional shifting in the temporal domain and impairs dual-task performance
Brown et al. (2018) [42]	USA	8 Licensed drivers	21 to 40 (30)	50% F 50% M	no (own control)	- Alprazolam (1 mg) - Hydrocodone/ acetaminophen (10 mg/ 325 mg) - Combination	35-min simulated driving on urban, interstate and rural roadway, night-time conditions	**BEH**: Detrimental effects of alprazolam on driving measures of lateral control and longitudinal control.
Daurat et al. (2013) [43]	France	14 Licensed drivers	25 to 35 (29.79 ± 3.5)	100% M	no (own control)	- Benzodiazepine (2 mg lorazepam)	- Simulator 200 km on highway - Real-world 200 km on highway	**BEH:** Increased the standard deviation of the lateral position (SDLP)
Leufkens et al. (2007) [44]	The Netherlands	18 Licensed drivers	21 to 45 (32.3 ± 2.0)	50% F 50% M	no (own control)	- Benzodiazepine (1 mg of XR or IR alprazolam)	- Real-world 100 km on highway	**BEH:** Increased SDLP **COG:** Impact on Divided Attention Task/ tracking performance/go reaction time
Mercier-Guyon & Choay, (1999) [45]	France	16 Licensed drivers (>5 years & >15,000 km)	29 to 44 (40)	100% M	no (own control)	- Lorazepam for 7 days (0.5 mg morning and lunchtime, 1 mg at bedtime) - Captodiamine for 7 days (50 mg, 3 times/day).	Closed circuit 900 m (15min) - 2 passages between beacons to choose to go through or to avoid - Braking in a designated area - Slalom	**BEH:** Increased driving errors due to clumsiness and disinhibition with lorazepam and decreased with captodiamine **COG:** Reduction in reaction time to auditory stimuli in favour of captodiamine (marginally significant)
O'Hanlon et al. (1995) [46]	The Netherlands	**Study 1 -** 16 **Study 2 -** 9 **Study 3** 56 anxious Licensed drivers (>3 years & >8000 km/year)	**St. 1** 25 to 43 (34 ± 4) **St. 2** 22 to 34 (25 ± 4) **St. 3** 24 to 64 (43 ± 0.9)	**St. 1** 50% F 50% M **St. 2** 100% F **St. 3** 64.3% F 35.7% M	no	**St. 1:** 8 days ondasentron (1 mg/4 mg) or diazepam (5 mg) 3 times/day. **St. 2:** 8 days suriclone (0.2 mg) or lorazepam (0.5 mg). **St. 3:** 15 days alpidem (50 mg) or lorazepam (2 mg)	Standard Driving test: 100 km highway	**BEH:** Diazepam increased SDLP after one 5 mg dose and even more after repeated dosing. Suriclone and lorazepam produced a marked rise in SDLP at the beginning of the dosing series and a lesser though still significant rise at the end. Lorazepam also affected the reaction time and suriclone nearly so from the first test day.
Okamura et al. (2018) [47]	Japan	1424 Licensed drivers (>20 years & driving frequency > once per week & medication)	22 to 79 (52.2 ± 11.3)	25% F 75% M	no	- Antianxiety drugs and antidepressants (including benzodiazepines) - Sleeping pills - Cold medicines, sinus medicines, etc (variable dosages)	Occupational Driver Behaviour Scale (ODBS) concerning speeding, rules violations, inattentionn and tiredness	**BEH:** People taking psychotropic show more favourable or careful driving attitudes (scored lower in ODBS) compared with cold/sinus medicines group, but they drive less frequently

(*continued on next page*)

Table 4 (*continued*)

Study	Country	Participants			Control group	Legal Drugs (anxiolytics)	Driving task/Survey	Impact Behaviour (BEH) Impact Cognition (COG) Risk of crash (RISK)
		N Sample	age rang (mean ± SD)	Gender Female/ Male				
Takahashi et al. (2010) [48]	Japan	18 Licensed drivers (>10 years & >5000 km/year)	32 to 44 (37.1 ± 3.3)	100% M	no (own control)	- Benzodiazepine (5 mg diazepam) - Tadospirone (20 mg)	- Car-following test to maintain a constant distance with a lead car - Harsh-braking test to maintain a constant speed and to avoid crashing into humanoid models on the road	**BEH:** Diazepam impaired the harsh-braking performance in acute dosing. Tandospirone does not impair it. No differences in standard deviation of lateral position (SDLP). **COG:** No differences in cognitive functions measured by cognitive tests (Wisconsin Card Sorting Test, WCST)
Touliou et al. (2013) [49]	Greece	51 15 treated 18 untreated 18 healthy control	Treated (42.4 ± 13.9) Untreated (36.9 ± 8.9) Control (35.4 ± 8.8)	51% F 49% M	yes	- Benzodiazepine (0.5 mg alprazolam)	- Lane tracking (20 min) in a highway environment maintaining a constant speed - Car-following (20 min) in a highway environment maintaining a safe distance from the lead vehicle	**BEH:** Increased weaving (SDLP) in treated and untreated anxiety patients after alprazolam intake, present even in small concentrations. Increase in brake reaction time in treated and untreated patients but not in the control group. **COG:** Decrease in alertness only in the control group after alprazolam intake. Untreated patients felt less vigilant in the alprazolam condition. Similarly, healthy participants felt significantly less vigilant after alprazolam intake
van der Sluiszen et al. (2019) [50]	The Netherlands	44 12 + 32 (benzodiazepine + hypnotic) 65 healthy control Licensed drivers (>3 years & >500 km/year)	Benzodiazep. (55.2 ± 9.6) Hypnotic. (55.6 ± 12.3) Control (57.9 ± 10.5)	Patients 59.1% F 40.9% M Control 43.1% F 56.9% M	yes	- Benzodiazepines - Hypnotics (variable dosages)	Standard Driving test: 100 km highway (1 h)	**BEH:** SDLP of hypnotics users exceeded 2.5 cm from controls, indicating clinically relevant impairment. SDLP of users of anxiolytics did not differ **COG:** Users of hypnotics and anxiolytics showed longer reaction times than control on neurocognitive tasks. Results, mostly inconclusive for users of anxiolytics, showed clinically relevant impairment in users of hypnotics for Psychomotor Vigilance Test, Digit Symbol Substitution Test and Determination Test. Mitigation of the effects at long term
Verster et al. (2002) [51]	The Netherlands	20 Licensed drivers (>3 years & >8000 km/year)	(25.1 ± 2.0)	60% F 40% M	no (own control)	- Benzodiazepine: (1 mg alprazolam)	Standard Driving test: 100 km highway	**BEH:** Increased SDLP, Speed and number of excursions out of the lane after alprazolam **COG:** Alertness decreased. Tracking ability was impaired, increased reaction times for both Stenberg Memory Scanning Test and Divided Attention test and increased number of errors too.

- Simulation and virtual reality. First of all, to complement the self-reported measures and to ease the replication of studies on particular cognitive processes under controlled conditions, the research on simulated and virtual environments would be desirable before passing to naturalistic driving and real traffic, which may be more conclusive. In any case, the experiments using simulation should focus on specific processes as some aspects of driving anxiety are probably not relevant when driving in a virtual scene.
- Specific populations. There are several populations who can experience driving anxiety due to or interacting with different factors, such as an emerging cognitive impairment in the case of older people, mobility problems, difficulties to manage attentional resources (e.g., ADHD), neurological disorder (e.g., epilepsy), other psychological troubles (e.g., autism), severe sequels after a motor vehicle collision (e.g., head trauma). The study of these populations was out of the scope of the present review, but it would be important to study the interaction between the mentioned factors and the fear of driving, since it can present distinct impacts on cognition and behaviour. Similarly, the effects of specific medication different than anxiolytics would be essential to guarantee safe transportation.
- Modern vehicles. The emergence and use of new vehicles come with different manifestations of driving anxiety, which can be more or less linked to the traditional concept of driving. For instance, range anxiety (driver's fear that a vehicle has insufficient energy storage) appears as an important source of stress when driving an electric vehicle [54]. Another example is the autonomous vehicle, since it can be seen as a solution or a source of driving anxiety [55], depending on the focus or the fear, the trait anxiety or the personality of the driver [56].
- Campaigns and prevention. The study on the advertising campaigns to raise awareness on the dangers on road could have a non negligible influence on the driving anxiety onset [10]. Thus, it would be desirable to approach the study safety message content and its effect to trigger driving anxiety as well as to consider the inverse point of view, i.e., how the campaigns to raise awareness about the issue of driving anxiety could be efficiently designed. In this way, likely there would be a higher number of concerned people intending to seek help and institutions could also know the extent of this problem. Besides, campaigns to inform about the influence of medication on driving skills would be useful, since this information is usually overlooked when reading a medical leaflet.
- It is important to conduct prevalence studies of driving anxiety in the general population. These studies allow us to estimate the extent of the phenomenon and to better discern the proportion of people affected by mild and moderate anxiety from those affected by severe or extreme anxiety.

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Data availability statement

No data was used for the research described in the article.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] A. Ehlers, S.G. Hofmann, C.A. Herda, W.T. Roth, Clinical characteristics of driving phobia, J. Anxiety Disord. 8 (4) (1994) 323–339.
[2] J.E. Taylor, The extent and characteristics of driving anxiety, Transport. Res. F Traffic Psychol. Behav. 58 (2018) 70–79, https://doi.org/10.1016/j.trf.2018.05.031.
[3] H.M. Zinzow, S.M. Jeffirs, Driving aggression and anxiety : intersections, assessment, and interventions, J. Clin. Psychol. 74 (1) (2018) 43–82, https://doi.org/10.1002/jclp.22494.
[4] J. Taylor, F.P. Deane, Comparison and characteristics of motor vehicle accident (MVA) and non-MVA driving fears, J. Anxiety Disord. 14 (3) (2000) 281–298.
[5] R.T. da Costa, M.R. de Carvalho, J. Cantini, R.C. da Rocha Freire, A.E. Nardi, Demographics, clinical characteristics and quality of life of Brazilian women with driving phobia, Compr. Psychiatr. 55 (2) (2014) 374–379.
[6] A. Fort, B. Collette, M. Evennou, C. Jallais, B. Charbotel, A.N. Stephens, A. Hidalgo-Muñoz, Avoidance and personal and occupational quality of life in French people with driving anxiety, Transport. Res. F Traffic Psychol. Behav. 80 (2021) 49–60, https://doi.org/10.1016/j.trf.2021.03.019.
[7] A.N. Stephens, B. Collette, A. Hidalgo-Munoz, A. Fort, M. Evennou, C. Jallais, The impacts of anxiety over driving on self-reported driving avoidance, work performance and quality of life, J. Transport Health 19 (2020), 100929, https://doi.org/10.1016/j.jth.2020.100929.
[8] C. Dula, C. Adams, M. Miesner, R. Leonard, Examining relationships between anxiety and dangerous driving, Accid. Anal. Prev. 42 (6) (2010) 2050–2056, https://doi.org/10.1016/j.aap.2010.06.016.
[9] S. Taylor, W.J. Koch, Anxiety disorders due to motor vehicle accidents : nature and treatment, Clin. Psychol. Rev. 15 (8) (1995) 721–738, https://doi.org/10.1016/0272-7358(95)00043-7.
[10] A.R. Hidalgo-Muñoz, M. Evennou, B. Collette, A.N. Stephens, C. Jallais, A. Fort, Cognitive and body manifestations of driving anxiety according to different onsets, Hist. Philos. Logic (2021), https://doi.org/10.1080/10615806.2021.1931144.
[11] J.A. Michon, A critical view of driver behavior models : what do we know, what should we do?, in: Human Behavior and Traffic Safety Springer, 1985, pp. 485–524.

[12] K. Steinhauser, F. Leist, K. Maier, V. Michel, N. Pärsch, P. Rigley, F. Wurm, M. Steinhauser, Effects of emotions on driving behavior, Transport. Res. F Traffic Psychol. Behav. 59 (2018) 150–163.

[13] F. Techer, C. Jallais, Y. Corson, F. Moreau, D. Ndiaye, B. Piechnick, A. Fort, Attention and driving performance modulations due to anger state : contribution of electroencephalographic data, Neurosci. Lett. 636 (2017) 134–139.

[14] Y. Bar-Haim, D. Lamy, L. Pergamin, M.J. Bakermans-Kranenburg, M.H. Van Ijzendoorn, Threat-related attentional bias in anxious and nonanxious individuals : a meta-analytic study, Psychol. Bull. 133 (1) (2007) 1.

[15] M.R. Tobias, T.A. Ito, Anxiety increases sensitivity to errors and negative feedback over time, Biol. Psychol. 162 (2021), 108092, https://doi.org/10.1016/j.biopsycho.2021.108092.

[16] M.W. Eysenck, N. Derakshan, R. Santos, M.G. Calvo, Anxiety and cognitive performance: attentional control theory, Emotion 7 (2) (2007) 336–353.

[17] Y.-C. Tsai, H.-J. Lu, C.-F. Chang, W.-K. Liang, N.G. Muggleton, C.-H. Juan, Electrophysiological and behavioral evidence reveals the effects of trait anxiety on contingent attentional capture, Cognit. Affect Behav. Neurosci. 17 (5) (2017) 973–983.

[18] A. Nieuwenhuys, R.R.D. Oudejans, Anxiety and perceptual-motor performance: toward an integrated model of concepts, mechanisms, and processes, Psychol. Res. 76 (6) (2012) 747–759.

[19] C.-M. Chang, E.C.-H. Wu, C.-Y. Chen, K.-Y. Wu, H.-Y. Liang, Y.-L. Chau, C.-S. Wu, K.-M. Lin, H.-J. Tsai, Psychotropic drugs and risk of motor vehicle accidents : a population-based case-control study, Br. J. Clin. Pharmacol. 75 (4) (2013) 1125–1133, https://doi.org/10.1111/j.1365-2125.2012.04410.x.

[20] L. Orriols, B. Delorme, B. Gadegbeku, A. Tricotel, B. Contrand, B. Laumon, L.-R. Salmi, E. Lagarde, Prescription medicines and the risk of road traffic crashes : a French registry-based study, PLoS Med. 7 (11) (2010), https://doi.org/10.1371/journal.pmed.1000366. Article 11.

[21] D. Shinar (Ed.), Traffic Safety and Human Behavior, Emerald Group Publishing, 2017.

[22] A. Liberati, D.G. Altman, J. Tetzlaff, C. Mulrow, P.C. Gøtzsche, J.P. Ioannidis, M. Clarke, P.J. Devereaux, J. Kleijnen, D. Moher, The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions : explanation and elaboration, J. Clin. Epidemiol. 62 (10) (2009) e1–e34.

[23] J.R. Landis, G.G. Koch, The Measurement of Observer Agreement for Categorical Data, Biometrics, 1977, pp. 159–174.

[24] M. Barnard, P. Chapman, The moderating effect of trait anxiety on anxiety-related thoughts and actions whilst driving, Pers. Indiv. Differ. 135 (2018) 207–211, https://doi.org/10.1016/j.paid.2018.07.027.

[25] J. Clapp, A. Baker, S. Litwack, D. Sloan, J. Beck, Properties of the Driving Behavior Survey among individuals with motor vehicle accident-related posttraumatic stress disorder, J. Anxiety Disord. 28 (1) (2014) 1–7, https://doi.org/10.1016/j.janxdis.2013.10.008.

[26] H. Gwyther, C. Holland, Feelings of vulnerability and effects on driving behaviour – a qualitative study, Transport. Res. F Traffic Psychol. Behav. 24 (2014) 50–59, https://doi.org/10.1016/j.trf.2014.03.001.

[27] T. Kontogiannis, Patterns of driver stress and coping strategies in a Greek sample and their relationship to aberrant behaviors and traffic accidents, Accid. Anal. Prev. 38 (5) (2006) 913–924, https://doi.org/10.1016/j.aap.2006.03.002.

[28] F. Lucidi, A.M. Giannini, R. Sgalla, L. Mallia, A. Devoto, S. Reichmann, Young novice driver subtypes : relationship to driving violations, errors and lapses, Accid. Anal. Prev. 42 (6) (2010) 1689–1696, https://doi.org/10.1016/j.aap.2010.04.008.

[29] C. Măirean, Posttraumatic stress symptoms, fear and avoidance of driving, and aberrant driving behaviors. The moderating role of gender, J. Transport Health 16 (2020), 100830, https://doi.org/10.1016/j.jth.2020.100830.

[30] M. Nees, K. Herwig, L. Quigley, J. Zhang, Relationships among driving styles, desire for control, illusion of control, and self-reported driving behaviors, Traffic Inj. Prev. 22 (5) (2021) 372–377, https://doi.org/10.1080/15389588.2021.1909728.

[31] T. Nordfjærn, T. Rundmo, Road traffic safety beliefs and driver behaviors among personality subtypes of drivers in the Norwegian population, Traffic Inj. Prev. 14 (7) (2013) 690–696, https://doi.org/10.1080/15389588.2012.759655.

[32] A. Przepiorka, T. Hill, A. Blachnio, M. Sullman, J. Taylor, P. Mamcarz, Psychometric properties of the Driving Behaviour Scale (DBS) among polish drivers, Transport. Res. F Traffic Psychol. Behav. 73 (2020) 29–37, https://doi.org/10.1016/j.trf.2020.06.008.

[33] A.E. Stewart, C.C. St Peter, Driving and riding avoidance following motor vehicle crashes in a non-clinical sample : psychometric properties of a new measure, Behav. Res. Ther. 42 (8) (2004) 859–879, https://doi.org/10.1016/S0005-7967(03)00203-1.

[34] J. Taylor, D. Paki, Wanna drive ? Driving anxiety and fear in a New Zealand community sample, N. Z. J. Psychol. 37 (2) (2008) 31–37.

[35] J. Taylor, M. Sullman, A. Stephens, Measuring anxiety-related avoidance with the driving and riding avoidance scale (DRAS), Eur. J. Psychol. Assess. 36 (1) (2020) 114–122, https://doi.org/10.1027/1015-5759/a000502.

[36] J.E. Taylor, A.N. Stephens, M.J.M. Sullman, Psychometric properties of the driving cognitions questionnaire, driving situations questionnaire, and driving behavior survey, Transport. Res. F Traffic Psychol. Behav. 76 (2021) 202–214, https://doi.org/10.1016/j.trf.2020.11.010.

[37] J.E. Taylor, F.P. Deane, J.V. Podd, Driving fear and driving skills: comparison between fearful and control samples using standardised on-road assessment, Behav. Res. Ther. 45 (4) (2007) 805–818.

[38] G.C. Gotardi, P.F. Polastri, P. Schor, R.R.D. Oudejans, J. van der Kamp, G.J.P. Savelsbergh, M. Navarro, S.T. Rodrigues, Adverse effects of anxiety on attentional control differ as a function of experience : a simulated driving study, Appl. Ergon. 74 (2019) 41–47, https://doi.org/10.1016/j.apergo.2018.08.009.

[39] J. Taylor, The extent and characteristics of driving anxiety, Transport. Res. F Traffic Psychol. Behav. 58 (2018) 70–79, https://doi.org/10.1016/j.trf.2018.05.031.

[40] J.E. Taylor, Driving phobia consequent to motor vehicle collisions, Motor vehicle collisions (2008) 389–416.

[41] M. Boucart, N. Waucquier, G.-A. Michael, C. Libersa, Diazepam impairs temporal dynamics of visual attention, Exp. Clin. Psychopharmacol 15 (1) (2007) 115–122, https://doi.org/10.1037/1064-1297.15.1.115.

[42] T.L. Brown, G. Milavetz, G. Gaffney, A. Spurgin, Evaluating drugged driving : effects of exemplar pain and anxiety medications, Traffic Inj. Prev. 19 (sup1) (2018) S97–S103, https://doi.org/10.1080/15389588.2017.1378814.

[43] A. Daurat, P. Sagaspe, L. Moták, J. Taillard, L. Bayssac, N. Huet, C. Authié, D. Mestre, P. Philip, Lorazepam impairs highway driving performance more than heavy alcohol consumption, Accid. Anal. Prev. 60 (2013) 31–34, https://doi.org/10.1016/j.aap.2013.08.004.

[44] T.R.M. Leufkens, A. Vermeeren, B.E. Smink, P. Van Ruitenbeek, J.G. Ramaekers, Cognitive, psychomotor and actual driving performance in healthy volunteers after immediate and extended release formulations of alprazolam 1 mg, Psychopharmacology 191 (4) (2007) 951–959, https://doi.org/10.1007/s00213-006-0669-8.

[45] C. Mercier-Guyon, J. Lejay, P. Choay, Comparative study of the effects of captodiamine and lorazepam on car driving ability, Clin. Drug Invest. 17 (6) (1999) 451–459, https://doi.org/10.2165/00044011-199917060-00005.

[46] J.F. O'Hanlon, A. Vermeeren, M.M.C. Uiterwijk, L.M.A. van Veggel, H.F. Swijgman, Anxiolytics' effects on the actual driving performance of patients and healthy volunteers in a standardized test : an integration of three studies, Neuropsychobiology 31 (2) (1995) 81–88, https://doi.org/10.1159/000119177.

[47] K. Okamura, G. Fujita, M. Kihira, R. Kosuge, Patterns of use, knowledge, and perceived effects of sedating medication on driving : a questionnaire survey of Japanese drivers who use sedating medication, Transport. Res. F Traffic Psychol. Behav. 54 (2018) 276–289, https://doi.org/10.1016/j.trf.2018.02.009.

[48] M. Takahashi, K. Iwamoto, Y. Kawamura, Y. Nakamura, R. Ishihara, Y. Uchiyama, K. Ebe, A. Noda, Y. Noda, K. Yoshida, T. Iidaka, N. Ozaki, The effects of acute treatment with tandospirone, diazepam, and placebo on driving performance and cognitive function in healthy volunteers, Hum. Psychopharmacol. Clin. Exp. 25 (3) (2010) 260–267, https://doi.org/10.1002/hup.1105.

[49] K. Touliou, E. Bekiaris, M. Panou, Effect of Alprazolam (0.5 Mg) on Driving Performance of Anxiety Patients and Healthy Controls (01495646), 2013, pp. 107–112, http://www.icadtsinternational.com/documents/?category=20th_T2013_Brisbane.

[50] N.N.J.J.M. van der Sluiszen, A. Vermeeren, J.C. Verster, A.J.A.E. van de Loo, J.H. van Dijken, J.L. Veldstra, K.A. Brookhuis, D. de Waard, J.G. Ramaekers, Driving performance and neurocognitive skills of long-term users of benzodiazepine anxiolytics and hypnotics, Hum. Psychopharmacol. 34 (6) (2019), https://doi.org/10.1002/hup.2715. Article 6.

[51] J.C. Verster, E.R. Volkerts, M.N. Verbaten, Effects of alprazolam on driving ability, memory functioning and psychomotor performance : a randomized, placebo-controlled study, Neuropsychopharmacology 27 (2) (2002) 260–269, https://doi.org/10.1016/S0893-133X(02)00310-X.

[52] L. Orriols, A. Luxcey, B. Contrand, B. Gadegbeku, B. Delorme, A. Tricotel, N. Moore, L.-R. Salmi, E. Lagarde, Road traffic crash risk associated with benzodiazepine and z-hypnotic use after implementation of a colour-graded pictogram : a responsibility study, Br. J. Clin. Pharmacol. 82 (6) (2016) 1625–1635, https://doi.org/10.1111/bcp.13075. Scopus.
[53] C. Fischer, J. Heider, A. Schröder, J.E. Taylor, Help ! I'm afraid of driving!" review of driving fear and its treatment, Cognit. Ther. Res. 44 (2) (2020) 420–444.
[54] Q. Yuan, W. Hao, H. Su, G. Bing, X. Gui, A. Safikhani, Investigation on range anxiety and safety buffer of battery electric vehicle drivers, J. Adv. Transport. (2018), https://doi.org/10.1155/2018/8301209.
[55] J. Kraus, D. Scholz, E.-M. Messner, M. Messner, M. Baumann, Scared to trust?–predicting trust in highly automated driving by depressiveness, negative self-evaluations and state anxiety, Front. Psychol. 10 (2020) 2917, https://doi.org/10.3389/fpsyg.2019.02917.
[56] W. Qu, H. Sun, Y. Ge, The effects of trait anxiety and the big five personality traits on self-driving car acceptance, Transportation 48 (5) (2021) 2663–2679.