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Naturalistic conversation improves daytime motorway driving performance under a benzodiazepine: A randomised, crossover, double-blind, placebo-controlled study

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ABSTRACT

The adverse effects of benzodiazepines on driving are widely recognised. The aims of this study were both to determine the impact of naturalistic conversation on the driving ability of drivers under a benzodiazepine, and to measure the accuracy of drivers' assessments of the joint effects of the benzodiazepine and conversation. Sixteen healthy male participants (29.69 ± 3.30 years) underwent a randomised, crossover, double-blind, placebo-controlled study with the benzodiazepine lorazepam (2 mg). They drove 200 km (125 miles) on a motorway in the morning. We measured two driving ability-related variables (i.e., lane-keeping performance), and collected a set of self-assessed variables (i.e., self-assessment of driving performance) during two 10-min sequences of interest (no conversation vs. conversation). An analysis of variance revealed an interaction whereby lane-keeping performance under lorazepam was worse in the no-conversation condition than in the conversation condition. No such difference was detected under placebo. Pearson's correlation coefficients revealed that self-assessments were (i) not at all predictive of lane-keeping when performed before the drive, but (ii) moderately predictive of lane-keeping performance when performed during or after the drive. We conclude that conversation with a passenger may contribute to safer lane-keeping when driving under a benzodiazepine. Moreover, a degree of awareness may be attained after some experience of driving under the influence of this type of medication.

1. Introduction

There is a growing body of research on the impact of benzodiazepines (BZDs) on driving (e.g., Orriols et al., 2011; Verster and Roth, 2012b). Be they prescribed as anxiolytics (e.g., alprazolam, lorazepam, oxazepam), as hypnotics (e.g., flunitrazepam, zolpidem, zopiclone) or for any other clinical reason (epilepsy, alcohol withdrawal, anaesthesia), their use is often accompanied by side effects that can compromise driving safety, such as clumsiness, daytime sedation, decreased alertness and a general decrease in cognitive performance (e.g., Leufkens et al., 2007). Accordingly, most of these drugs are classified by the International Council on Alcohol, Drugs and Traffic Safety (www.icadts.com) as Category III, that is, as being likely to produce severe effects or presumed to be potentially dangerous, being equivalent to a blood alcohol concentration (BAC) > 0.8 g/l (>0.08%).

Setting aside the fact that BZD users often have blood concentrations that exceed the therapeutic limits (Kriikku et al., 2012), BZDs have mainly been found to impair the trajectory control component of driving performance, that is, lane-keeping (Verster and Roth, 2011). These impairments have generally been quantified in terms of the standard deviation of steering wheel movements (SDSWMs; e.g., Thiffault and Bergeron, 2003), inappropriate line-crossings (ILCs; e.g., Davenne et al., 2012; Philip et al., 2005), or – most robustly – by the standard deviation of lateral position (SDLP, or weaving; e.g., Verster and Roth, 2013b). Recently, Daurat et al. (2013) showed that a single-dose, 2-mg lorazepam intake (vs. placebo) induces a higher increase in SDLP than BAC > 0.8 g/l (>0.08%) does. In addition, BZD users – including both chronic users and healthy volunteers – have been found to be at increased risk of accident involvement not only in placebo-controlled settings (Dassanayake et al., 2011; Verster and Roth, 2013a), but also when they are compared with users of other medicinal drugs where there

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is no evidence of any such risk (Orriols et al., 2009; but see also Kuypers et al., 2012). Meta-analytical evidence therefore suggests that the risk of accident is up to 1.61 times greater in BZD users than in controls (Rapoport et al., 2009).

Distraction, responsible for approximately 79% of all traffic collisions and 65% of near misses (Neale et al., 2005), is widely acknowledged to represent an increasing hazard for drivers (Bakiri et al., 2013; Hancock et al., 2003; Horberry et al., 2006). Given that naturalistic conversation while driving creates a costly dual-task situation (Maciej et al., 2011; Strayer and Johnston, 2001), its distracting effects might be expected to further diminish the cognitive resources of drivers under BZD. Another possibility, however, is that when occurring in low-level stimulation long-lasting vigilance tasks – and, moreover, under BZD – conversation might have an alerting effect (Kaida et al., 2007), helping the driver to maintain her attention at a more proficient level.

In this vein, the effects of conversation on lane-keeping have sometimes been found to be absent (Horrey and Wickens, 2006; Rakauskas et al., 2004) or even positive, mainly in the context of monotonous highway driving (Brookhuis et al., 1991). For instance, Oron-Gilad et al. (2008) found that a trivia alertness-maintaining task (AMT), involving choosing answers to multiple-choice questions, led to a lower mean SDLP during those 10-min sequences of monotonous (simulated) driving where the trivia AMT was administered. Similarly, Gershon et al. (2009) showed that two occurrences (60 and 100 min into the drive) of a similar trivia task in a simulated monotonous drive of 140 min also led to a decrease in SDLP. In both studies, this enhancement of SDLP was accompanied by an enhancement of drivers' vigilance owing to the activating effects of the trivia-induced conversation. This is similar to Schmidt et al.'s (2011) finding that verbally assessing drivers' sleepiness improved their vigilance, compared with pre-assessment baseline measures, although this improvement only persisted for 2 min at most beyond the verbal interaction (Schmidt et al., 2011; see also Kaida et al., 2007).

To the best of our knowledge, these conversation-related effects have rarely been tested in real-world driving settings (Schmidt et al., 2011) and have never been investigated in drivers under the influence of BZD. Given the available research evidence, we therefore hypothesized that, in a real-world setting combining BZD and monotonous highway driving, engaging in conversation with a passenger would improve the drivers' lane-keeping performance, mainly by enhancing their vigilance (see also Atchley and Chan, 2011). Moreover, although previous research on the activating effects of conversation has often combined measures of drivers' performance with drivers' self-assessments (be they linked to the drivers' sleepiness or to their lane-keeping performance; Engström et al., 2005; Gershon et al., 2009; Oron-Gilad et al., 2008; Schmidt et al., 2009), the direct association between drivers' actual performance and their performance (or sleepiness) self-assessments has rarely been statistically tested (Horne and Baulk, 2004).

The role of self-assessments in driving safety has repeatedly been acknowledged (Ackerman et al., 2010; Holland and Rabbitt, 1992). It has been suggested that a more accurate assessment of their abilities may help drivers to deal more efficiently with, for example, hazard perception-related (Weiss et al., 2013) and cognitive decline-related (Korner-Bitensky et al., 2009) concerns. Arguably, being aware of the deleterious effects of certain medications on driving performance is essential for making appropriate decisions, such as not taking the wheel when driving abilities are impaired.

Evidence suggests, however, that drivers are not very skilful in spontaneously assessing their abilities (e.g., Sundström, 2008). For instance, drivers have been found to overestimate (i) their skills when asked to compare themselves with their peers or with the average driver (McCormick et al., 1986; Svenson, 1981; but see also De Craen et al., 2011), (ii) their ability to detect hazards (Horswill et al., 2013), and also (iii) what can be considered a safe speed (Mannering, 2009).

Surprisingly, there is very little data on drivers' self-assessments under the influence of BZD. Verster and Roth (2012a) reported that assessments collected after a driving session (i.e., perceived quality of driving performance and level of mental effort) were more predictive of driving performance under the influence of medicinal drugs (r^2s = .25 and .17, respectively) than those collected beforehand (i.e., alertness, r^2 = .13; Verster and Roth, 2012a). Analyses of self-assessments specifically related to driving under the influence of BZD, which significantly increases drivers' SDLP (Verster & Roth, 2012a, Table 3), have revealed that, in some cases (i.e., after the intake of zolpidem, 10 and 20 mg), self-assessments are highly correlated with impaired lane-keeping performance (rs up to .81, all ps < .01), whereas in other cases (i.e., after the intake of alprazolam, 1 mg), the correlations between self-assessments and lane-keeping performance fail to reach significance (rs < .37, ps > .05). This indicates that drivers' awareness of BZD-induced impairments may vary substantially across substances.

This review of the state of the art highlights the difficulty of formulating specific hypotheses on the accuracy of drivers' self-assessments relative to driving under the influence of BZDs. At most, one could hypothesise that drivers' prior confidence in their driving abilities is not predictive of their subsequent real-world driving performance (De Craen et al., 2011; see also Verster and Roth, 2012a, Fig. 1), but that experience of driving under medication helps them achieve more accurate insight into the BZD-related risks (Koriat, 1997; Koriat and Bjork, 2006; see also Verster and Roth, 2012a, Figs. 2 and 3).

In sum, recognising that the accuracy of drivers' self-assessments when under BZD is crucially important, we conducted the present study in order to assess both the effects of conversation on drivers' lane-keeping performance and the accuracy of drivers' self-assessments while driving under the influence of BZD, either with or without conversation. With this aim in mind, we investigated not only self-assessments of confidence in driving ability before and during the driving session, but also self-assessments of lane-keeping performance and mental effort after the driving session. Given that conversation with a passenger can be an efficient means of combating sleepiness (Gershon et al., 2011; Nordbakke and Sagberg, 2007), we reasoned that this study would make a valuable contribution to the debate on countermeasures for hypovigilance – and more specifically BZD use-related hypovigilance (e.g., Schmidt et al., 2011).

The presumed effects were investigated in a real-world driving setting, as driving a simulator can increase drivers' hypovigilance and thus bias – albeit in a systematic way – any BZD-related effects (Daurat et al., 2013; Davenne et al., 2012). Furthermore on-road testing is an ecological instrument that is reliably sensitive to a host of substances, including BZD (for a discussion, see Verster and Roth, 2013b). The data yielded by this study were therefore not primarily focused on the impact of BZDs per se on lane-keeping performance, given that this has already been investigated (Daurat et al., 2013) – moreover in comparison with simulated driving settings.

In this study, 2-mg lorazepam was chosen over other BZDs because it is a molecule with a short to moderate action duration (half-life of 9–16 h). It was privileged at the expense of molecules with long half-lives to permit a limited duration of drug's influence after the experiment. Moreover, lorazepam has strong sedative/hypnotic effects. In France the usual adult dosage is 1.25 mg in the morning, 1.25 mg at noon, 1.25 mg in the evening and 1–2 mg at bedtime (if insomnia associated with anxiety). The aim of our study being to show that naturalistic conversation can fight sleepiness induced by BZD, at the 2-mg dosage, we are sure the drivers are asleep.