Received: 8 September 2022 | Revised: 3 February 2023 | Accepted: 6 February 2023

DOI: 10.1002/hup.2865

RESEARCH ARTICLE

WILEY

Aroma of the essential oil of peppermint reduces aggressive driving behaviour in healthy adults

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Abstract

Aggressive driving is of increasing concern in modern society. This study investigated the potential for the presence of an ambient aroma to reduce aggressive responses in a simulated driving situation. Previous literature has demonstrated the beneficial effect of peppermint (*Mentha piperita*) aroma on driver alertness and we aimed to identify any impact on aggressive driver behaviour. Fifty volunteers were randomly assigned to one of two conditions (peppermint essential oil aroma and no aroma). Aggressive driving behaviours were measured in a virtual reality driving simulator. The analysis indicated that the peppermint aroma significantly reduced aggressive driving behaviours. The presence of the aroma also produced medium sized effects on some aspects of mood from pre-test levels. These results provide support for the use of ambient aromas for the modification of driving behaviours. It is proposed that applying peppermint into daily driving may be a beneficial for reducing driver aggression.

KEYWORDS
aggressive driving, aroma, peppermint

1 | INTRODUCTION

Environmental and therapeutic uses of plants and essential oils date back to at least 1800 BC (Myatt, 2005). Following a long history of folk medicine use, contemporary research has shown essential oil aromatherapy may be an effective treatment of symptoms in specific disorders. For example, agitation associated with neurodegenerative disorders such as dementia and Alzheimer's disease has been shown to benefit from aromatherapy (Ballard et al., 2002). Forbes et al. (2005) further discussed non-pharmacological management for agitated behaviour in dementia, reporting that both lavender and melissa oils produced significant benefits in such patients. Aggression and agitation are of course not limited to clinical populations, and it has been suggested that there is a more general need for interventions for aggression, specifically reactive aggression, in the wider population (Denson, 2015).

One area where aggression is an increasing societal problem is that of driving. Aggression has been found to be a significant factor that predicts driving violations, and intensifies risky driving behaviours (Sani et al., 2017). Aggressive driving is an umbrella term that covers behaviours and actions that have the potential to bring danger to other drivers on the road. These include but are not restricted to; speeding, driving too close to the car in front, not respecting traffic regulations, and improper lane changing or weaving (United Nations Economic Commission for Europe 2004). Aggressive driving is associated with traffic accidents (Čabarkapa et al., 2018), and the U.S. National Highway Traffic Safety Administration estimates that two thirds of crash deaths are linked to aggressive driving (Goodwin et al., 2015). Aggressive driving may also be a causal factor in incidents of 'road rage' (Dukes et al., 2001), that is, severe forms of driving-related anger expression that can have catastrophic consequences (Bjureberg & Gross, 2021). In addition, driving in an aggressive manner is bad for the environment, using more fuel and creating higher levels of dangerous emissions than non-aggressive driving (Tzirakis et al., 2007). Taken together, this evidence supports the need for interventions that might reduce aggressive driving behaviours.

There is limited research that has considered the use of aromatherapy in a driving context. Suzuki et al. (2006) investigated the impact of the aroma of trees and reported that alpha-pinene reduced driver fatigue and improved the safety time margin to the preceding vehicle. This is of particular interest given that close driving or 'tailgating' is one of the principal markers of aggressive driving and a primary contributor to accidents (Paleti et al., 2010). Raudenbush et al. (2009) investigated the effect of peppermint aroma on driving behaviour and found it to increase ratings of alertness and decrease frustration over the course of a driving scenario. Given the long-established relationship between frustration and aggression (Berkowitz, 1989) such a finding might also suggest an effect of relevance. Raudenbush and colleagues also suggest that the administration of peppermint aroma over a prolonged driving period may have the potential to decrease highway accidents. Peppermint has also been shown to significantly improve reaction times to unexpected events whilst driving under conditions of sleep deprivation, another situation closely linked to road traffic accidents (Kwak et al., 2015). Pujiartati and Faturrochman (2019) provided supporting data collected over a two-hour driving simulation that indicated increased awareness, measured objectively via electroencephalogram (EEG) and subjectively via a sleepiness scale when exposed to peppermint aroma. Overall, these data suggest that peppermint aroma has the potential to temporarily improve driving performance and reduce factors associated with aggression. Outside of the driving domain peppermint aroma has consistently been demonstrated to increase alertness whether measured objectively via reaction time tasks (Deivanayagame et al., 2020), physiologically by way of EEG patterns (Park et al., 2019), subjectively (Hoult et al., 2019) or by proxy through decreased fatigue (Kennedy et al., 2018). Fatigue is one factor that has previously linked to aggressive driving (Fountas et al., 2019) and if peppermint can reduce fatigue and increase driver alertness as indicated above, this may improve attention towards driving regulations and reduce aggressive driving behaviours. Reactive aggression and risky decision making have previously been found to correlate (Kuin et al., 2015). It could be that at times when the driving experience increases aggressive feelings, an individual may make more risky driving choices resulting in violation of driving regulations and aggressive driving behaviours. If peppermint aroma can moderate the aggressive response it may reduce risky aggressive driving behaviours that may be a consequence of instrumental aggression towards other road users.

There is no extant research that the authors are aware of investigating the impact of aroma specifically on aggressive driving behaviour. Dmitrenko et al. (2020) evaluated the impact of intermittent dispersal of aromas on driving safety during an aggression inducing simulated drive. The results indicated that both rose and peppermint aromas reduced the number of collisions, with rose also reducing the average driving speed. In contrast, civet aroma led to an increased number of collisions and faster driving. Civet is an animal by-product with an unpleasant aroma at high concentrations and its negative impact is supportive of the notion that unpleasant smells impair performance (Ilmberger et al., 2001). Dmitrenko and colleagues did not measure aggressive driving behaviours per se however, rather choosing to focus on the extent that events can induce anger and any associated implications for safety. Here we will measure aggressive driving behaviours of participants that may or may not be related to the actions of other road users. The key outcome of interest being whether ambient peppermint aroma can reduce general levels of aggressive driving. Although we are employing peppermint as the treatment aroma it is not perhaps the principal aroma that has been linked to aggression. Although research has shown that lavender is an effective aroma to reduce aggression, it is also considered to be a sedative, an effect that has been attributed to the presence of linalool (Tomi et al., 2011) and linalyl acetate and/or camphor levels (Tomi et al., 2018). Given that sedative antidepressants have previously been linked to impaired driving performance (Ramaekers, 2017), it does not seem an appropriate candidate in the domain of aggressive driving and this study will not test the effect of lavender.

Received wisdom states that men are more aggressive than women, but a review by Björkqvist (2018) identified that this only applies to physical aggression, and that females use more indirect aggression, and that verbal aggression is equally used by both sexes. Aggressive driving behaviour may be seen as a construct that incorporates elements of physical, indirect and verbal aggression but the expression of aggressive driving is a complex phenomenon with a range of psychological causes (Lajunen & Parker, 2001). There is evidence that males display greater aggressive driving than females for example, Sârbescu et al. (2014), but others report no sex difference for example, Wickens et al. (2012), and at least one study has reported higher aggressive driving amongst females than males (Harris et al., 2014). Given the somewhat unclear position, gender is included in the current study as a factor of interest.

Due to the increasing incidence of aggressive driving and the need for preventative measures (Burns & Katovich, 2003), this study proposed to investigate ambient aroma as a simple, low cost intervention. Given the evidence reported above regarding peppermint in driving scenarios this study aimed to examine the effect of the aroma of peppermint in a virtual reality scenario designed to elicit aggressive driving behaviour. It is hypothesised that compared to a no aroma control, the presence of peppermint aroma will.

- Increase driver alertness and calmness, and reduce negative moods, such as aggression and stress.
- Reduce the number of aggressive driving behaviours observed.

2 | METHOD

2.1 | Design

This quantitative study adopted an experimental between-subject design. Participants were randomly assigned to one of two conditions that constituted the independent variable: peppermint aroma and no aroma (control). Dependant variables were the number of aggressive driving behaviours recorded during the virtual reality driving experience, and the participants' subjective evaluations of mood, aggression and stress. Given the existence of individual differences in aggressive driving tendencies, scores from the Aggressive Driving Scale were employed as a covariate. An a priori power analysis, with an alpha of 0.05 and power of 0.80, indicated that 25 participants within each condition would be an adequate sample size to compare group means with a medium effect. The medium effect size was based on that reported by Moss et al. (2008).

2.2 | Participants

Participants were recruited through advertisement posts on social media websites and also displayed around a university campus in the UK. Posters informed participants about a study investigating the use of virtual reality (VR) for driving simulation but made no mention of aroma. This was done to avoid expectancy effects contaminating the data. All participants were over the age of 18-years old and held a full UK driving licence. Fifty volunteers consented to take part in the study. The peppermint condition included 13 males ($M_{age} = 22.54$, $SD_{age} = 2.90$) and 12 females ($M_{age} = 21.25$, $SD_{age} = 1.82$). The control condition included 11 males ($M_{age} = 22.00$, $SD_{age} = 2.10$) and 14 females ($M_{age} = 21.00$, $SD_{age} = 1.75$).

2.3 | Materials

2.3.1 | Aggressive driving scale

This 24-item questionnaire developed by Krahé and Fenske (2002) and further validated by Zhang et al. (2016) was utilised to measure each participant's general aggressive driving behaviour. Participants were presented with statements such as *"How often do you get into fights with other drivers?"*, *"How often do you disregard the speed limit on a motorway?"* etc. Responses were recorded on a 5-point Likert scale, 0 represented "*Never*" and 4 represented *"Very often"*. A higher score indicated a more aggressive driving behaviour.

2.3.2 | Mood questionnaire

Participants were given a 5-item questionnaire before and after completing the driving task. Participants were required to "*Circle the following number which corresponds best to how you are feeling right now*". Participants were given 5 different moods to report, Aggressive, Alert, Calm, Happy and Stressed. Responses were recorded using a 5-point Likert scale, ranging from 0 as *"Not at all"* to 4 as *"Very"*. Single item scales were used as they have been evaluated as equally valid as multiple item measures and take less time to administer (Gardner et al., 1998).

2.3.3 | Aroma

Tisserand pure essential oil of peppermint (obtained from Tisserand.com) was used to produce the aroma. The essential oil is organic, certified by the Soil Association and the production facilities hold: ISO9001:2015 Quality Management Systems certified under both UKAS and EFfCI (European Federation for Cosmetic Ingredients). ISO22716 Cosmetics Good Manufacturing Practice and ISO14001 Environmental Management Systems certification. Characterisation by certificate of analysis of Lot batch number 228101 conducted by First Natural Brands Ltd., Sussex, UK identified the main constituents presented in Table 1.

The product specification sheet identifies that the essential oil is in accordance with the requirements of Articles 3 (2) (d) of regulation (EC) 1334/2008 and therefore can be designated as natural and does not contain any solvents or additives.

Five drops of the undiluted oil were applied onto the diffuser pad of a "Tisserand Aroma-stream". The Aroma-stream device employs an unheated fan diffusion method and was placed in the testing room out of sight of the participant. It was switched on at the highest fan setting for 30 min prior to testing of each participant and throughout the testing period.

2.3.4 | Testing room

The testing room measured 5 × 3m. A schematic diagram of the room layout is presented in Figure 1. The room is naturally ventilated and windows were left open overnight between testing days to refresh

TABLE 1 Characterisation by certificate of analysis of the peppermint essential oil.

Constituent range (%)	Result (%)
L-menthol 30–55	36.20
Trans menthone 12–33	26.70
1,8-Cineole 2–10	5.70
Menthyl acetate 2–10	5.10
d,l-Isomenthone 1–6	4.50
Beta caryophyllene 0.01–3.5	3.10
Limonene 0.01–3	2.70
Neo-menthol 2–8	2.80
Menthofuran 0.01–9	3.20

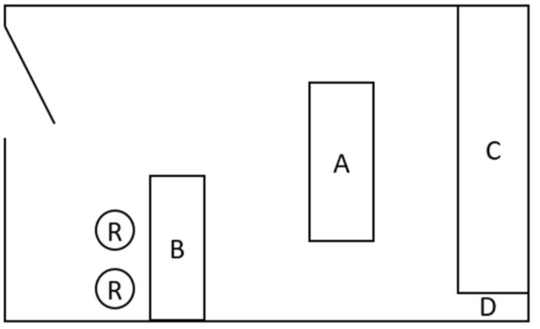

FIGURE 1 Testing room layout. A = Driving simulator, B = Control desk, C = Storage units below windows, D = Position of aroma diffuser, R = Researchers.

the environment. There was no indication of any aroma carryover to the days used for the no aroma condition. The room does not receive direct sunlight and the temperature was maintained between 19 and 22 degrees Celsius.

2.3.5 | Virtual reality driving simulator

This study utilised the simulation software 'City Car Driving' on 'Steam'. 'Steam' is a digital distribution platform designed for playing, discussing and creating games. It is available at https://store.steampowered.com. The virtual reality driving scenario was presented through an Oculus Rift VR headset. This provided a realistic driving simulation in an environment which resembled real life.

The driving simulator hardware consisted of a Logitech G29 wheel, pedals, force shifter and seat. The seat, steering wheel and VR headset were adjusted according to the participant's measurements. This ensured there was no discomfort during the driving experience. The 'City Car Driving' parameters were set initially for calm driving to permit participants to become acquainted with the system set up during a 5-min practice period. Following the practice, the settings were adjusted to be suitable to the nature of the study (Table 2) that is, to provide a driving experience which might stimulate aggression. For example, other drivers would abruptly brake without apparent reason, cut into the participant's lane without indication etc. A total of 35 of these events occurred randomly but with equal frequency for all participants. Each participant was required to drive for 15-min in the aggression inducing driving task.

2.3.6 | Aggressive driving behaviours

The driving behaviours that may be considered aggressive were based on findings from Sarwar et al. (2017). In addition, verbal insults to other drivers was added to the list as these have also been commonly reported (Ellison-Potter et al., 2001) (See Table 3). Each instance of aggressive driving behaviour exhibited by participants during the driving task was recorded by the software and verbal responses were independently recorded by two researchers monitoring the participant. Inter-rater reliability was performed for the records of the verbal responses. Kappa (Cohen, 1960) was calculated based on Hallgren (2012) and produced a value of 0.74 indicating moderate agreement between the two researchers (McHugh, 2012). Although a little low, this indicates the difficulty in ascribing exclamations as shock or surprise in general or being aimed at another driver directly.

TABLE 2 Driving simulator scenario settings.

Emergency situations	Setting
Dangerous change of traffic	Often
Emergency braking of car ahead	Often
Dangerous entrance of the vehicle to the oncoming lane	Often
Pedestrian crossing the road in a wrong place	Often
Road accident	Often
Traffic	
Vehicular traffic density	50%, average traffic density with traffic problems arising
Traffic behaviour	Aggressive traffic, extreme driving conditions
Pedestrian traffic density	50%, average traffic density
Season, weather and time of day	
Season	Summer
Weather	Clear
Time of day	Morning

TABLE 3 Aggressive driving behaviour scoring criteria.

Verbal insults/negative comments towards other drivers
Violating stop signs or signals
Cutting another vehicle off
Speeding (continued speeding after notification from simulator—5 mph over speed limit)
Not using signal indicators when making a turn or changing lanes
Braking abruptly or without cause
Following too closely (tailgating) a preceding vehicle
Overtaking another vehicle in a rushed manner

2.4 | Procedure

Ethical approval for this study was granted by the Northumbria University Ethics System, ref: 12793. Participants in both conditions first completed the Aggressive Driving Scale (ADS) and pre-test mood measures before entering the test room. A practice period of 5 min was given to all participants to familiarise them with the VR driving simulator. Participants were instructed to drive as if real-life driving. Following the practice session each participant had a short break whilst the settings were adjusted and 15 min test driving in the aggressive scenario followed. Participants were not given any instructions concerning the driving route. Following the test driving phase participants completed the post-test mood measures and the experiment ended. The genuine aim of the study was concealed until completion of the study to prevent expectancy or demand characteristics influencing the data. Participants were fully debriefed and given the opportunity to ask any questions concerning the true nature of the study.

2.5 | Procedure for analysis

This study utilised the Analysis of Covariance (ANCOVA) to analyse the effects of aroma condition and sex of participant on the aggressive driving data. Aggressive driving scores from the ADS being applied as the covariate. The homogeneity of regression slopes assumption was tested prior to running the main analysis. A Mulitivariate Analysis of Variance (MANOVA) was used to analyse the impact of condition on the change in mood scores (Post-Pre). Follow up univariate ANOVAs were conducted for the change in each of the mood variables. Sex of participant was not included in the analysis of subjective scale scores as previous research does not indicate that aromas differentially affect males and females subjective mood states.

3 | RESULTS

3.1 | Aggressive driving

Descriptive statistics for the aggressive driving behaviour scores are presented in Table 4.

The test of the Aroma condition*Sex*General driving aggression interaction was not significant indicating that the homogeneity of regression assumption was not violated F (1,43) = 0.446, $p = 0.508$. The analysis of covariance revealed that the covariate driving aggression score made a significant contribution to the analysis F (1, 45) = 5.376, $p = 0.025$. A significant main effect of aroma condition was present once general driving aggression was controlled for statistically F (1, 45) = 4.865, $p = 0.033$, $\eta_p^2 = 0.098$. Comparison of the adjusted means shows that the peppermint condition ($M = 21.23$) produced significantly lower aggressive driving behaviours than did the control condition ($M = 25.67$). See Figure 2. No main effect of sex, F (1, 45) = 0.001, $p = 0.974$, or aroma condition*sex interaction effect, F (1, 45) = 0.366, $p = 0.548$, was found.

TABLE 4 Means (SD) [*N*] for aggressive driving scores.

	Control	Peppermint	Totals
Female	24.50 (8.26)	21.33 (8.47)	23.04 (8.34)
	[*N* = 14]	[*N* = 12]	[*N* = 26]
Male	26.18 (7.01)	21.77 (5.12)	23.79 (6.33)
	[*N* = 11]	[*N* = 13]	[*N* = 24]
Total	25.24 (7.63)	21.56 (6.78)	23.40 (7.38)
	[*N* = 25]	[*N* = 25]	[*N* = 50]

3.2 | Subjective measures

A multivariate analysis of variance revealed a significant difference between the conditions for the compound dependent variable, Wilks' Lambda = 0.781, F (5, 44) = 2.474, $p = 0.046$, $\eta_p^2 = 0.219$. Bonferroni corrected univariate ANOVAs indicate that none of the individual variables maintained significance once the correction was applied, although medium effect sizes based on Cohen (2013) criteria were observed for Aggression, Alert and Stressed (Table 5).

4 | DISCUSSION

This study examined whether the ambient aroma of peppermint may be a simple and effective intervention to reduce aggressive driving behaviours. It was hypothesised that the presence of peppermint aroma would reduce aggressive driving behaviours and negative feelings such as aggression and stress, whilst increasing alertness and calmness. The researchers expected the ADS scores to be related to aggressive driving behaviour as it is reported to have good predictive validity when compared to a simulated driving session (Zhang et al., 2016). This was observed and the inclusion of the ADS as a covariate increased the power of the study by statistically removing variance in the aggressive driving dependent variable that was not attributable to the aroma condition. The Ancova analysis indicated that peppermint significantly reduced aggressive driving behaviours with a medium effect size. Although the conservative nature of the Bonferroni corrected univariate analyses for the subjective variables precluded any significant findings, medium effect sizes for an increase in alertness, and decreases in stress and aggression were also observed. A small effect size was found for the increase in calmness. Taken together these findings suggest that the introduction of ambient aroma may have beneficial effects for drivers and support and extend those of Dmitrenko et al. (2020) who measured driver anger as a consequence of driving incidents. Anger is considered a major cause of aggressive driving (Dula & Ballard, 2003), and we assessed participants on a range of aggressive driving behaviours whilst free driving in a simulator programmed to include a wide range of randomly occurring incidents that may induce anger and more importantly might be reflected in increased aggressive driving in the virtual reality diving simulation.

Although driving behaviour in simulators is considered less realistic than in the field, they have been successfully employed in studies of fatigue (Philip et al., 2003), distraction (Mehler et al., 2009) and safety and traffic accidents (Lee et al., 2002, 2003). Research into aggressive driving in simulators has been more limited. Harder

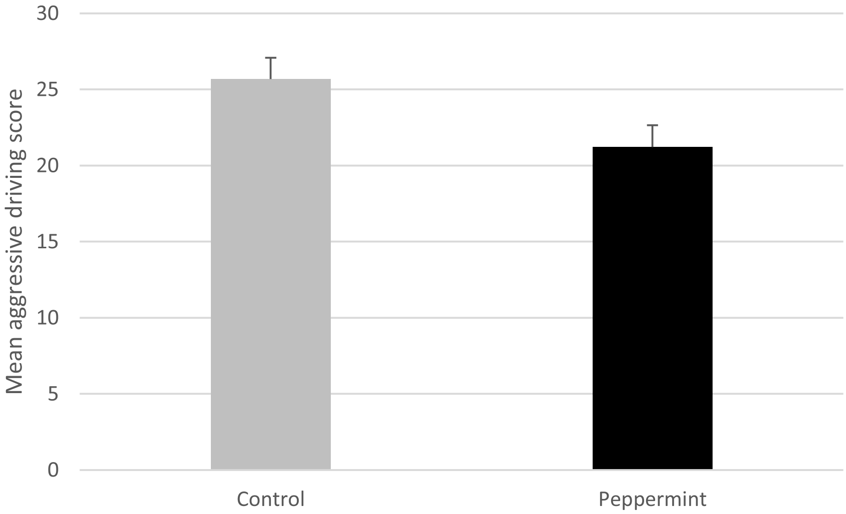

FIGURE 2 Estimated marginal means for aggressive driving behaviour. Error bars represent standard errors.

TABLE 5 Mean Post—Pre difference scores (SD), uncorrected and Bonferroni corrected *p* values and partial eta squared values for the univariate ANOVAs.

Variable	Peppermint	Control	Uncorrected significance	Bonferroni corrected significance	Partial eta squared
Aggression	−0.16 (0.85)	0.40 (1.15)	0.057	0.285	0.074
Alert	0.12 (0.78)	−0.40 (1.00)	0.046	0.230	0.080
Happy	−0.12 (0.97)	0.08 (0.86)	0.445	1	0.012
Stressed	−0.32 (0.90)	0.24 (1.01)	0.044	0.200	0.082
Calm	−0.28 (0.79)	0.12 (1.13)	0.154	0.770	0.042

et al. (2008) reported that individuals self-identifying as more hostile produced greater incidents of aggressive driving compared to those who were low in hostility. Similarly, Abou-Zeid et al. (2011) found trait aggressiveness was linked to aggressive driving and that frustrating incidents whilst driving produced greater levels of aggressive driving behaviours irrespective of trait aggression. Zhang et al. (2016) employed a driving simulation in the validation of the aggressive driving scale employed in the current study as a covariate. It is noteworthy however, that the aforementioned studies employed screen-based simulations, rather than the virtual reality technique employed in the current study. Virtual reality can provide a near-realistic driving experience (Ihemedu-Steinke et al., 2017). The technique has been successfully employed as an adjunct to cognitive behavioural therapy treatment to reduce aggressive driving in veterans (Zinzow et al., 2018), and to promote eco-sustainable driving behaviour by reducing excessive acceleration and speed (Pietra et al., 2021). However, we believe this study represents the first time it has been used to specifically assess the impact of aroma on aggressive driving behaviour.

Why might peppermint aroma have such an impact on aggressive driving behaviour? Although the impact of odor itself has been shown to influence mood (Lis-Balchin, 1997), it is unlikely that the odor of an essential oil is sufficiently potent to be the full cause because adaptation to odorant occurs quickly (Kurahashi & Menini, 1997). The essential oil of peppermint contains a number of volatile, potentially active components including 1,8-cineol, menthone, isomenthone, menthol, menthyl acetate and caryophyllene. When examined individually these compounds have been found to deliver arousing effects in mice as measured by ambulatory behaviour, and these effects are argued to be pharmacologically mediated (Umezu et al., 2001). When inhaling the aroma of the essential oil the constituent elements are absorbed via the lungs into the blood stream, pass through the blood–brain barrier and may produce effects on the brain's neurons in the same manner as other drugs. In terms of neuronal mechanisms López et al. (2010) provide a comprehensive analysis. To summarise, peppermint has been shown to inhibit monoamine oxidase, an enzyme that metabolises the neurotransmitters serotonin and adrenaline/noradrenaline this needs a supporting reference!. Such activity has been linked to antidepressant effects. In addition, peppermint exhibits moderate binding to gamma amino butyric acid (GABA) benzodiazepine receptors, something that may have anxiolytic effects (López et al., 2010). It has also been suggested that peppermint influences the cholinergic system (Moss et al., 2008). Such an effect has been supported by in vitro research that demonstrates that peppermint essential oil exhibited nicotinic receptor binding properties and inhibited acetylcholinesterase (Kennedy et al., 2018). The cholinergic system has been shown to be implicated in cognitive functioning such as memory (Solari & Hangya, 2018) and attention (Demeter & Sarter, 2013). Such neuronal effects that influence mood and cognition in a positive manner may be the root of the effects observed here. Interestingly, peppermint aroma has also been shown to improve physical activity such as exercise.

Meamarbashi (2014) found that peppermint affected the bronchial smooth muscle tonicity and improved lung capacity and inhalation ability. It may be that the improved breathing efficiency may lead to increased alertness through improved oxygen delivery to the brain, an effect that has previously been linked to improvements in attention and memory (Moss et al., 1998), and to reduced driver fatigue via the delivery of 40% concentrated oxygen (Ji et al., 2012).

The effectiveness of aromatherapy is often questioned and there is often a lack of evidence to assess the effectiveness of aromas (Fellowes et al., 2004). Typically, researchers have struggled to find aromatherapy-specific effects on variables (Chamine & Oken, 2015), and it may be beneficial to consider why certain studies yield significant results and others do not. Method of administration may play an important role. Press-Sandler et al. (2016) suggested that essential oils are required to be applied close to the olfactory system to produce positive outcomes. This suggests that the olfactory properties of the aromas are key. However, when inhaled in an ambient dispersal manner, volatile aroma compounds are able to enter the blood stream (Moss & Oliver, 2012) and may affect the neural systems responsible for emotions and memories (Thomas, 2002). In a driving context such ambient dispersal is clearly preferable to avoid distracting the driver. Current vehicles utilise car fresheners to provide a pleasant aromatic scent in the car. The current study findings suggest that aromatherapy could be adapted into the use of car fresheners in order to reduce driving aggression.

This study has provided evidence for a potential peppermint aroma based intervention to reduce aggressive driving behaviours. Denson (2015) suggested there was a need for an intervention for reactive aggression which has been linked to risk-tasking behaviours, and in turn risky and aggressive driving behaviours (Cui et al., 2016; Sani et al., 2017). Future work should investigate how aroma may be best applied in daily driving routines. It is possible that intermittent dispersal may be preferable (Funato et al., 2009; Susami et al., 2011) and this could perhaps be linked to real time detection of driver fatigue (Tang et al., 2016). The evaluation of different aromas is also pertinent as individual preferences may be important. Baron and Kalsher (1998) reported that a pleasant aroma (lemon) improved simulated driving performance, although only when no gift was provided to participants for good performance. This interesting interaction demonstrates how other factors may also be important in this area. Jovanovic et al. (2011) reported that driving motives significantly predicted aggressive driving and it may be that incentives can moderate such motives. However, the implementation of such incentives would be difficult and potentially expensive. Reducing aggressive driving continues to be a governmental priority with previous campaigns focusing on the areas of law enforcement and driver education (Lee et al., 2010). The potential for a successful intervention based on the in-car dispersal of an ambient aroma is not something to be sniffed at.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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How to cite this article: Moss, M., Ho, J., Swinburne, S., & Turner, A. (2023). Aroma of the essential oil of peppermint reduces aggressive driving behaviour in healthy adults. *Human Psychopharmacology: Clinical and Experimental*, *38*(2), e2865. https://doi.org/10.1002/hup.2865