Department of Psychology

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A pilot study to evaluate the impact of inhalation of 'think tank' rosemary scented oxygen on cognition and mood.

Introduction

Brief inhalation of pure oxygen has been demonstrated to increase blood oxygen saturation and improve cognitive functioning in healthy adults (Moss et al., 1998; Scholey et al., 1998). Exposure to the ambient aroma of rosemary (*Salvia rosmarinus*) has also been shown to improve memory and impact on mood in healthy children (Moss et al., 2017), adults (Moss et al., 2003) and older adults (Moss, 2014). This study assessed the potential impact of brief inhalation of pure oxygen scented with organic rosemary aroma. Two compounds with overtly similar behavioural effects but potentially different underlying mechanisms may exhibit pharmacologically additive or non-additive (synergistic) actions (Tallarida et al., 1997). If they are additive then the whole is effectively the sum of its parts, whereas synergistic effects may be more or less than the sum of the individual effects, depending on how they interact. In order to investigate this, a comparison was made between four different pressurised gas conditions: Ambient air with rosemary, Ambient air with no rosemary, 95% Oxygen with no rosemary and 95% Oxygen with rosemary. Based on previous evidence as cited above the following hypotheses were made:

1) Cannisters containing oxygen alone will improve memory
2) Cannisters containing rosemary aroma with compressed air will improve memory and impact on mood.
3) Cannisters containing both oxygen and rosemary aroma affect memory and mood in a manner that may or may not be additive or synergistic.

Method

Design

A repeated measures placebo-controlled crossover design was employed. The independent variable being the administration of four combinations outlined above. A Latin square design (Table 1) ensured that each condition was presented an equal number of times in each serial order position to avoid any systematic order effects from contaminating the data. The dependent measures were blood oxygen saturation, Alert, Calm and Content mood variables and the cognitive variable, Word Recall, measured as the number of correctly recalled words from four sequentially presented lists.

Table 1. Latin square design indicating the serial order of presentation of the gas cannisters

GROUP	CANNISTER 1	CANNISTER 2	CANNISTER 3	CANNISTER 4
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	C

Participants

Twenty healthy adult volunteers (mean age = 22.3 yrs, SD = 4.3) were each be paid £10 for completing the study. Group one consisted of five females (mean age = 24.2 yrs, SD = 7.3). Group 2 consisted of five females (mean age = 20.2 yrs , SD = 1.9). Group 3 consisted of four females (mean age = 20.5 yrs, SD = 1.3) and one male aged 27 yrs. Group 4 consisted of four females (mean age = 22.5 yrs, SD = 4.4) and one male aged 25 yrs.

Materials

Each participant was provided with four personal (5 ltr) cannisters holding the four different gas aroma combinations. These were provided by the study funder and all were identical except for being marked on the base with a letter A, B, C or D. The participants and research assistant who completed the data collection were thus blind to the contents of each cannister.

Paper and pencil visual analogue scales were used to assess the mood variables 'Alert', 'Content' and 'Calm' (Bond & Lader, 1974).

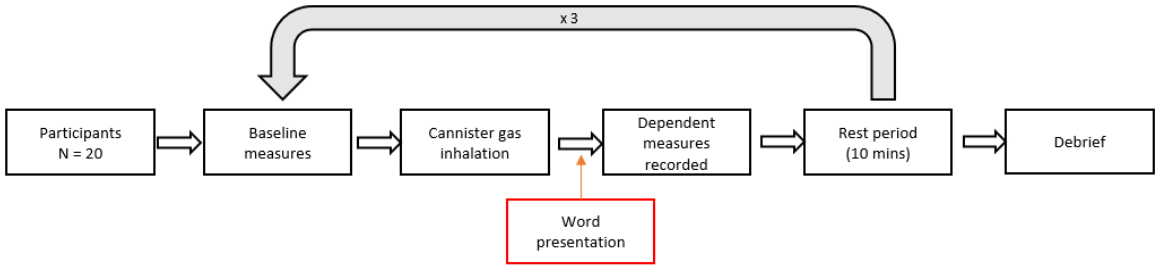
A Wellue viatom fingertip pulse oximeter (Shenzhen Creative Industry Co. Ltd.) was used to measure blood oxygen saturation.

Four lists of one, two and three syllable words matched for imagery, concreteness and frequency were presented using timed Powerpoint presentations. Each word was presented on a computer screen for one second with a one second inter-item blank screen display.

Procedure

When volunteers arrived at the lab they were provided with information sheets and then if they wished to proceed they provided informed consent. Participants were randomly allocated to 'group' that defined order of presentation of the interventions. Baseline mood recordings and blood oxygen saturation were taken. Participants then took 15 inhalations from the first personal cannister (each participant having their own set of four to enhance health and safety). Blood oxygen saturation was again recorded. Fifteen words were then be presented on a screen at a rate of one every two seconds with a display time of one seconds each. Participants then had 60 seconds in which to write down as many words as they could recall. A 10 minute rest period then took place before the participants switched to their next cannister and the process repeated until all four cannisters had been tested (see figure 1). On completion of testing participants were debriefed and any questions answered.

Figure 1. Procedure diagram



Analysis strategy

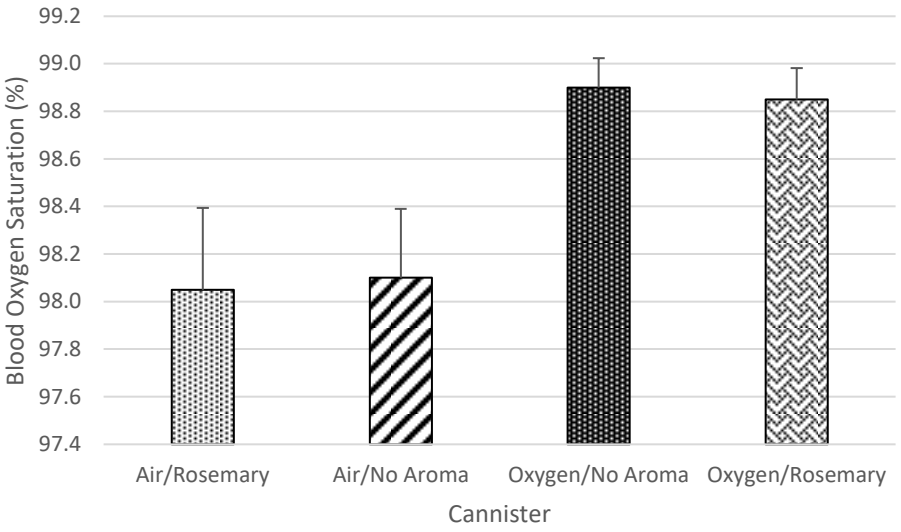
The data have been analysed for this report as a simple comparison of the four cannisters. The analysis method is a series of one way repeated measures analyses of variance (Anovas). The repeated measures factor is cannister with four levels and the dependent variables are blood oxygen saturation, word recall, and the three mood measures: Alert, Content and Calm.

Results

Blood Oxygen Saturation

The analysis indicated a significant difference to exist between the four cannisters (Figure 2). It can be seen that inhalation from the two cannisters that contained oxygen produced the highest mean saturation levels as would be expected. However, the conservative nature of the statistical pairwise comparisons means that none of the direct comparisons between pairs of cannisters was significant.

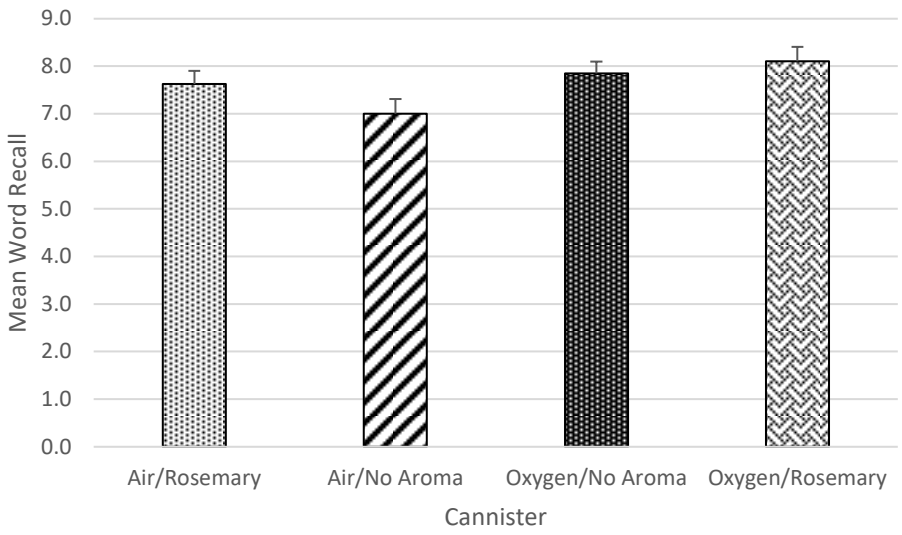
Figure 2. Mean Blood Oxygen Saturation levels (%) for all participants (N = 20) following inhalation from each of the four cannisters. Error bars represent standard errors.



Word Recall

The analysis revealed a significant difference in word recall between the four cannisters (Figure 3). However, the conservative nature of the statistical pairwise comparisons means that none of the direct comparisons between pairs of cannisters was significant. When compared to the Air/No Aroma cannister the Air/Rosemary delivered a 9% increase, the Oxygen/No Aroma delivered a 12% increase and the Oxygen/Rosemary a 15% increase in correct word recall. These increases are a little larger than I have typically found for either oxygen or rosemary and does represent the first time they have been tested in combination. Interestingly the effects of rosemary and oxygen are not fully additive. If they were you might expect a 21% improvement for the combination.

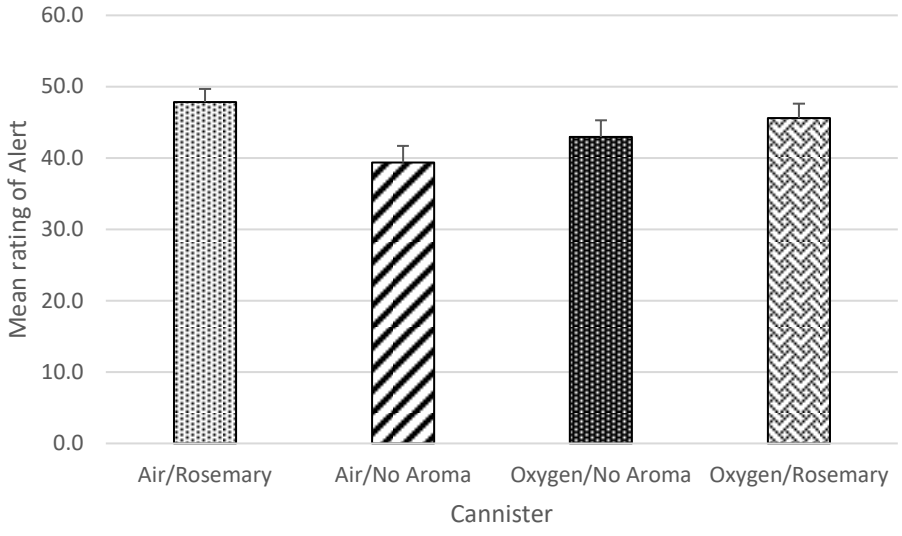
Figure 3. Mean word recall scores for all participants (N = 20) for all conditions. Error bars represent standard errors.



Mood - Alert

A significant difference between the four cannisters was found for ratings of Alertness (Figure 4). However, the conservative nature of the statistical pairwise comparisons means that none of the direct comparisons between pairs of cannisters was significant. Interestingly the rosemary/Air cannister produced the greatest level of alertness followed by oxygen/rosemary. Previous work that I have undertaken found no impact of oxygen on alertness so it is not surprising that the rosemary aroma appeared to be the most effective component.

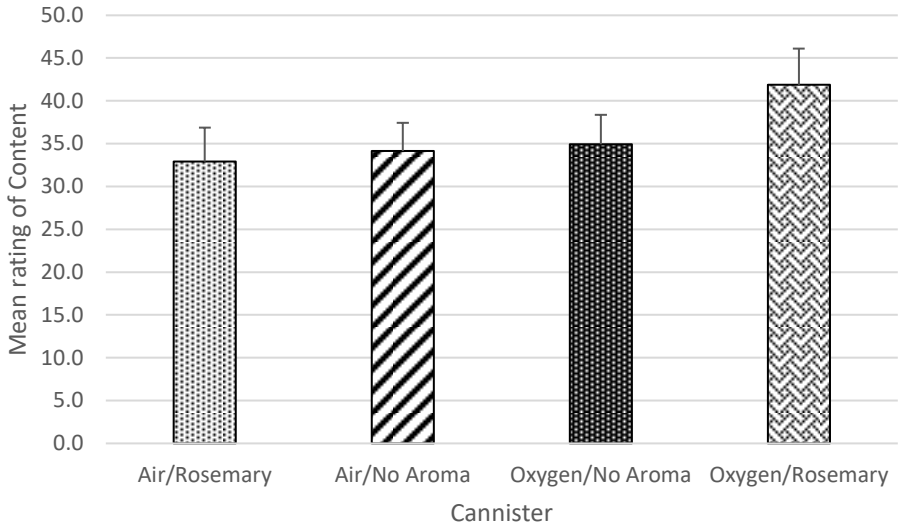
Figure 4. Mean ratings of Alertness for all participants (N = 20) for all conditions. Error bars represent standard errors.



Mood – Content

A significant difference between the four cannisters was found for ratings of Contentedness (Figure 5). However, the conservative nature of the statistical pairwise comparisons means that none of the direct comparisons between pairs of cannisters was significant. Looking at the mean values however indicates that the oxygen/rosemary combination produced the highest levels of contentedness. This is not something I have observed previously for either oxygen or rosemary in isolation.

Figure 5. Mean ratings of Contentedness for all participants (N = 20) for all conditions. Error bars represent standard errors.



Mood – Calm

No significant difference was found between the for conditions for Calmness.

Discussion

The results of this study support the hypotheses that inhalation of oxygen and rosemary aroma impact on memory in a beneficial manner when delivered in isolation. Considering the size of the effects observed here we find that administering rosemary aroma in compressed air increased word recall by around 8%, a figure comparable to that reported for ambient rosemary aroma by Moss et al. (2003). In the case of oxygen alone the 11% improvement is also comparable to that reported previously by Moss et al. (1998) and is supported by the significant increase in blood oxygen saturation observed here. Of greater interest however, is the evaluation of the oxygen/rosemary combination. This study represents the first time that such a combination has been tested. The observed 15% improvement in recall compared to the no aroma/air control cannister suggests that there is some additive effect of being exposed to oxygen and rosemary aroma simultaneously. These results coalesce to provide evidence in support of the potential for Think Tank use to improve memory for information presented immediately after use of the cannister.

With regard to mood, previous work on oxygen administration eg Moss et al. (1998) reported no impact on the three mood variables assessed in the current study. It is perhaps then not surprising that oxygen alone did not increase measures of Alert, Content or Calm here. Rosemary aroma has been reported to increase alertness (Diego et al., 1998; Moss et al., 2003) and this effect was also observed here for both the rosemary/air and rosemary/oxygen conditions although it is not clear

why rosemary/air appears to be sightly greater in effect than rosemary/oxygen. In contrast, the rosemary/oxygen condition was the only one to increase ratings of Content, and by an impressive 30% compared to no aroma/air. The air/rosemary condition did not increase feelings of Content which stands in juxtaposition to previous findings for ambient rosemary aroma (Moss et al., 2003), although the previous work reported change from baseline scores across a longer and more arduous cognitive testing battery where the effect of rosemary was more of a buffering effect against a decline in Content over the testing period. It is also worth noting that the variability in scores on this measure across participants in the current study was greater than for alertness, suggesting that the effect is by no means universal. No impact was observed for the Calm variable which is in line with Moss et al. (2003), although in contrast, Diego et al. (1998) reported rosemary to produce greater relaxation and reduce anxiety.

Conclusion

This study has provided data that support the proposition that Think Tank rosemary scented oxygen has the potential to improve memory and mood in healthy adults. The small scale of the study does mean that some of the effect sizes, although comparable to previously reported for both oxygen and rosemary in isolation, do not reach statistical significance. This study also represents the first time that a combination of rosemary and oxygen administration has been evaluated, and suggests that a potential additive benefit may be attained.

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