Are nutritional variables associated with cognition in stimulant dependence?

Claire F Whitelock & Karen D Ersche

Department of Psychiatry and Behavioural & Clinical Neuroscience Institute, University of Cambridge, UK

Introduction

Treatment of drug addiction is still a challenge. Although medications are available which are effective for dependent users of alcohol, nicotine and opiates, none have proven effective for users of stimulants like cocaine and amphetamine[1].

Cognitive deficits arsing from, or exacerbated by, chronic drug use seem to moderate treatment outcomes because skills such as attention and memory are required in order to learn and implement strategies taught during treatment sessions[2]. As a result, some researchers have suggested that tackling cognitive deficits pharmacologically with cognitive enhancing drugs may improve treatment prognosis[3].

Food has also been suggested as cognitively enhancing[4]. For example, high fat diets have been linked to decreased attention[5], while vitamin and fish oil supplements may improve domains of cognition which typically decline with age[6]. Nutritional supplements are often given to alcohol dependent individuals to alleviate cognitive symptoms[7].

However, the subject of nutrition in drug dependent individuals is not well studied. Available research suggests that diets are poor: high in fats, sugars, and carbohydrates, and low in vitamins, protein and fruit[8,9]. We aimed to investigate whether differences in diet shown by stimulant dependent individuals might be related to their cognitive deficits. If so, dietary intervention might enhance treatment success.

Hypothesis

We hypothesised that the dietary intake of stimulant dependent and healthy volunteers would differ, as has been reported in the literature. Due to the reported link between nutrients and cognitive functions, we further hypothesised that such dietary differences would be related to stimulant dependent and healthy volunteers' differential cognitive functioning.

Methods

Fifty-eight stimulant dependent volunteers, all except one of whom were dependent on cocaine, and 63 healthy volunteers were recruited. All participants completed neurocognitive tests from the widely-used and validated Cambridge Neuropsychological Testing Battery (CANTAB; www.camcog.com), as shown in Figure 2.

Participants also completed the EPIC-Norfolk Food Frequency Questionnaire (FFQ) which is a validated measure within Europe for the assessment of usual dietary intake in the past year[10,11] (Figure 1).

FFQ and cognitive data were analysed for differences between groups with Multivariate Analysis of Covariance (MANCOVA) with gender, smoking status, alcohol and calorie intake as covariates in the analysis of FFQ, and verbal intelligence, dysphoric mood, smoking status, alcohol and calorie intake as covariates in the analysis of cognitive data. We corrected for multiple comparisons using the Bonferroni correction.

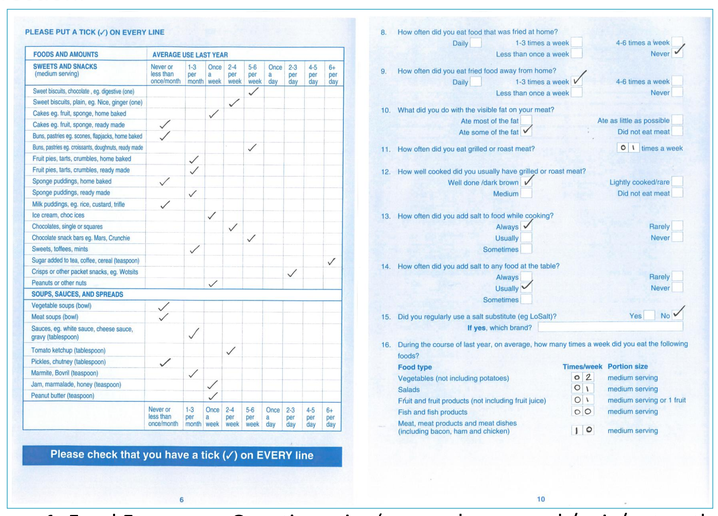

Figure 1. Food Frequency Questionnaire (www.srl.cam.ac.uk/epic/nutmethod)

Table 1, Sample Characteristics

Demographics	Healthy Volunteers	Stimulant Dependent Volunteers	*F* or X^2	*P*
N	63	58		
Age (years)	35.49 (±9.65)	35.75 (±7.90)	0.03	0.869
Gender (male:female)	50 : 13	55 : 3	5.02	0.025
Years of education (years)	13.56 (±2.80)	11.28 (±1.91)	26.94	<0.001
Verbal intelligence (NART; score)	115.00 (±7.00)	107.56 (±9.70)	22.29	<0.001
Dysphoric mood (BDI-II; score)	2.56 (±3.36)	17.53 (±11.92)	91.43	<0.001
Smoking status (non- smoker, previous smoker, smoker)	25 : 31 : 7	3 : 2 : 53	77.96	<0.001
Body mass index (BMI; score)	25.56 (±3.83)	24.23 (±3.50)	3.89	0.051

Scorings. BDI-II (0-13: minimal, 14-19: mild, 20-28: moderate, 29-63: severe), BMI (0-18.5: underweight, 18.5-25: ideal, 25-30: overweight, 30 and above: obese).

Results

Demographic data are shown in Table 1. There were significant differences in gender, verbal intelligence, years of education, and smoking status between drug users and controls, but not in body mass index (a measure of weight relative to height) or age. These differences were statistically controlled for in the subsequent analyses.

Group differences in dietary food intake

Stimulant dependent participants had a higher calorie diet and drank more alcohol than healthy volunteers. Holding these differences constant, there were eight foods which stimulant dependent participants ate in greater quantities, and two which they ate lesser of (see Table 2). Drug users also performed more poorly than healthy volunteers in each of the cognitive tasks (see Figure 3).

Relationship between food intake and cognition

In healthy volunteers, **fibre** (r = .43, p<.01), **fructose** (r = .28, p<.05), **glucose** (r = .27, p<.05), **vitamin B6** (r = .34, p<.001) and **fruit** (r = .40, p<.01) were positively correlated with **processing speed** in the test of sustained attention. However, there were no correlations between food and cognitive functions in drug users.

Figure 2

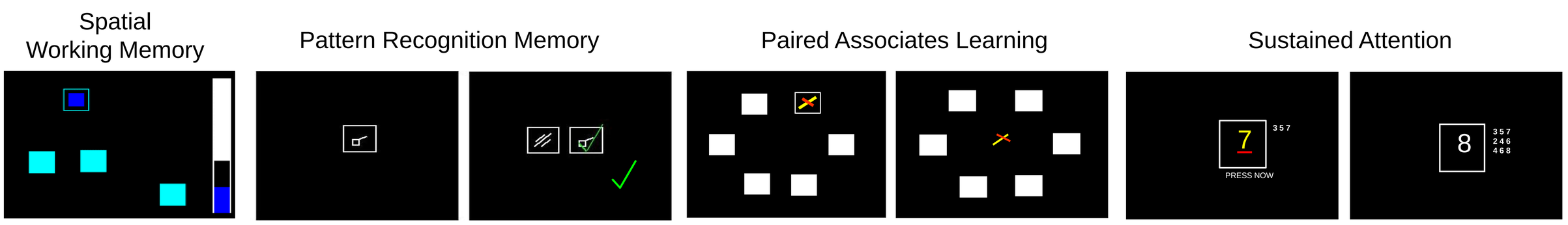

Table 2, Dietary Differences between Groups

Nutrients	Healthy Volunteers	Stimulant-Dependent Volunteers	*F*	*P*
Fibre (g)	17.79 (±14.18)	18.08 (±13.79)	13.10	<0.001
Glucose (g)	24.23 (±18.98)	27.03 (±24.57)	17.42	<0.001
Vitamin B6 (mg)	2.52 (±1.30)	2.66 (±1.40)	19.03	<0.001
Fat (g)	75.74 (±28.23)	143.57 (±100.93)	24.10	<0.001
Monounsaturated Fatty Acids (g)	27.55 (±10.88)	54.11 (±40.57)	18.52	<0.001
Saturated Fatty Acids (g)	28.13 (±10.49)	55.31 (±37.69)	23.56	<0.001
Fruit (g)	287.24 (±448.10)	193.03 (±348.64)	13.16	<0.001
Fructose (g)	26.47 (±20.49)	26.20 (±24.89)	17.95	<0.001

Note. Comparisons between groups were controlled for differences between groups in gender composition, smoking status, alcohol (g), and energy (calorie) intake.

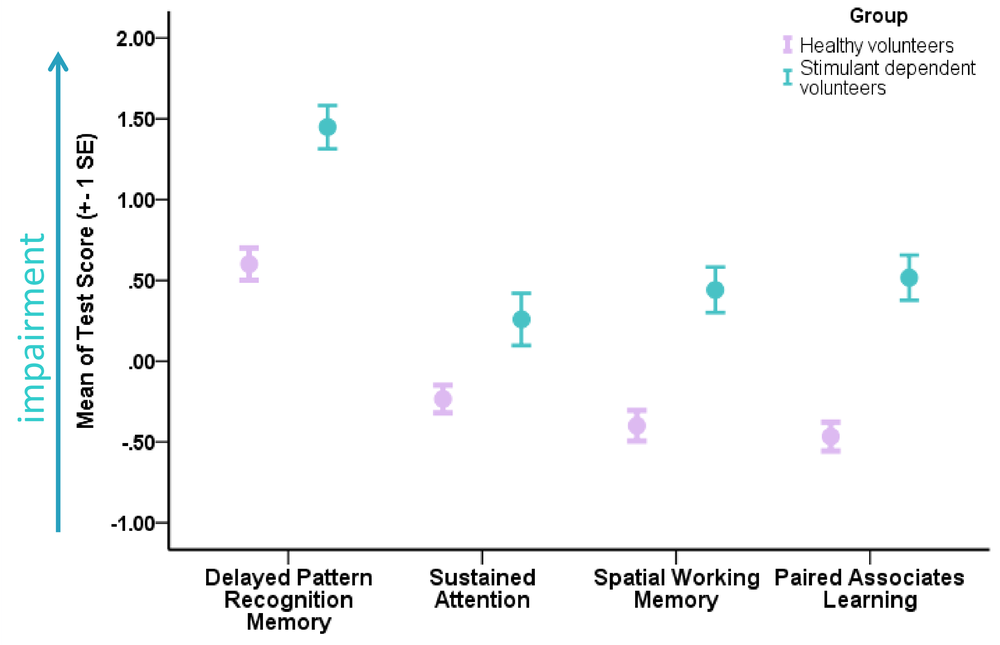

Figure 3. Summary scores of the cognitive tests, Z-transformed

Conclusions

Stimulant dependent volunteers were more cognitively impaired than healthy volunteers in tests of spatial working memory, visual memory and new learning, and attention, as has been shown in previous research[12]. Diets between groups differed in terms of energy intake, alcohol content, and types of foods consumed. However, while there was a correlation, albeit weak, between dietary variables and cognition in healthy volunteers, such a relationship was not present in the drug using individuals. This suggests that the cognitive deficits of the stimulant-dependent volunteers may be too severe to be amenable to dietary interventions, and that the subject of cognitive enhancement via nutrition for treatment-seeking drug users requires further consideration and investigation. As improving unhealthy diets could also be beneficial to general health, nutritional intervention might also bring positive outcomes in this sense.

References

1. Lingford-Hughes AR et al. (2012). *J Psychopharmacol* 26:899-952. **2**. Aharonovich E et al. (2006). *Drug Alcohol Depen,* 81: 313-322. **3**. Sofuoglu M et al. (2013). *J Neuropharm*, 64: 452-463. **4**. Spencer JPE (2008). *Proc Nutr Soc, 67*: 238-252. **5**. Edwards LM et al. (2011). *FASEB J 25*: 1088-1096. **6**. Durga et al. (2007). *Lancet, 369*: 208-216. **7**. Martin et al. (2004). *Alcohol Res Health*, 27: 134-142. **8**. Cowan J & Devine C (2008). *Appetite, 50*: 33-42. **9**. Santaloria-Fernandez FJ et al. (1995). *Drug Alcohol Depen, 38*: 11-18. . **10** Welch AA et al. (2005). *J Hum Nutr Diet, 18*: 99-116. **11**. Mulligan AA et al. (submitted). **12**. Jovanovski D et al. (2005). *J Clin Exp Neuropsychol, 27*: 189-204.

Acknowledgements

We would like to thank the staff of the Wellcome Trust Clinical Research Facility at Addenbrooke's Hospital, Cambridge for their support in carrying out the study, and the Mental Health Research Network (MHRN) for their help in the recruitment of participants, as well as the participants themselves. We would also like to thank Angela Mulligan and her team at the University of Cambridge's EPIC project for the use of the EPIC-Norfolk FFQ and for the extraction of the nutritional data. Further acknowledgement goes to the study sponsors, Cambridge University Hospitals NHS Foundation Trust and the University of Cambridge. This work, including KDE and CFW, were funded by the Medical Research Council (G0701497).

Disclosure statement: No potential conflict of interest.