Alcohol use in adolescence and later working memory: findings from a large population-based birth cohort

Liam Mahedy

Liam.mahedy@bristol.ac.uk
Background

- Alcohol use is prevalent during adolescence ~50% reported having drunk at least one alcoholic drink (Fuller et al., 2013)

- Working memory (WM) - critical for planning and decision making, not fully developed until adulthood

- Evidence from:
  - Animal studies - alcohol use during adolescence is associated with alterations in brain structure (Giedd & Rapoport, 2010)
  - Brain imaging studies - cognitive impairments (reductions in hippocampal brain volume) in heavy-drinking adolescents, compared to non-drinking controls (Squeglia et al., 2012)
Background

- Alcohol use preceded cognitive deficits; while others found evidence for the opposite direction (Peeters et al., 2014 – narrative review)

- The discrepancies in these findings could be due to a number of reasons:
  - using cross-sectional studies
  - the use of small sample sizes
  - using high-risk samples
  - examining low levels of alcohol consumption
Aim

- We hypothesized that sustained heavy drinking, defined as regular binge drinking (assessed at age 15 years), would be adversely associated with WM (assessed at age 18 years)
Methods

- ALSPAC - ongoing population-based study

- Pregnant women resident in the former Avon (South West England) due dates between 04/1991 and 12/1992
  - 13,617 mother-offspring pairs from singleton live births who survived to at least 1 year
  - Missing data - Multiple imputation and inverse probability weighting (MI/IPW)
    - 2-back task (N=3,351)
    - 3-back task (N=3,319)
Measures – alcohol use

- 3 measures listed in order of increasing severity (Melotti et al., 2013):

1. **heavy typical drinking** (more than four drinks per occasion in the previous 6 months)
2. **frequent drinking** (≥20 times in the previous 6 months)
3. **regular binge drinking** (consuming more than five drinks in any 24-hour period on ≥20 occasions in the previous 2 years)
Measures - working memory

- N-back task (2- and 3-back versions) – 48 trials for each task

- Four metrics were examined for both versions:
  1. **Hits**, or the percentage of matching numbers correctly identified as matches,
  2. **False alarms**, or the percentage of non-matching numbers incorrectly identified as matches
  3. Median **reaction times** for hits and false alarms, as an indicator of processing efficiency
  4. **Discriminability index (d’)** which is a signal-detection metric that takes into account both hits and false alarms to derive an overall estimate of signal detection ability
Measures - potential confounders

- Gender, income, social economic position, housing tenure, parity, maternal education, maternal smoking – all assessed during pregnancy

- IQ at age 8 years (Nagel et al., 2013)

- Smoking status at age 15 years (Loughead et al., 2009; Zhang et al., 2010)

- Removed individuals with head injury/unconsciousness before age 11 years (n=112)
Alcohol use and $d'$ for the 2-back task

Model 1: unadjusted model
Alcohol use and $d'$ for the 2-back task

Model 1: unadjusted model

Model 2: adjusted for gender, income, SEP, housing tenure, parity, maternal education, maternal smoking in pregnancy
Alcohol use and d’ for the 2-back task

Model 1: unadjusted model
Model 2: adjusted for gender, income, SEP, housing tenure, parity, maternal education, maternal smoking in pregnancy
Model 3: further adjusted for IQ at age 8 years
Alcohol use and d’ for the 2-back task

Model 1: unadjusted model
Model 2: adjusted for gender, income, SEP, housing tenure, parity, maternal education, maternal smoking in pregnancy
Model 3: further adjusted for IQ at age 8 years
Model 4: further adjusted for weekly smoking status at age 15 years
Alcohol use and d’ for the 3-back task

Model 1: unadjusted model
Alcohol use and d' for the 3-back task

Model 1: unadjusted model

Model 2: adjusted for gender, income, SEP, housing tenure, parity, maternal education, maternal smoking in pregnancy
Alcohol use and d´ for the 3-back task

Model 1: unadjusted model
Model 2: adjusted for gender, income, SEP, housing tenure, parity, maternal education, maternal smoking in pregnancy
Model 3: further adjusted for IQ at age 8 years
Alcohol use and d’ for the 3-back task

Model 1: unadjusted model
Model 2: adjusted for gender, income, SEP, housing tenure, parity, maternal education, maternal smoking in pregnancy
Model 3: further adjusted for IQ at age 8 years
Model 4: further adjusted for weekly smoking status at age 15 years
Regular binge drinking and 4 metrics of WM: 3-back task

Model 1: unadjusted model
Model 2: adjusted for gender, income, SEP, housing tenure, parity, maternal education, maternal smoking in pregnancy
Model 3: further adjusted for IQ at age 8 years
Model 4: further adjusted for weekly smoking status at age 15 years
Limitations

- Examined one potential pathway – reverse causation
- Attrition – multiple imputation / weighted models
- Self-report alcohol use – evidence to suggest that self-reported alcohol use is a reliable and valid method (Del Boca & Darkes, 2003)
- Self-report WM – shared method variance
- Residual confounding
Summary and Implications

- Provide some evidence that regular binge drinking in mid-adolescence is associated with impaired WM after adjusting for confounding variables.

- Intervention aimed at preventing heavy alcohol use in adolescents (e.g., Koning et al., 2009) might be effective in reducing impairments in WM.

- Future research should explore possible mechanisms underlying this association and examine whether these associations persist into adulthood.

- Include smoking status in future studies.
Acknowledgements

University of Bristol
Prof. Matt Hickman
Prof. Marcus Munafò
Dr Jon Heron
Dr Gemma Hammerton

University of Liverpool
Prof. Matt Field
Dr Suzie Gage

Families, midwives, ALSPAC team
Descriptive results

Hits, false alarms and d’: 2- and 3-back tasks
Descriptive results

Mean reaction time: 2- and 3-back tasks

- Hits - RT
- False alarms - RT

- 2-back
- 3-back