Temporal Patterns of Substance Use and Their Effects on Cognition in Young Adults: (An Inverse Probability Weighting Approach)

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Experimental Pharmacopsychology and Psychological Addiction Research

Risk and Resilience Research

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Background

Substance Use and Cognitive Functions in Young Adults

Substance use is prevalent among young adults [1-3]

- Highly neuroplastic and sensitive period of brain maturation [4-6]

Substance use has acute, post-acute and long-term effects

- increased risk of substance use disorder [7-10]
- functional and cognitive impairments [11-14]

Substance-specific cognitive impairments

- Cannabis → attention and declarative memory [15-18]
- Ecstasy → declarative memory [19-21]
- Cocaine → working memory; widespread cognitive deficits [22-26]

Research Gap

Most previous studies…

- Focus on highly selective samples with chronic and intense use
- Rely on subjective self-report measures
- Rarely examine substance use patterns over time

RQ: In a large community-representative sample of young adults…

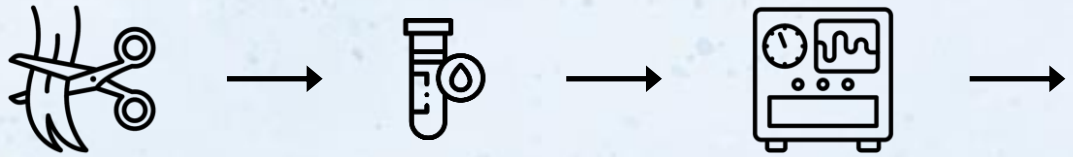
1) Can we distinguish temporal substance use patterns?
2) Are different substance use patterns associated with cognitive functions?

Methods

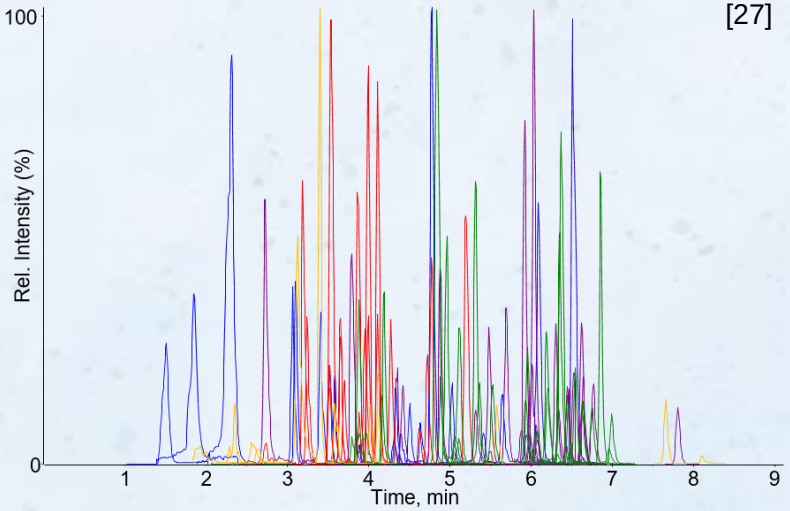
Instruments

Substance use in past 3 months

- Concentration in hair (pg/mg)



[27]

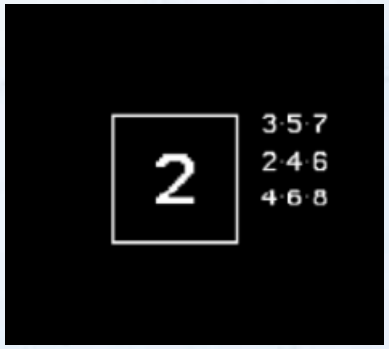


Cognitive functions

- Cambridge Neuropsychological Test Automated Battery (CANTAB) [28]

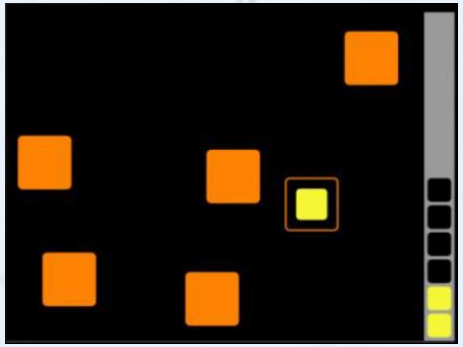
CANTAB

Sustained attention



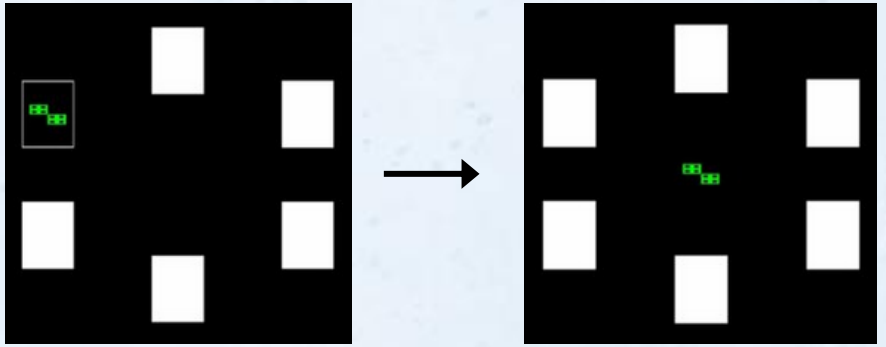
Signal detection

Working memory



Retention and manipulation

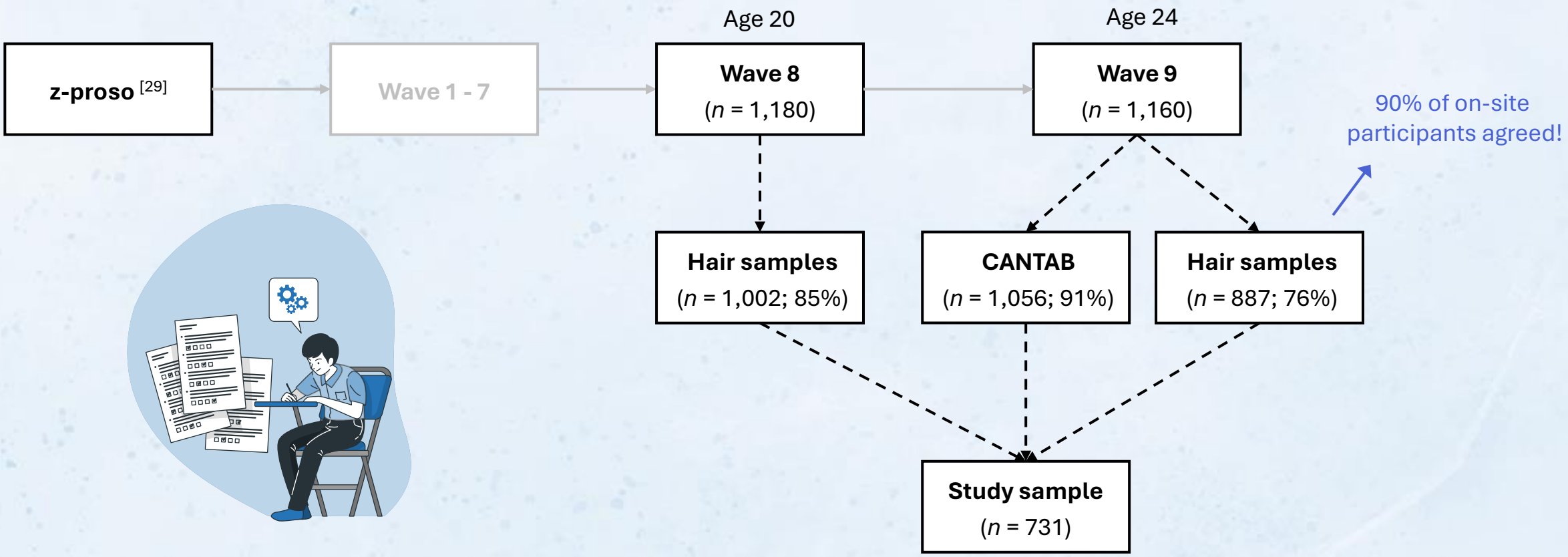
Declarative memory



Encoding

Recall

Participants



Sample Characteristics from W9 (*n* = 731)

Age, *years*	
Mean (SD)	24.4 (0.4)
Range	23; 25
Sex, *n*	
Male	373 (51%)
Female	358 (49%)
Highest education, *n*	
Below apprenticeship	67 (9%)
Apprenticeship	272 (37%)
Vocational	182 (25%)
Academic	210 (29%)

SES, *ISEI*	
Mean (SD)	47.2 (19.6)
Range	16; 90
Migration status, *n*	
No	410 (56%)
Yes	321 (44%)
Gaming experience	
Mean (SD)	2.3 (1.7)
Range	1; 7
Legal substances, *n*	
Daily smoking	240 (33%)
Daily drinking	37 (5%)

(Preliminary) Statistical Analysis

Preprocessing

Step 1: Latent Profile Analysis

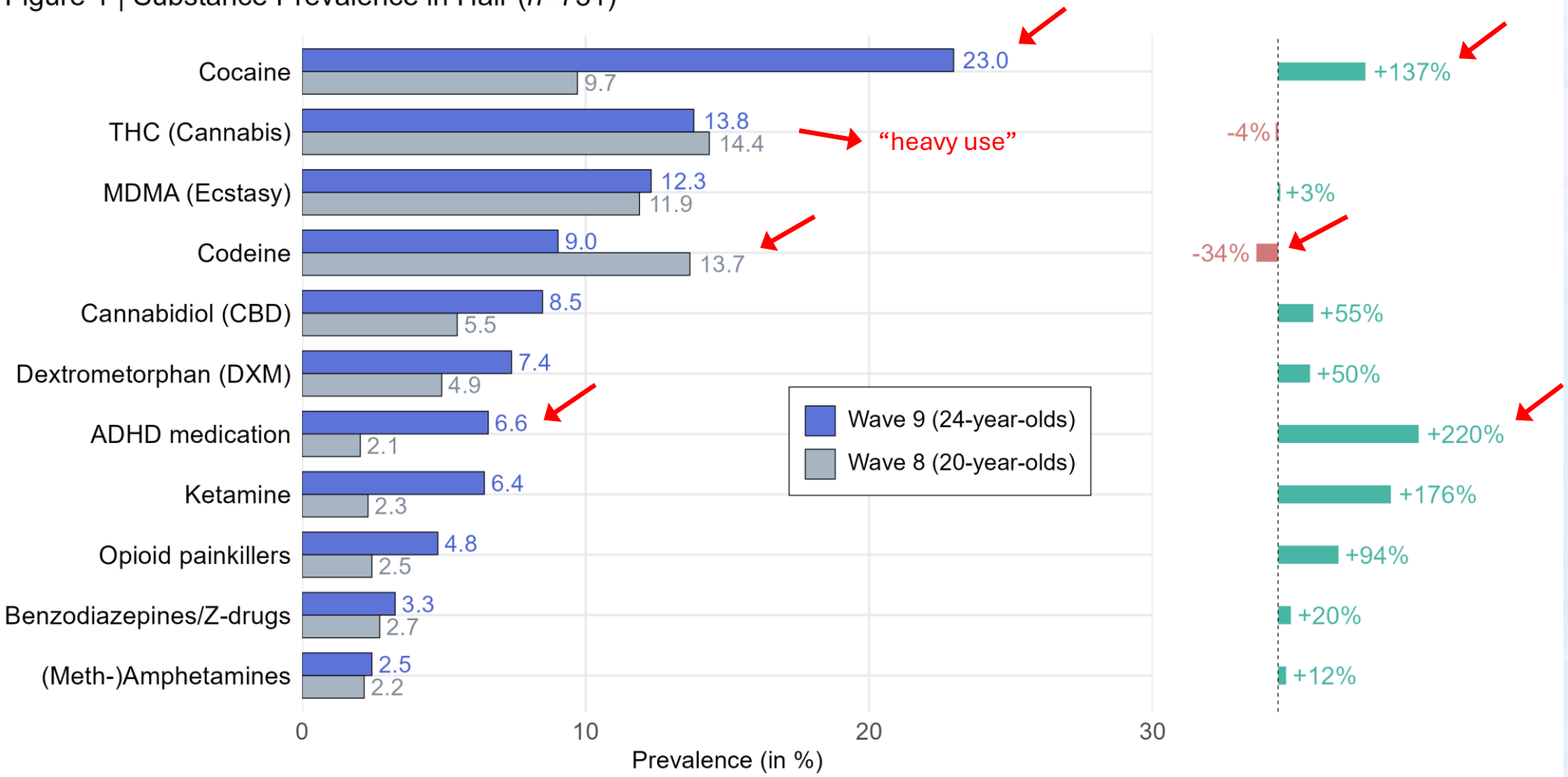
- Difference in substance concentrations as indicator

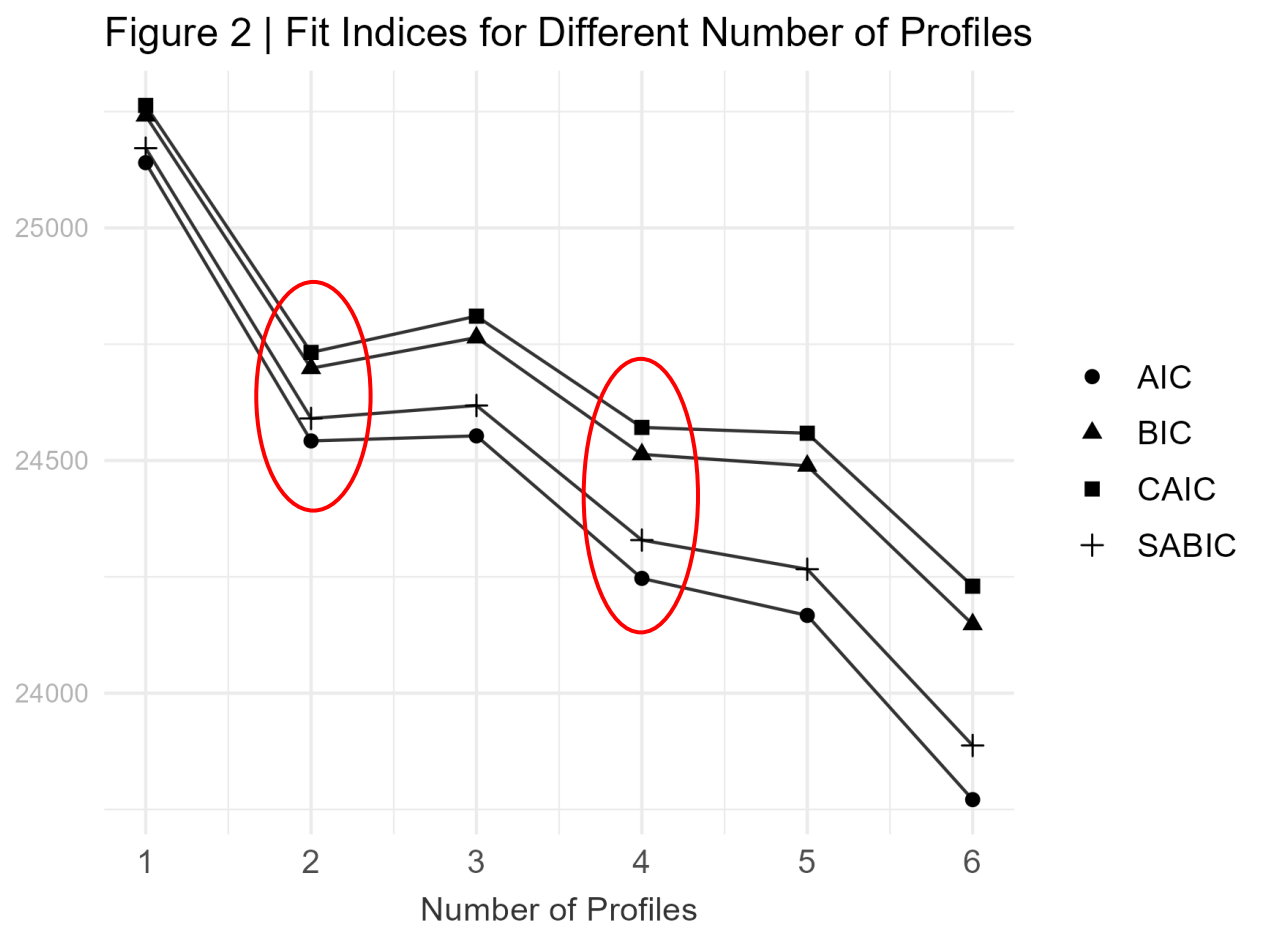
Step 2: Multivariable regression models

- Predictor: Substance profiles
- Outcome: CANTAB
- Covariates: Sex, SES, education, migration status, gaming experience, daily tobacco / alcohol use

Results

Figure 1 | Substance Prevalence in Hair (*n*=731)





Profiles	BLRT	*p*	Entropy
1	–	–	1
2	622.0	**.010***	.995
3	13.2	.594	.515
4	330.3	**.010***	.639
5	103.6	**.010***	.691
6	419.9	**.010***	.732

Figure 3 | 2-Profile Solution

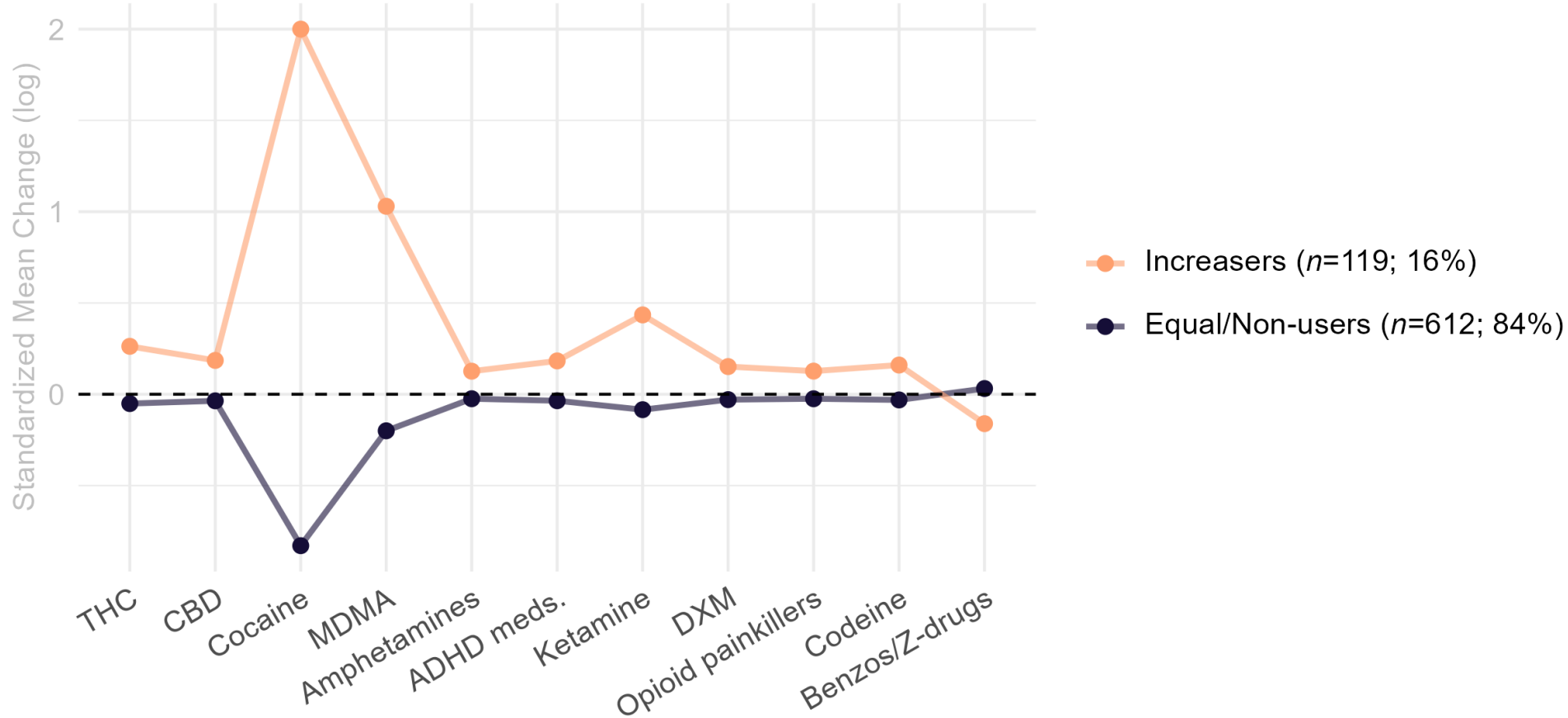


Figure 4 | 4-Profile Solution

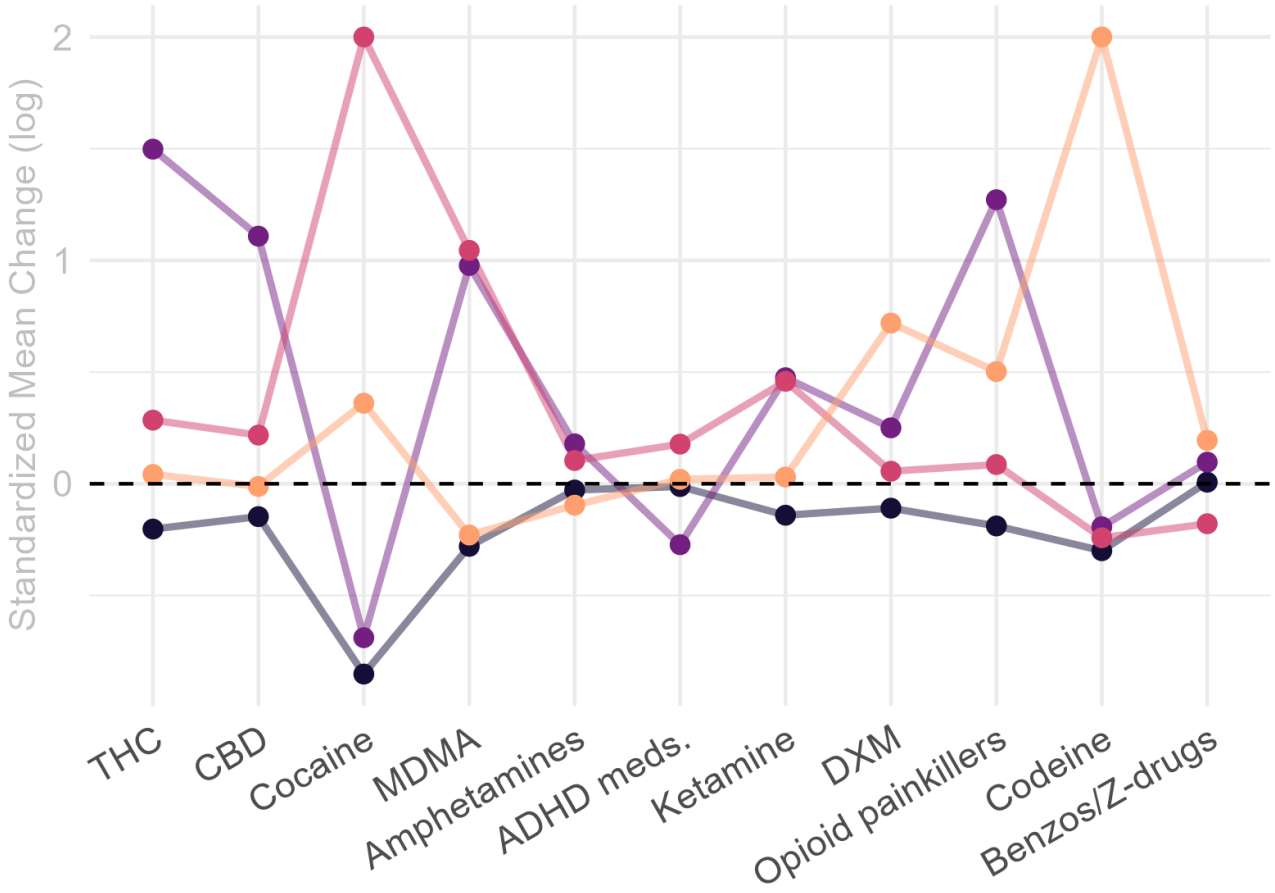


Figure 4 | 4-Profile Solution

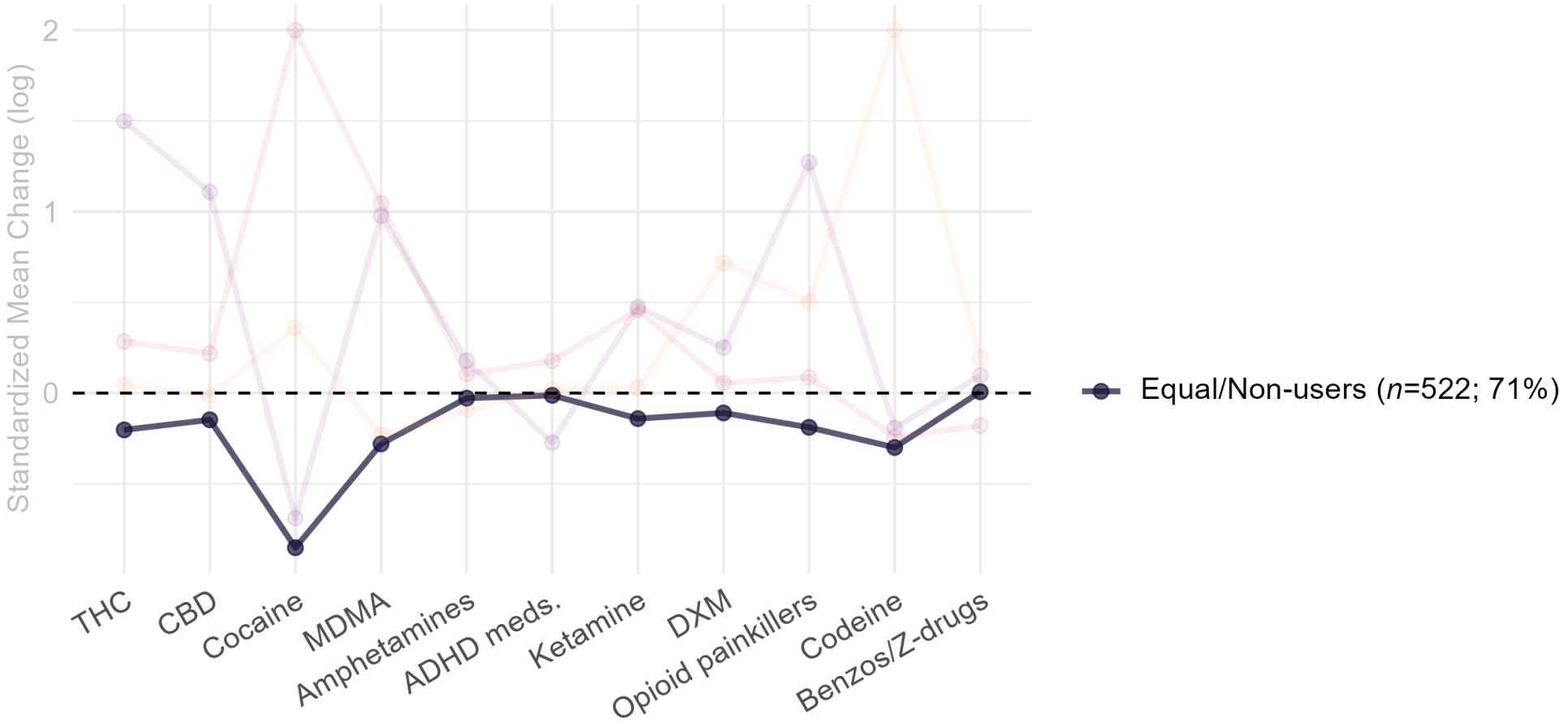


Figure 4 | 4-Profile Solution

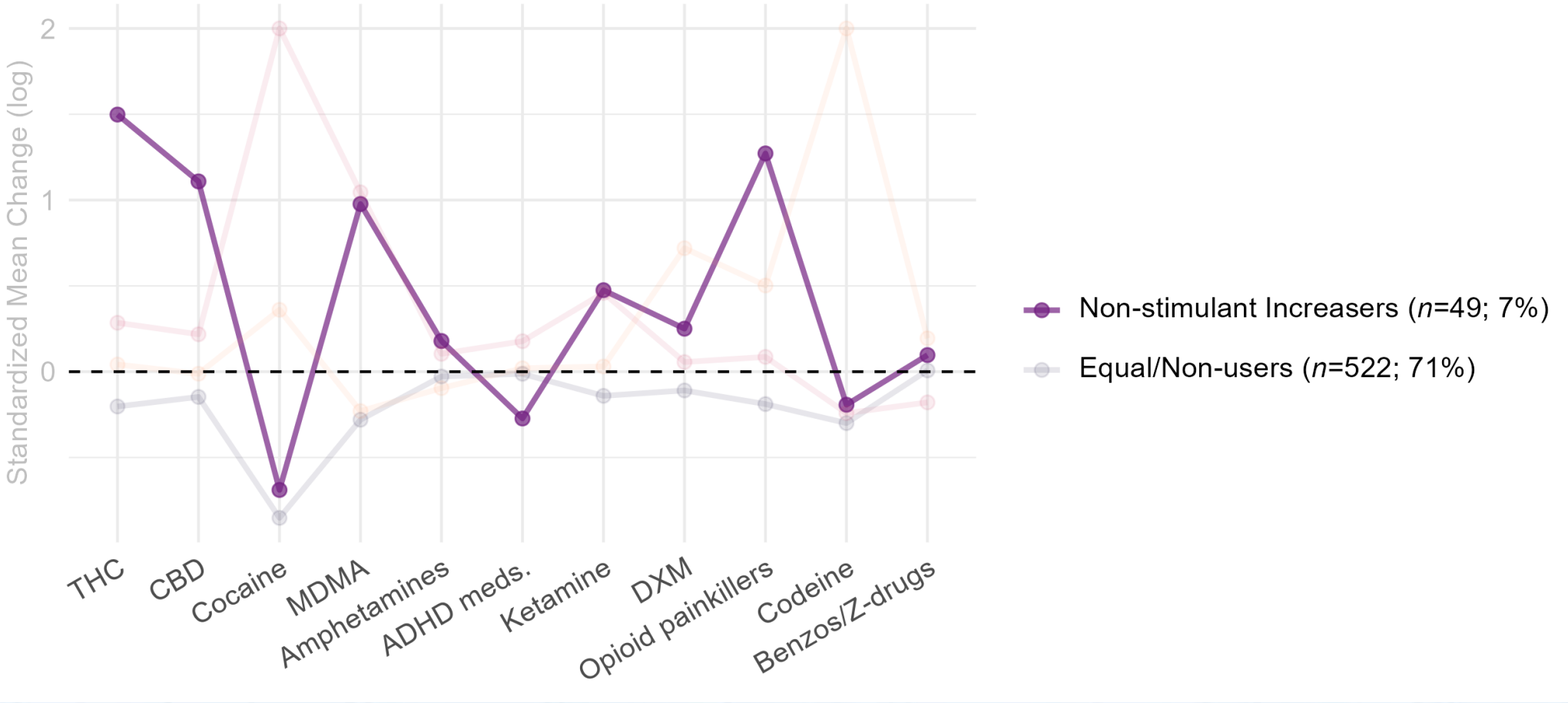


Figure 4 | 4-Profile Solution

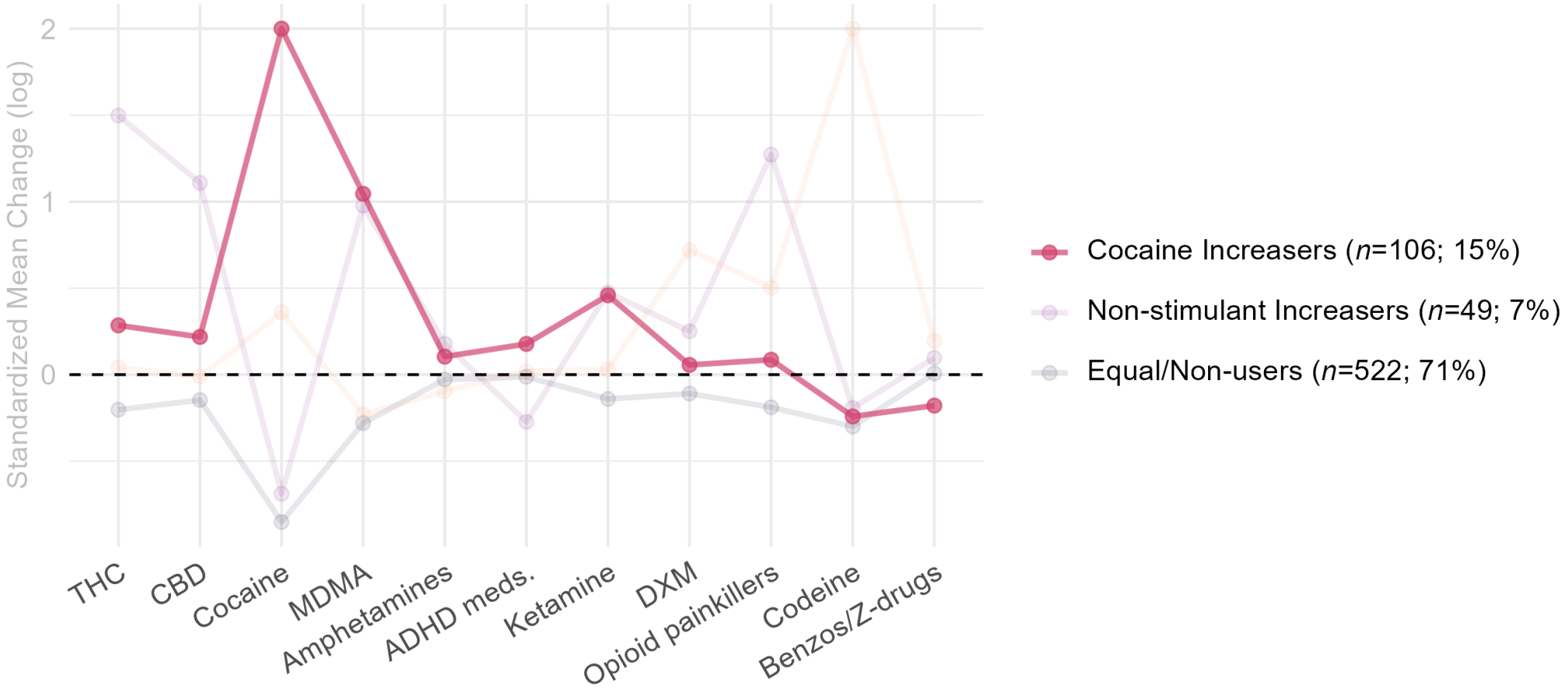


Figure 4 | 4-Profile Solution

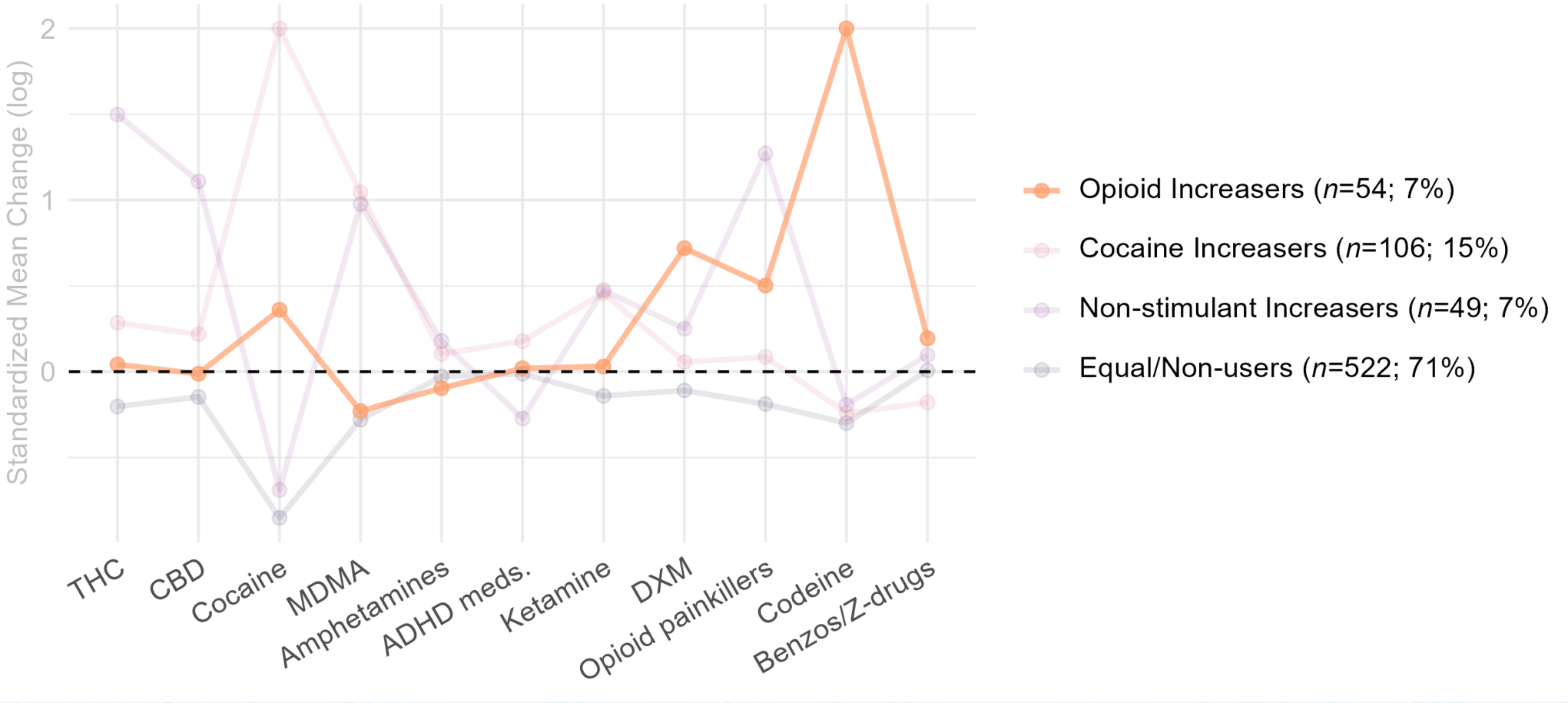
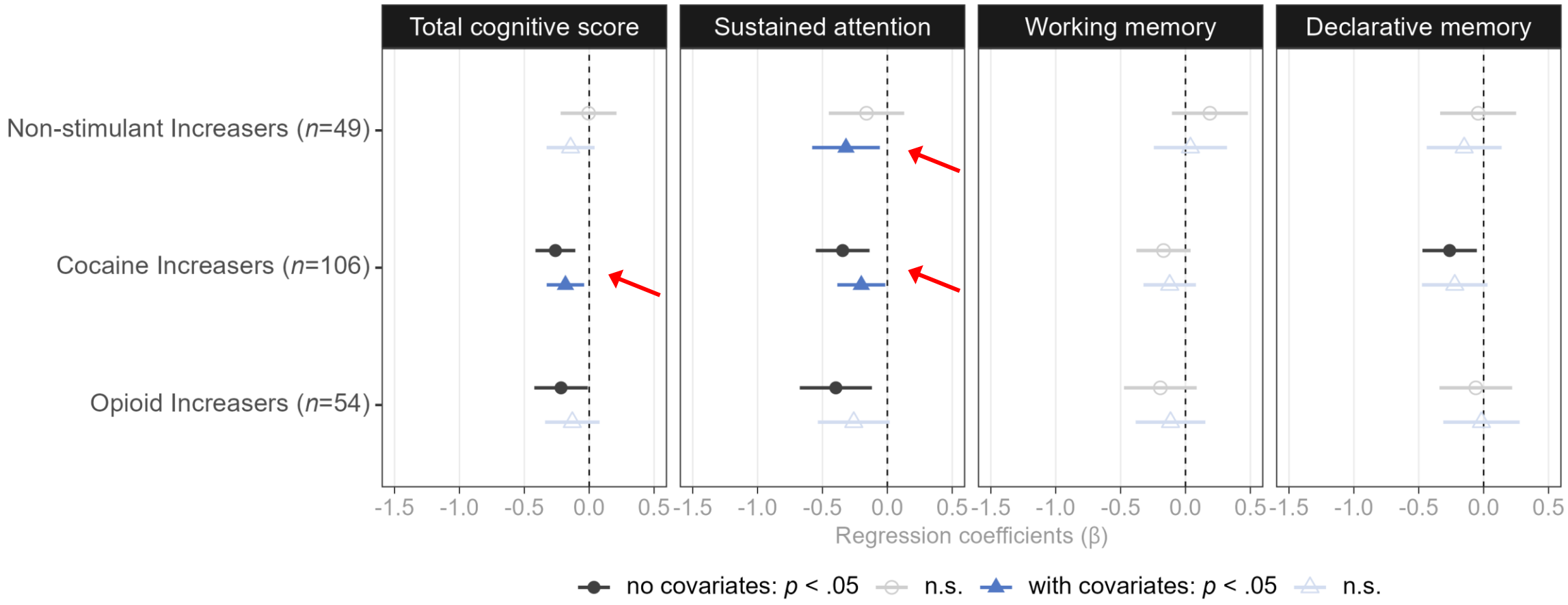


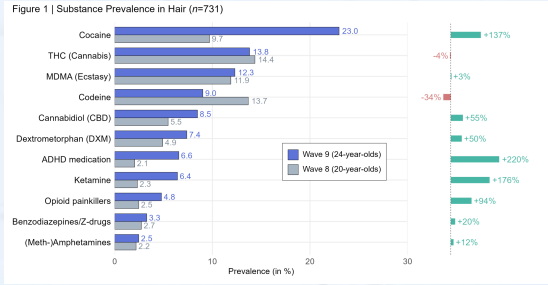
Figure 5 | Cognitive Funtions and Substance Use Profiles



Summary (I)

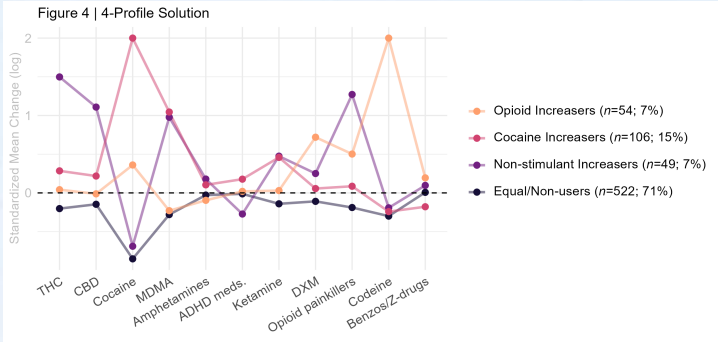
Prevalence rates

- Prevalence rates are generally high; especially Cocaine (~23%)
- Most prevalence rates increase from W9 → W8; except THC and Codeine



Substance profiles

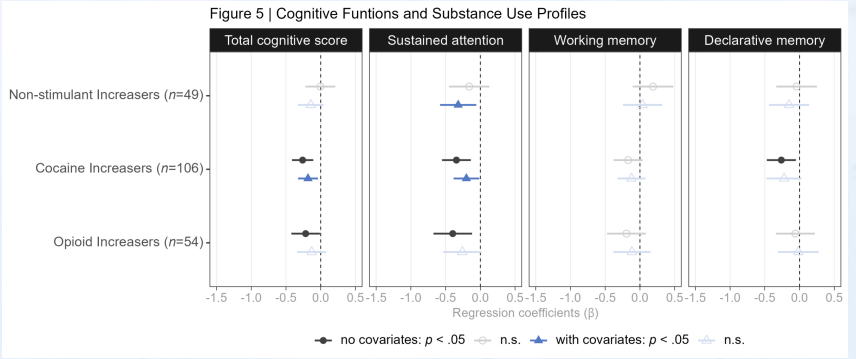
1) Equal/Non-users (*n*=522; 71%)
2) Non-stimulant increasers (*n*=49; 7%)
3) Cocaine increasers (*n*=106; 15%)
4) Opioid increasers (n=54; 7%)



Summary (II)

Cognitive functions (compared to equal/non-users)

- Worse total score in
  - Cocaine increasers
- Worse attention in
  - Cocaine increasers
  - non-stimulant increaser



Next Steps

Propensity scores

- Treatment variable: Substance use profiles
- Creating a score capturing pre-treatment cognitive functioning

Alternative modelling approaches

- Latent change score model
- ...Any suggestions? ☺

Thank you!

+ **Markus R. Baumgartner** and **Tina M. Binz** from the Institute of Forensic Medicine
+ Risk and Resilience team
+ Experimental Pharmacopsychology and Psychological Addiction Research team
+ z-proso infrastructure, collaborators, and participants

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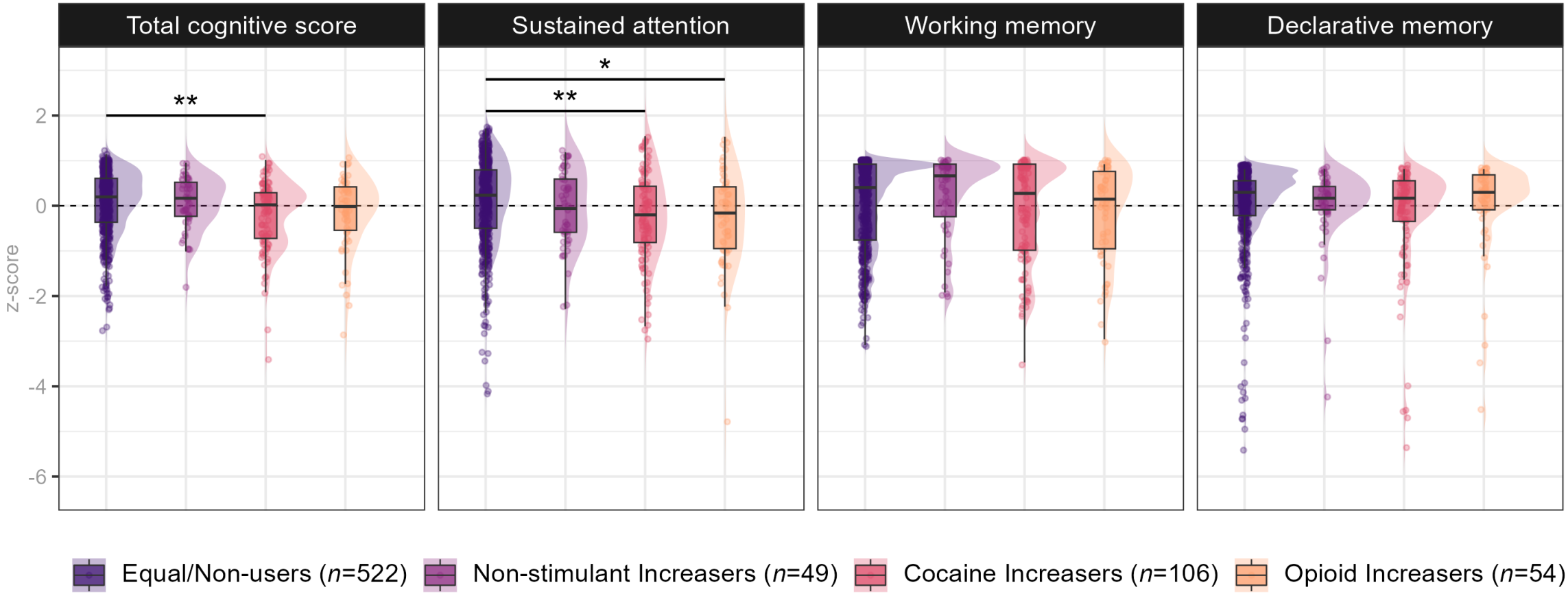
BACKUP SLIDES

Figure 4 | Pairwise Group Comparisons of Substance Profiles



Action-packed Videogames

If you think back over the last 12 months: How often have you done the following?

- Played action-packed computer or video games, which contain intense and/or realistic portrayals of violence and killing (e.g. “first person shooters” etc.).
    - *1 = never*
    - *2 = 1-2 times*
    - *3 = 3-12 times*
    - *4 = several times a month*
    - *5 = once a week*
    - *6 = several times a week*
    - *7 = daily*

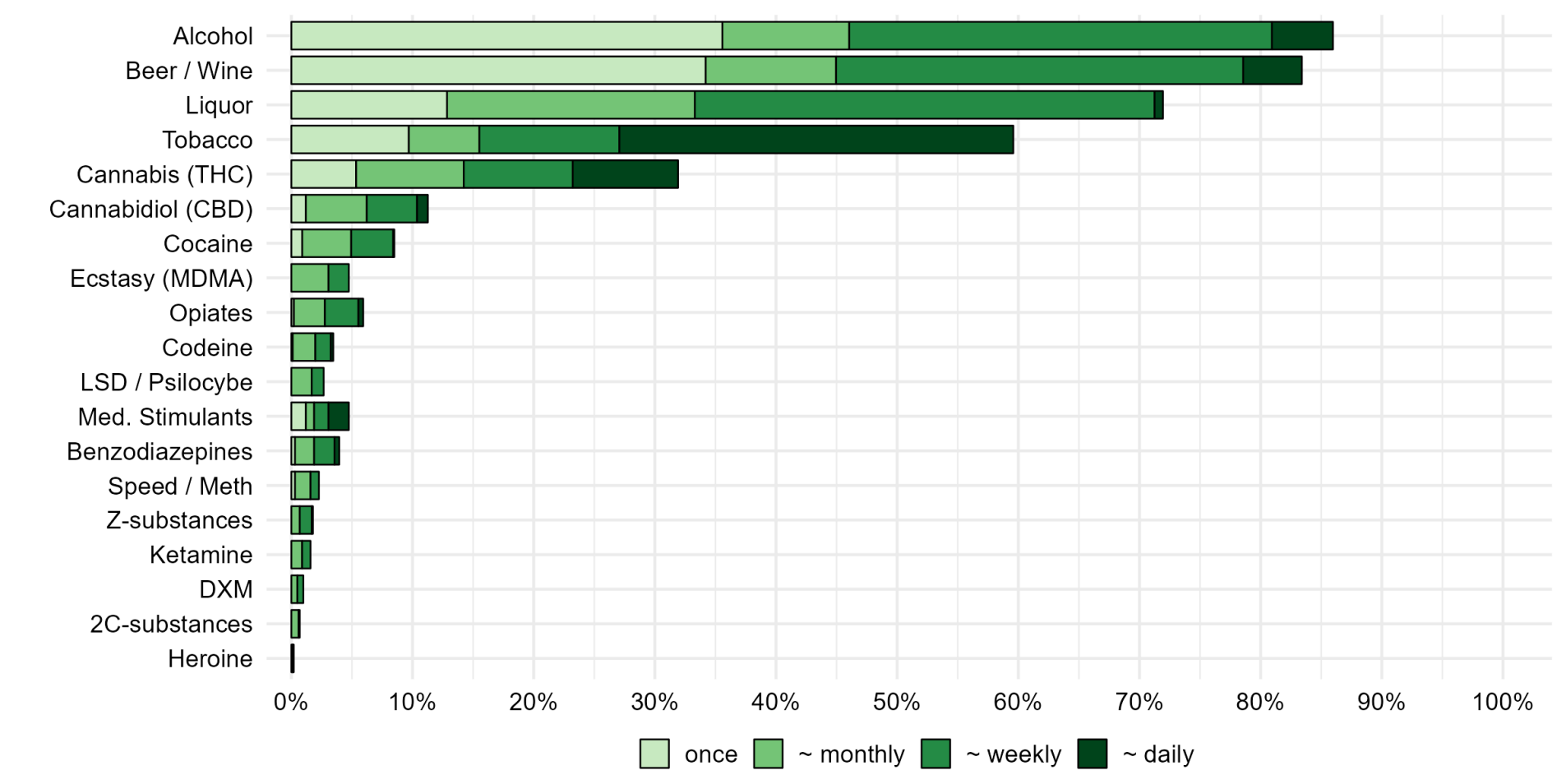
c.f. Daphne Bavelier’s work on playing action video games enhancing cognitive skills

- Bediou, B., Adams, D. M., Mayer, R. E., Tipton, E., Green, C. S., & Bavelier, D. (2018). Meta-analysis of action video game impact on perceptual, attentional, and cognitive skills. *Psychological Bulletin, 144*(1), 77–110. https://doi.org/10.1037/BUL0000130

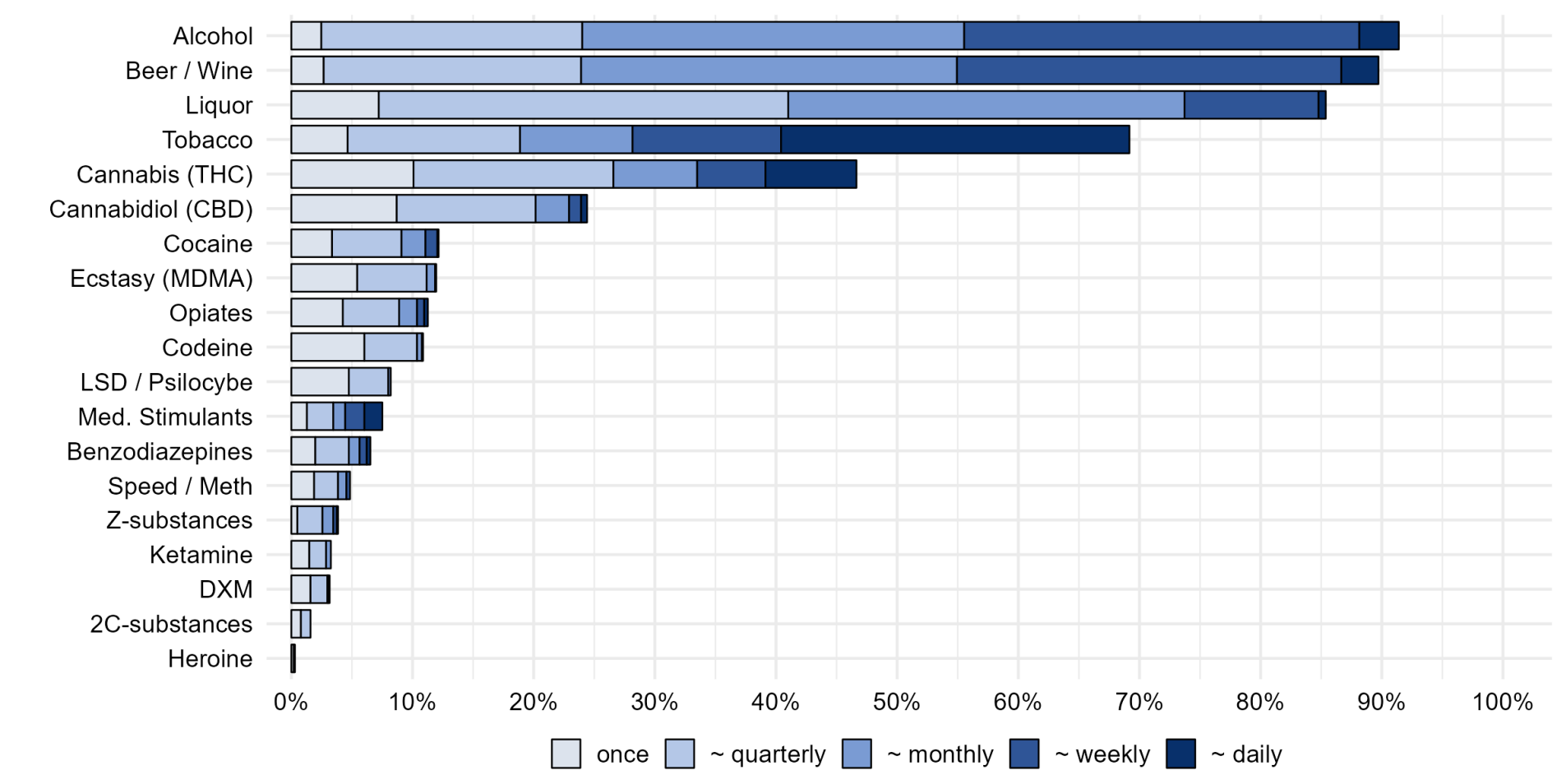
Cross-sectional Results from W9

	impaired by	
Total cognitive score	←	Cannabis, cocaine, Ecstasy, ketamine, codeine, PSUSI
Vigilance	←	Cannabis, cocaine, codeine, PSUSI
Working memory	←	Codeine
Declarative memory	←	Cocaine, ketamine, PSUSI

W9 Total Sample 3-month SR Prevalence



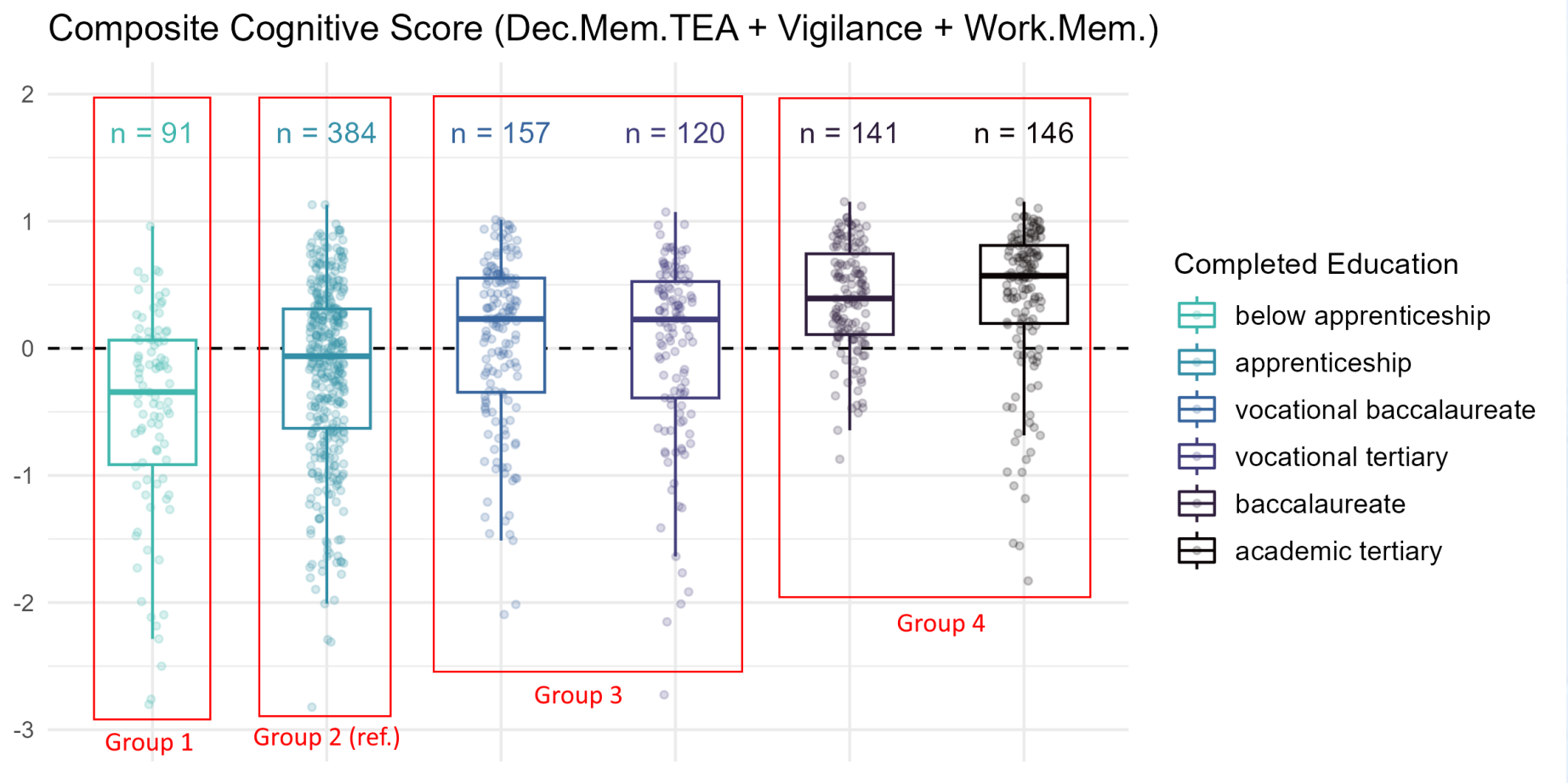
W9 Total Sample 12-month SR Prevalence



	Self-reported substance use (*n* = 1012)											
	lifetime	past 12 months					past 3 months				age of onset	
	prevalence	*prevalence*	*quarterly*	*monthly*	*weekly*	*daily*	*prevalence*	*monthly*	*weekly*	*daily*	*M (SD)*	*Med. [range]*
Alcohol	961 (95.0)	925 (91.4)	218 (21.5)	319 (31.5)	330 (32.6)	33 (3.3)	870 (86.0)	353 (34.9)	360 (35.6)	51 (5.0)	15.4 (2.1)	15 [5, 24]
Beer/wine	942 (93.1)	908 (89.7)	215 (21.2)	314 (31.0)	321 (31.7)	31 (3.1)	844 (83.4)	340 (33.6)	346 (34.2)	49 (4.8)	15.4 (2.1)	15 [5, 24]
Liquor	926 (91.5)	864 (85.4)	342 (33.8)	331 (32.7)	112 (11.1)	6 (0.6)	728 (71.9)	384 (37.9)	130 (12.8)	7 (0.7)	16.2 (2.1)	16 [5, 25]
Tobacco	887 (87.6)	700 (69.2)	144 (14.2)	94 (9.3)	124 (12.3)	291 (28.8)	603 (59.6)	117 (11.6)	98 (9.7)	329 (32.5)	15.4 (2.5)	15 [6, 25]
THC	750 (74.1)	472 (46.6)	167 (16.5)	70 (6.9)	57 (5.6)	76 (7.5)	323 (31.9)	91 (9.0)	54 (5.3)	88 (8.7)	16.3 (2.4)	16 [11, 25]
CBD	394 (38.9)	247 (24.4)	116 (11.5)	28 (2.8)	10 (1.0)	5 (0.5)	114 (11.3)	42 (4.2)	12 (1.2)	9 (0.9)	19.9 (2.3)	20 [11, 25]
MDMA	238 (23.5)	121 (12.0)	58 (5.7)	7 (0.7)	1 (0.1)	–	48 (4.7)	17 (1.7)	–	–	19.2 (2.6)	19 [14, 24]
Cocaine	204 (20.2)	123 (12.2)	58 (5.7)	20 (2.0)	10 (1.0)	1 (0.1)	86 (8.5)	35 (3.5)	9 (0.9)	1 (0.1)	19.7 (2.4)	20 [13, 24]
LSD/shrooms	157 (15.5)	83 (8.2)	33 (3.3)	2 (0.2)	–	–	27 (2.7)	10 (1.0)	–	–	19.8 (2.5)	20 [13, 25]
Speed	122 (12.1)	49 (4.8)	20 (2.0)	7 (0.7)	3 (0.3)	–	23 (2.3)	7 (0.7)	3 (0.3)	–	19.0 (2.6)	19 [14, 24]
THC-synth.	71 (7.0)	41 (4.1)	15 (1.5)	1 (0.1)	1 (0.1)	–	5 (0.5)	2 (0.2)	–	–	19.4 (2.5)	20 [14, 24]
Ketamine	63 (6.2)	33 (3.3)	14 (1.4)	4 (0.4)	–	–	16 (1.6)	7 (0.7)	–	–	20.6 (2.3)	20 [15, 25]
2C	47 (4.6)	16 (1.6)	8 (0.8)	–	–	–	7 (0.7)	1 (0.1)	–	–	19.6 (2.8)	19 [15, 24]
Heroine	8 (0.8)	3 (0.3)	1 (0.1)	–	–	–	2 (0.2)	–	1 (0.1)	–	20.8 (3.8)	21.5 [16, 25]
Codeine	225 (22.2)	110 (10.9)	44 (4.3)	4 (0.4)	–	1 (0.1)	35 (3.5)	13 (1.3)	1 (0.1)	2 (0.2)	17.0 (4.0)	18 [3, 24]
Opiates	144 (14.2)	114 (11.3)	47 (4.6)	15 (1.5)	6 (0.6)	3 (0.3)	60 (5.9)	28 (2.8)	2 (0.2)	4 (0.4)	18.2 (4.1)	18 [6, 24]
Stims	109 (10.8)	76 (7.5)	22 (2.2)	10 (1.0)	16 (1.6)	15 (1.5)	48 (4.7)	12 (1.2)	12 (1.2)	17 (1.7)	18.1 (4.6)	19 [7, 24]
Benzos	103 (10.2)	66 (6.5)	28 (2.8)	9 (0.9)	6 (0.6)	3 (0.3)	40 (4.0)	17 (1.7)	3 (0.3)	4 (0.4)	20.0 (2.9)	20 [12, 25]
DXM	60 (5.9)	32 (3.2)	14 (1.4)	1 (0.1)	1 (0.1)	–	10 (1.0)	5 (0.5)	–	–	16.6 (4.5)	17 [3, 25]
Z-drugs	52 (5.1)	39 (3.9)	21 (2.1)	9 (0.9)	3 (0.3)	1 (0.1)	18 (1.8)	10 (1.0)	–	1 (0.1)	20.6 (2.7)	21.5 [16, 24]

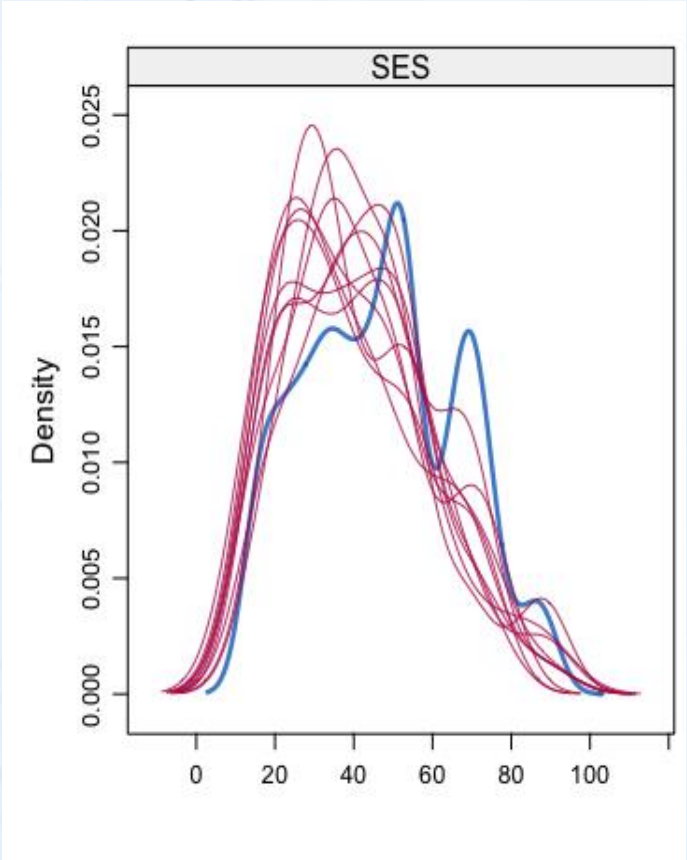
Note. 12-month abstinence: *n* = 36 (3.6 %); except tobacco & alcohol: *n* = 359 (35.5 %); except tobacco, alcohol, THC & CBD: *n* = 604 (59.7 %)

Education Grouping

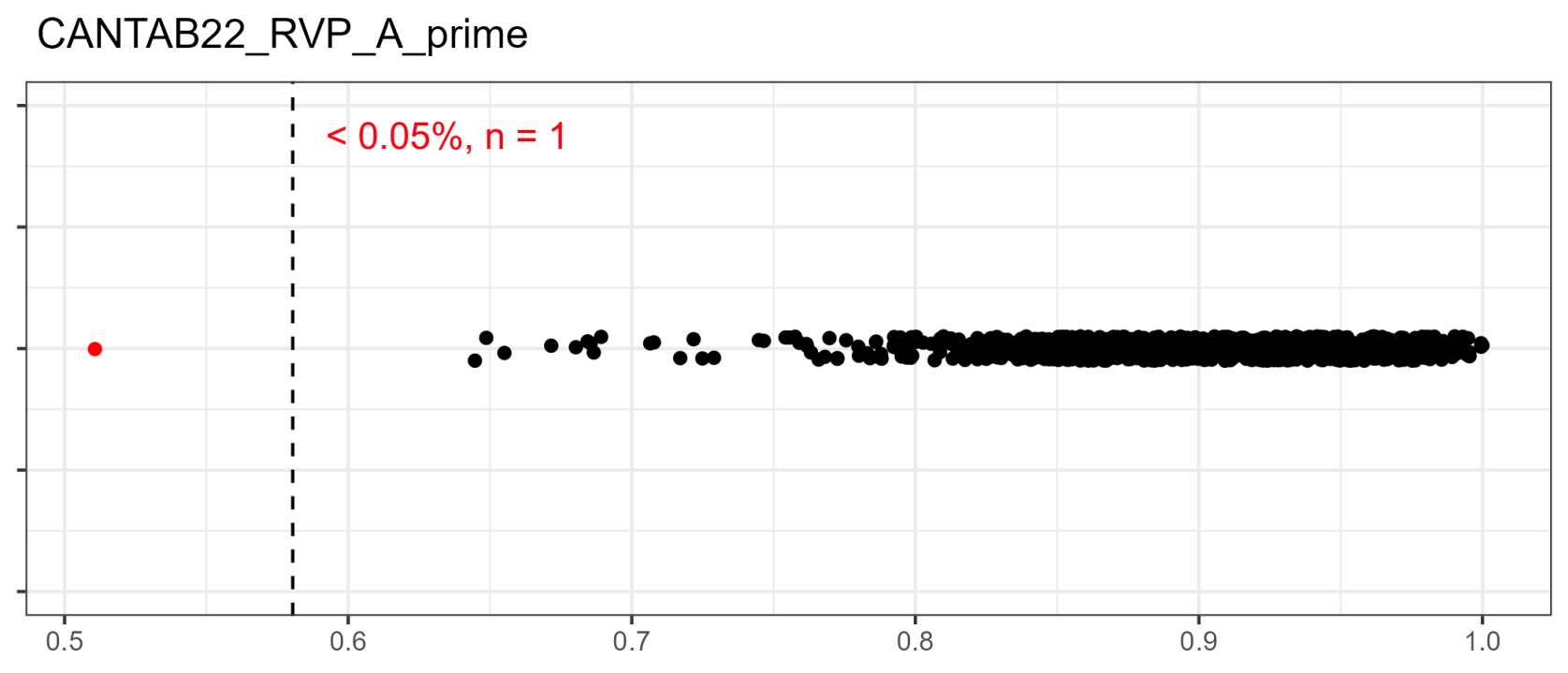


Imputed Sociodemographics (I)

Imputed Sociodemographics (II)



CANTAB Outlier Removal (I)



CANTAB Outlier Removal (II)