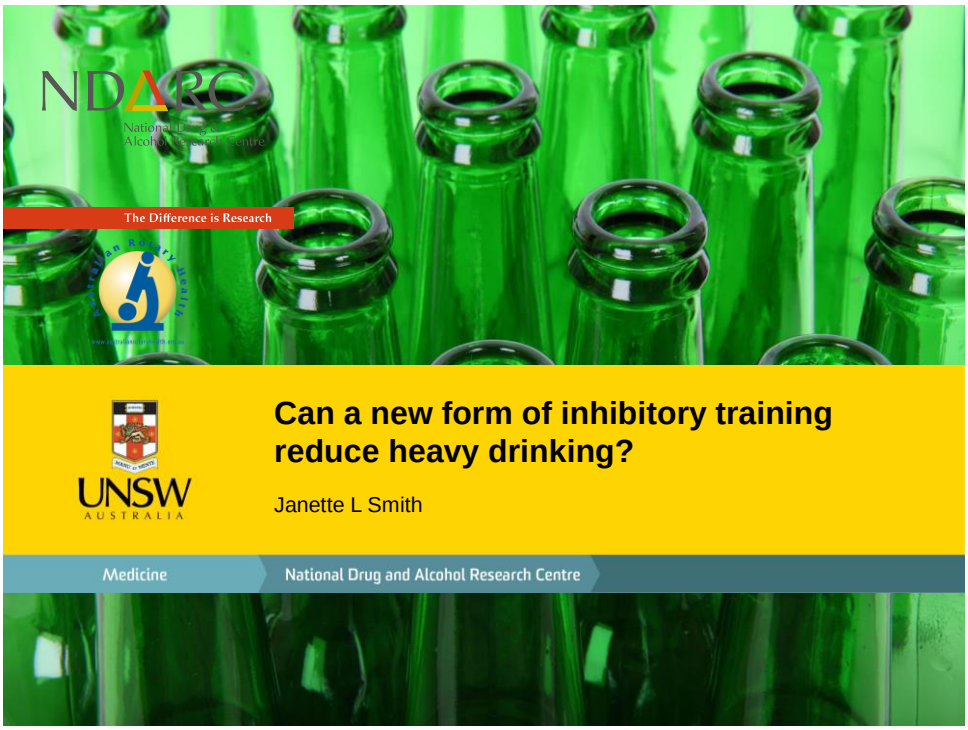
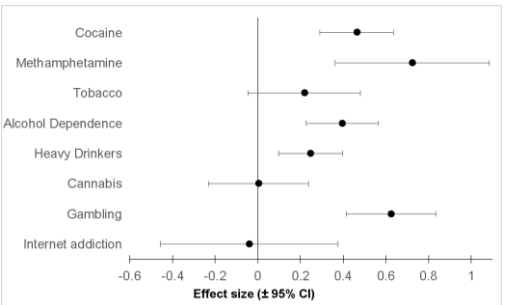


Inhibitory deficits in addiction

- Inhibition: the ability to interrupt, delay, or withhold performance of an inappropriate response
- Increasing importance in models of development and maintenance of addiction
  - Old models: limbic system → generates pathological desire for drug
  - New models: frontal control system → problems exercising control over those desires
    (e.g., Jentsch & Pennington, 2014, Neuropharmacology; Goldstein & Volkow, 2002, Am J Psychiatry)
- Inhibitory deficit differs by addiction
  (Smith et al., 2014, Drug Alc Depend)
- Apparent for alcohol dependence as well as heavy drinking
- Which came first?
  - Consumption → dysfunction
  - Dysfunction → consumption
- Remediate dysfunction → reduction in consumption?



Can inhibitory training reduce heavy drinking?

- If inhibition improves, undesirable behaviours decrease
  - Substantial literature on binge eating, overweight and obesity, healthy food choices
  - Growing literature concerning risky alcohol consumption
  - 10 minute computer task → ~20% reduction in uni students over 1 week
  - Also effective with motivated individuals seeking treatment (e.g., Wiers' work)
  - Theoretically could be delivered online
- Two main methodologies: Beer-NoGo and Restrained-Stop

Beer-NoGo

"Press the button when you see the letter F; do not press when you see the letter P"

Images are task-irrelevant, but alcohol always presented with P – 'NoGo' – requiring inhibition

Can inhibitory training reduce heavy drinking?

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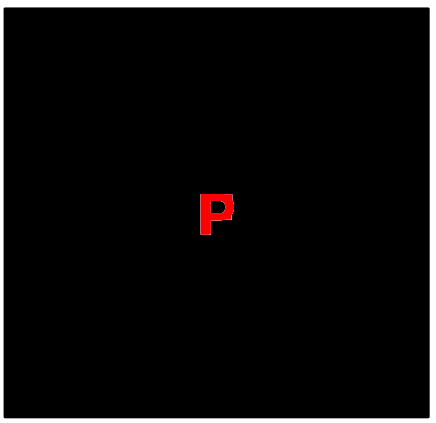
  - Substantial literature on binge eating, overweight and obesity, healthy food choices
  - Growing literature concerning risky alcohol consumption
  - 10 minute computer task → ~20% reduction in uni students
  - Also effective with motivated individuals seeking treatment
  - Theoretically could be delivered online
- Beer-NoGo:
  - Pairing response inhibition with task-irrelevant images of beer
  - Alters alcohol associations
  - Effect size ~0.48 (Jones et al., 2016, Appetite; Allom et al., 2016, Health Psychol Rev)

Restrained-Stop

"Press left for F, right for P, and do not press if the letter turns red. Correct responses are more important than fast responses"



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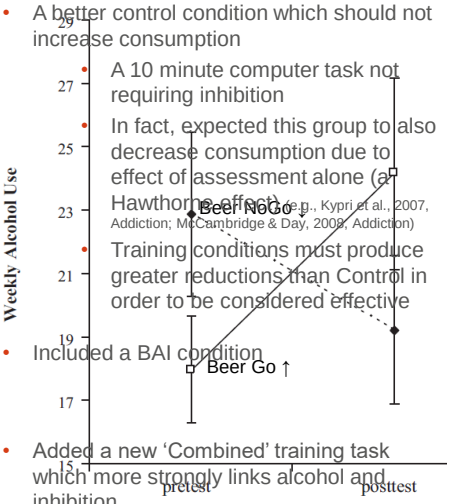
  - Theoretically could be delivered online
- Beer-NoGo:
  - Pairing response inhibition with task-irrelevant images of beer
  - Alters alcohol associations
  - Effect size ~0.48 (Jones et al., 2016, Appetite; Allom et al., 2016, Health Psychol Rev)
- Restrained-Stop
  - Complete an inhibitory task with instructions to be particularly restrained (no images of alcohol)
  - Primes a restrained response set generally
  - Effect size ~0.24 (Jones et al., 2016, Appetite; Allom et al., 2016, Health Psychol Rev)

Past research

- Inhibitory training often compared to 'control' conditions which actually *increase* alcohol consumption
  - Possibly overestimating the effect of training (as measured by time x group interaction)
- Few studies compare to other proven methods of reducing consumption such as Brief Alcohol Intervention (BAI)
- No link between alcohol and inhibition (Restrained-Stop), or no *necessary* link (Beer-NoGo)

Our study

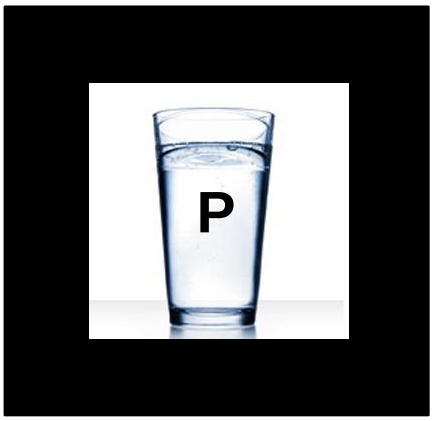
- A better control condition which should not increase consumption
  - A 10 minute computer task not requiring inhibition
  - In fact, expected this group to also decrease consumption due to effect of assessment alone (a Hawthorne effect) (e.g., Kypri et al., 2007, Addiction; McCambridge & Day, 2008, Addiction)
  - Training conditions must produce greater reductions than Control in order to be considered effective
- Included a BAI condition
- Added a new 'Combined' training task which more strongly links alcohol and inhibition



Houben et al. (2011, Drug Alc Depend)

A new ‘Combined’ training task

“Press left for F, right for P, and do not press if the image changes”



Alcohol is the cue for inhibition

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Participants

- 114 university students:
  - Aged 18-30
  - Liked beer
  - Consumed at least 4 standard drinks in the week before baseline testing
  - Not pregnant or have any other contraindications to drinking alcohol
- Not informed of the study’s true aims until debriefing (similar to other studies)
- Randomly assigned to conditions
  - Control (n = 22)
  - Beer-NoGo (n = 24)
  - Restrained-Stop (n = 22)
  - Combined (n = 22)
  - BAI (n = 24)
- Groups not significantly different for age (~22), sex ratio (37%F), AUDIT score (~11), BIS-11 impulsivity (~63) or drinks/week (~16)

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Methods

Baseline (60 minutes)

- Consent
- Demographics
- AUDIT
- Barratt Impulsiveness Scale (BIS-11)
- **TLFB for week preceding**
- Implicit Association Task
- Flanker task
- Training task or BAI
- Implicit Association Task
- Flanker task
- Bogus taste test

1 week follow-up (30 minutes)

- **TLFB for week between sessions**
- Implicit Association Task
- Flanker task
- Awareness probe
- Debriefing
- Second consent
- Reimbursement ($25) and sex-specific information on their drinking

TLFB primary measure: total drinks/week
14 drinks/week = 14 on 1 day, or 2-3 on 5 days?
Secondary measures: beer drinks/week, drinking days/week, binge days/week, maximum drinks/day, average drinks/drinking day

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		Control	Beer-NoGo	Restrained-Stop	Combined	BAI	All
Total drinks/week	d_{RM} (95% CI)	0.336 (-0.052, 0.723)	0.301 (-0.112, 0.714)	0.212 (-0.138, 0.562)	0.291 (-0.051, 0.632)	0.472 (-0.107, 1.052)	**0.324** (0.130, 0.519)
	d_{IGPP} (95% CI)		-0.035 (-0.601, 0.531)	-0.123 (-0.645, 0.399)	-0.045 (-0.561, 0.471)	0.137 (-0.560, 0.834)	
[illegible]	d_{RM} (95% CI)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	d_{IGPP} (95% CI)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Binge days/week	d_{RM} (95% CI)	0.048 (-0.308, 0.404)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	d_{IGPP} (95% CI)		0.292 (-0.250, 0.834)	0.395 (-0.133, 0.924)	[illegible] (-0.287, 0.735)	(-0.412, 0.715)	
Max drinks/day	d_{RM} (95% CI)	0.414 (-0.119, 0.948)	0.367 (-0.044, 0.777)	0.212 (-0.206, 0.631)	**0.455** (0.012, 0.898)	0.292 (-0.273, 0.858)	**0.341** (0.129, 0.553)
	d_{IGPP} (95% CI)		-0.047 (-0.720, 0.626)	-0.202 (-0.880, 0.476)	0.041 (-0.653, 0.734)	-0.122 (-0.899, 0.656)	
Average drinks/drinking day	d_{RM} (95% CI)	0.459 (-0.042, 0.960)	0.138 (-0.224, 0.501)	0.100 (-0.267, 0.467)	**0.460** (0.048, 0.871)	-0.036 (-0.484, 0.412)	**0.209** (0.025, 0.392)
	d_{IGPP} (95% CI)		-0.321 (-0.939, 0.298)	-0.359 (-0.980, 0.262)	0.001 (-0.648, 0.649)	-0.495 (-1.167, 0.177)	

d_{RM}: Repeated measures effect size
Indexes change over time
Positive effect size reflects reduction from baseline to follow-up

d_{IGPP}: Difference in effect of time between conditions

Positive effect size reflects greater reduction in the test condition relative to Controls
0.2 = small
0.5 = medium
0.8 = large

Total drinks/week:
Significant reduction over time across conditions

No difference between conditions: while training and BAI conditions were associated with small-medium reductions in drinking, *so was the Control condition*

		Control	Beer-NoGo	Restrained-Stop	Combined	BAI	All
Total drinks/week	d_{RM} (95% CI)	0.336 (-0.052, 0.723)	0.301 (-0.112, 0.714)	0.212 (-0.138, 0.562)	0.291 (-0.051, 0.632)	0.472 (-0.107, 1.052)	**0.324** (0.130, 0.519)
	d_{IGPP} (95% CI)		-0.035 (-0.601, 0.531)	-0.123 (-0.645, 0.399)	-0.045 (-0.561, 0.471)	0.137 (-0.560, 0.834)	
Beer drinks/week	d_{RM} (95% CI)	0.232 (-0.030, 0.493)	**0.414** (0.075, 0.753)	0.068 (-0.305, 0.442)	-0.031 (-0.376, 0.314)	**1.095** (0.517, 1.672)	**0.336** (0.162, 0.509)
	d_{IGPP} (95% CI)		0.183 (-0.245, 0.610)	-0.163 (-0.619, 0.293)	-0.263 (-0.696, 0.170)	**0.863** (0.230, 1.496)	
Drinking days/week	d_{RM} (95% CI)	-0.173 (-0.423, 0.077)	0.246 (-0.117, 0.610)	0.187 (-0.156, 0.530)	-0. (-0.418		
	d_{IGPP} (95% CI)		0.420 (-0.022, 0.861)	0.360 (-0.064, 0.785)	0.0 (-0.335		
Binge days/week	d_{RM} (95% CI)	0.048 (-0.308, 0.404)	0.340 (-0.069, 0.748)	**0.443** (0.053, 0.833)	0.2 (-0.095		
	d_{IGPP} (95% CI)		0.292 (-0.250, 0.834)	0.395 (-0.133, 0.924)	0.2 (-0.287		
Max drinks/day	d_{RM} (95% CI)	0.414 (-0.119, 0.948)	0.367 (-0.044, 0.777)	0.212 (-0.206, 0.631)	**0.4** (0.012		
	d_{IGPP} (95% CI)		-0.047 (-0.720, 0.626)	-0.202 (-0.880, 0.476)	0.0 (-0.653		
Average drinks/drinking day	d_{RM} (95% CI)	0.459 (-0.042, 0.960)	0.138 (-0.224, 0.501)	0.100 (-0.267, 0.467)	**0.4** (0.048		
	d_{IGPP} (95% CI)		-0.321 (-0.939, 0.298)	-0.359 (-0.980, 0.262)	0.001 (-0.648, 0.649)	-0.495 (-1.167, 0.177)	

Beer drinks/week:

Maximum drinks/day: Significant reduction over time across conditions

Average drinks/day: Significant reduction over time across conditions

No difference between conditions

No difference between conditions

Summary

- Participation in our study associated with reduction in weekly alcohol consumption
  - Total drinks, 4/5 secondary measures
  - Within-subject effect sizes 0.21-0.34 across conditions
  - *Regardless* of the control/training/BAI condition to which the participant was randomly assigned

- In line with many other studies reporting an effect of assessment on alcohol consumption
  - Mechanism of this effect is debated
  - But from a public health perspective, the mechanism of action is unimportant so long as it is reliable (McCambridge & Day, 2008, Addiction)
  - Suggests utility of widespread application of assessment protocols via the internet or in primary care settings

Summary

- Brief alcohol intervention was most successful at reducing alcohol consumption
  - Beer drinks/week, drinking days/week
  - Largest effect size for total drinks/week, although not significantly different to Controls
  - In line with numerous studies showing that BAIs are effective at reducing consumption among heavy drinkers
- Can inhibitory training reduce heavy drinking?
  - When compared to a carefully selected Control condition, no
  - Considering training as a treatment adjunct may be premature, although better results have been observed among motivated individuals (vs. uni students not seeking treatment)
  - Despite the discouraging lack of a large effect for our three training protocols, investigation of inhibitory training is not a fruitless endeavour
  - Rather, investigators will need to carefully consider the possible sources of observed alterations in drinking behaviour
  - Ensure chosen task design produces an effect beyond that of simple assessment, and indeed beyond other proven methods of reducing consumption

Acknowledgements

- Ms Nicole Dash, University of Wollongong, Australia
- Assoc Prof Stuart Johnstone, University of Wollongong, Australia
- Dr Katrijn Houben, Maastricht University, The Netherlands
- Prof Matt Field, University of Liverpool, United Kingdom
- Australian Rotary Health Postdoctoral Research Fellowship
- Mr Tony Kemp, programmed training tasks
- janette.smith@unsw.edu.au
- Smith, Dash, Johnstone, Houben, Field (submitted Oct 18 2016) Current forms of inhibitory training produce no greater reduction in drinking than simple assessment. *Drug and Alcohol Dependence*

What's next?

- Beer-NoGo: largest effect size among inhibitory tasks for reducing beer drinks/week
  - More effective with participants who prefer (not just like) beer?
  - Use participant's preferred drink (beer, red wine, white wine, spirits etc)?
  - Use participant's preferred brand/label?
- Presentation of beer images in Beer-NoGo and Combined conditions may have increased alcohol consumption (e.g., by increasing craving), counteracting the inhibitory training
  - What is the effect of presenting beer images with no associated task?
- For how long does the effect last? Longer follow-ups than 1 week
- Combined task: alcohol images perhaps still not necessarily the signal for inhibition
  - Possible that an image *change* was the attended feature
  - Images change from landscapes to water (ignore, respond) or alcohol (inhibit) – must process content of image

Floor effects?

- Consumption and AUDIT scores among our sample of heavy drinkers are lower than previous studies
- Light drinkers have less room to reduce drinking, or perhaps the protocols are more effective with heavy drinkers?
- Split into groups with AUDIT 11 or less (n = 66) vs. 12 or more (n = 48)
- Group x training condition x time ANOVA
- Greater reduction for BAI than Controls, larger in the heavier drinkers, for
  - Total drinks
  - Beer drinks
  - Binge episodes
  - → BAI intervention most successful with heavier drinkers
  - But still no effects for other training conditions

Results

	Control (n = 22)	Beer-NoGo (n = 24)	Restrained-Stop (n = 22)	Combined (n = 22)	BAI (n = 24)
Age (years)	22.2 ± 0.8	21.6 ± 0.6	21.7 ± 0.7	21.4 ± 0.6	21.6 ± 0.6
Sex ratio (F:M)	9:13	9:15	6:16	9:13	9:15
AUDIT	11.4 ± 0.9	12.0 ± 1.0	12.0 ± 1.0	9.6 ± 0.7	11.4 ± 0.9
Impulsivity (BIS)	60.2 ± 2.0	63.2 ± 1.9	64.1 ± 2.1	63.4 ± 2.0	61.5 ± 2.1
Drinks/week at entry	14.4 ± 2.4	16.5 ± 2.0	20.1 ± 3.1	13.7 ± 1.6	16.5 ± 2.7

- Values are mean ± SE
- Recruited a sample of heavy drinkers (AUDIT ≥ 8), not significantly different between groups for AUDIT, impulsivity, or drinks/week

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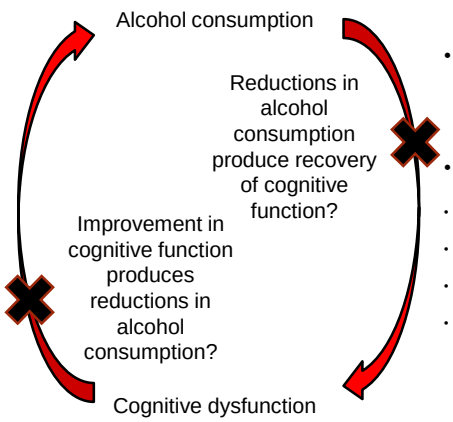
Cause and effect?

- Deficits in inhibitory performance and/or brain activation at baseline, predicts substance use anywhere from 3 months to 6 years later
- Dalton (poster 60); Mahmood et al. (2013, Addict Behav); Norman et al. (2011, Drug Alc Depend); Tarter et al. (2003, Am J Psychiatr); Rubio et al. (2008, Alc Clin Exp Res)



- Causal role explicitly or implicitly assumed by most researchers
- Few directly test this
  - Maurage et al. (2009, J Psychiatr Neurosci):
  - Non-binge drinkers tested at baseline and 9 months later
  - Half had commenced binge drinking
  - Binge drinkers showed delayed processing of emotional stimuli at Time 2, despite no difference at Time 1

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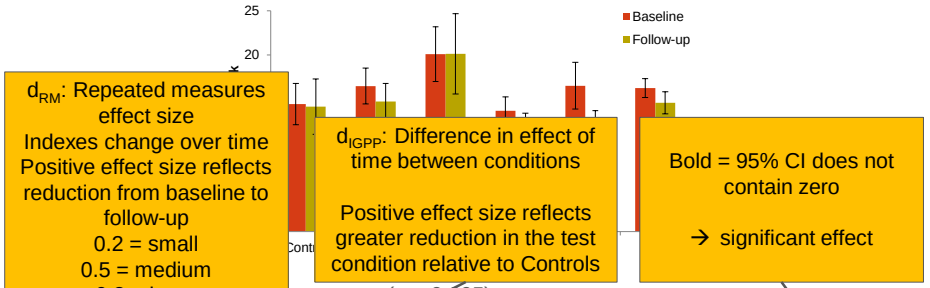
Total drinks/week



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0.2 = small
0.5 = medium
0.8 = large

d_{IGPP}: Difference in effect of time between conditions

Positive effect size reflects greater reduction in the test condition relative to Controls

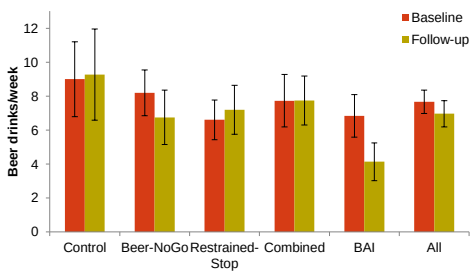
Bold = 95% CI does not contain zero

→ significant effect

- ss groups (p = 0.005)
- No effect of condition: inhibitory tasks produced small reductions, but *so did the Control*

	Control	Beer-NoGo	Restrained-Stop	Combined	BAI	All
d_{RM} (95% CI)	0.336 (-0.052, 0.723)	0.301 (-0.112, 0.714)	0.212 (-0.138, 0.562)	0.291 (-0.051, 0.632)	0.472 (-0.107, 1.052)	**0.324** (0.130, 0.519)
d_{IGPP} (95% CI)		-0.035 (-0.601, 0.531)	-0.123 (-0.645, 0.399)	-0.045 (-0.561, 0.471)	0.137 (-0.560, 0.834)	

Beer drinks/week



- Reduction over time across groups (p = 0.001)
- BAI reduced more than Controls (p = 0.064)

	Control	Beer-NoGo	Restrained-Stop	Combined	BAI	All
d_{RM} (95% CI)	0.232 (-0.030, 0.493)	**0.414** (0.075, 0.753)	0.068 (-0.305, 0.442)	-0.031 (-0.376, 0.314)	**1.095** (0.517, 1.672)	**0.336** (0.162, 0.509)
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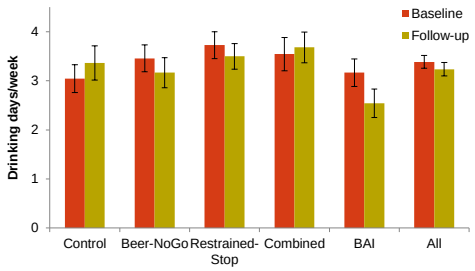
Drinking days/week



- No reduction over time across groups (p = 0.125)
- BAI reduced number of drinking days more than Controls (p = 0.024)

	Control	Beer-NoGo	Restrained-Stop	Combined	BAI	All
d_{RM} (95% CI)	-0.173 (-0.423, 0.077)	0.246 (-0.117, 0.610)	0.187 (-0.156, 0.530)	-0.115 (-0.418, 0.189)	**0.571** (0.088, 1.053)	0.143 (-0.020, 0.306)
d_{IGPP} (95% CI)		0.420 (-0.022, 0.861)	0.360 (-0.064, 0.785)	0.058 (-0.335, 0.452)	**0.744** (0.201, 1.288)	

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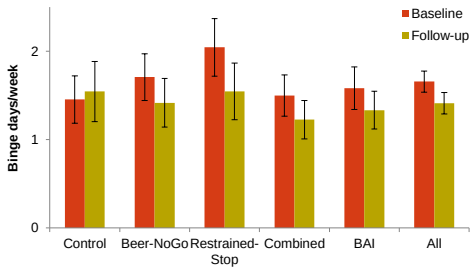
Binge days/week



- Reduction over time across groups (p = 0.006)
- No effect of condition

	Control	Beer-NoGo	Restrained-Stop	Combined	BAI	All
d_{RM} (95% CI)	0.048 (-0.308, 0.404)	0.340 (-0.069, 0.748)	**0.443** (0.053, 0.833)	0.272 (-0.095, 0.638)	0.199 (-0.237, 0.635)	**0.268** (0.091, 0.445)
d_{IGPP} (95% CI)		0.292 (-0.250, 0.834)	0.395 (-0.133, 0.924)	0.224 (-0.287, 0.735)	0.151 (-0.412, 0.715)	

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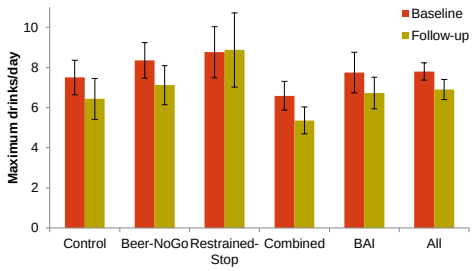
Maximum drinks/day



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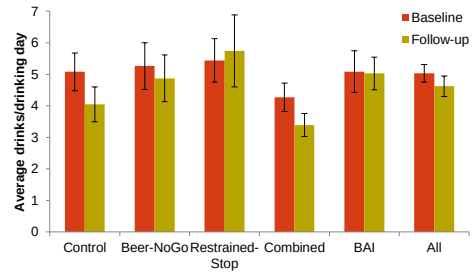
	Control	Beer-NoGo	Restrained-Stop	Combined	BAI	All
d_{RM} (95% CI)	0.414 (-0.119, 0.948)	0.367 (-0.044, 0.777)	0.212 (-0.206, 0.631)	**0.455** (0.012, 0.898)	0.292 (-0.273, 0.858)	**0.341** (0.129, 0.553)
d_{IGPP} (95% CI)		-0.047 (-0.720, 0.626)	-0.202 (-0.880, 0.476)	0.041 (-0.653, 0.734)	-0.122 (-0.899, 0.656)	

Average drinks/drinking day



- Reduction over time across groups (p = 0.032)
- No effect of condition

	Control	Beer-NoGo	Restrained-Stop	Combined	BAI	All
d_{RM} (95% CI)	0.459 (-0.042, 0.960)	0.138 (-0.224, 0.501)	0.100 (-0.267, 0.467)	**0.460** (0.048, 0.871)	-0.036 (-0.484, 0.412)	**0.209** (0.025, 0.392)
d_{IGPP} (95% CI)		-0.321 (-0.939, 0.298)	-0.359 (-0.980, 0.262)	0.001 (-0.648, 0.649)	-0.495 (-1.167, 0.177)	