Loss Aversion in Behavior and Risk for Cigarette Smoking and Other Substance Use in Women

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  - Michael DeSarno
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Behavior and Health

- Individual behavior implicated in >40% of all deaths each year in the United States (Schroeder, 2007).
  - #1 cause of preventable death.
- Behavior change can have a massive impact on society.
  - *Substance misuse, overeating, sedentary lifestyle, medical nonadherence, etc.*
- *Progress has been made…*
  - Much to do, especially to address marginalized and vulnerable populations (e.g., Leventhal et al., 2019).

Role of Choice and Reinforcement

- Relative density of reinforcing activities.
  - Drug and nondrug rewards (e.g., Heyman, 1996).
  - Increase access to nondrug reinforcement, decrease drug use
    - Contingency Management and Community Reinforcement Approach (Higgins et al., 1991).
- Behavior also results in **lost** reinforcers.
  - Opportunities, relationships, wellbeing, etc.
- **Loss aversion**
  - Expected and experienced losses have a stronger influence on behavior than equivalent gains.
    - "Endowment effect" (e.g., Kahneman et al., 1991).
  - Ask for twice as much to give something up than you would pay to get it.
  - "Negativity bias" (Baumeister et al., 2001; Fiske, 1980).
  - Foundational principle in Prospect Theory and integral to work that received 2 Nobel prizes in economics (2002, 2017).

Loss Aversion and Health

- Working hypothesis: Loss aversion (LA) is a ***protective*** factor.
- Low LA and substance use problems:
  - Alcohol dependence
    - Decreased sensitivity to losses (Bernhardt et al., 2017; Brevers et al., 2014; Genauck et al., 2017).
    - Cortical atrophy (posterior frontomedial cortex) associated with low LA independent of other executive function deficits (Gianelli et al., 2022).
  - Cocaine
    - Lower LA (Meade et al., 2017; Strickland et al., 2017).
  - Poly/Heterogeneous use
    - Low LA longitudinally predicted greater substance use 1 year later (Kraplin et al., 2020).
- Can LA be distinguished from **Delay Discounting**?
  - Reinforcers lose value as delay to receipt increases (Rachlin et al., 1991; Bickel et al., 1999; MacKillop et al., 2011).
  - Value lost is greater among individuals using substances (e.g., heroin, cigarettes) compared to matched controls (Bickel et al., 1999; Madden et al., 1996).
  - Longitudinal association of high discounting and uptake of regular cigarette smoking in adolescents (Audrain-McGovern et al., 2009).
- Studies of LA in substance use do not account for delay discounting or **cigarette smoking**.
  - Smoking is highly co-morbid with other substance use and affective disorders (e.g., Parker et al., 2019).

Loss Aversion and Risk for Cigarette Smoking

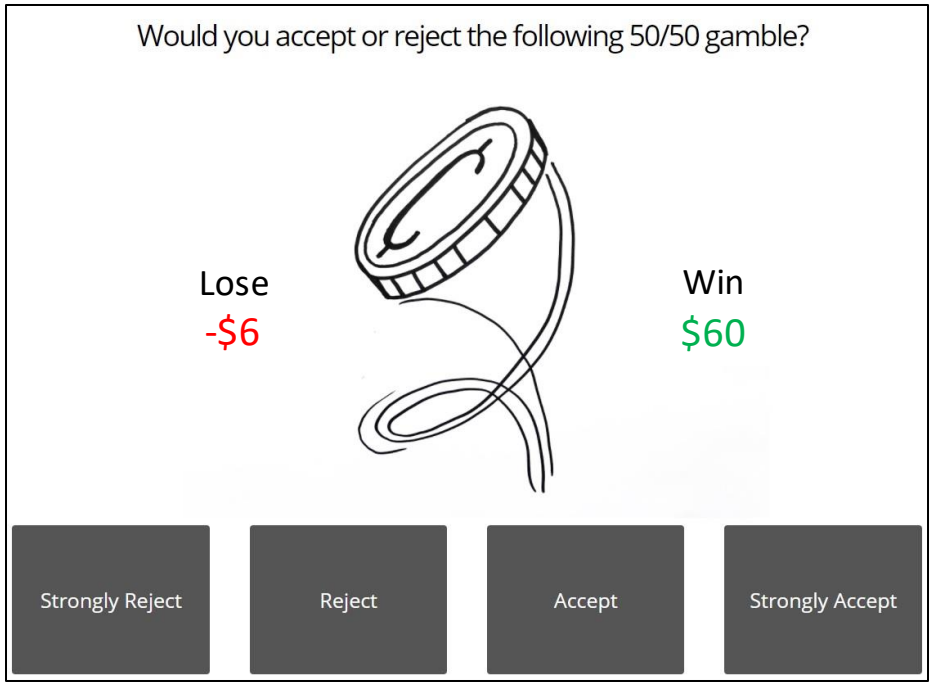
1. *Is low LA associated with cigarette smoking?*
2. *Are low LA and high delay discounting (DD) independently related to smoking?*
3. *How do loss aversion and delay discounting combine to influence cigarette smoking and other substance use?*

Sample from Amazon Mechanical Turk (n=400).

- Reported current daily cigarette smoking (>10 cigarettes per day) and never smoking (<100 cigarettes lifetime) matched on age, gender, and educational attainment.

Method

- Measure of **LA:** Gamble acceptance task (Tom et al., 2007).
  - Hypothetical 50-50 gambles, choose to accept or reject.
  - **In-person** and **online** (Tom et al., 2007; Walasek & Stewart, 2015)
  - **Substance use** (Brevers et al., 2014; Strickland et al., 2017).

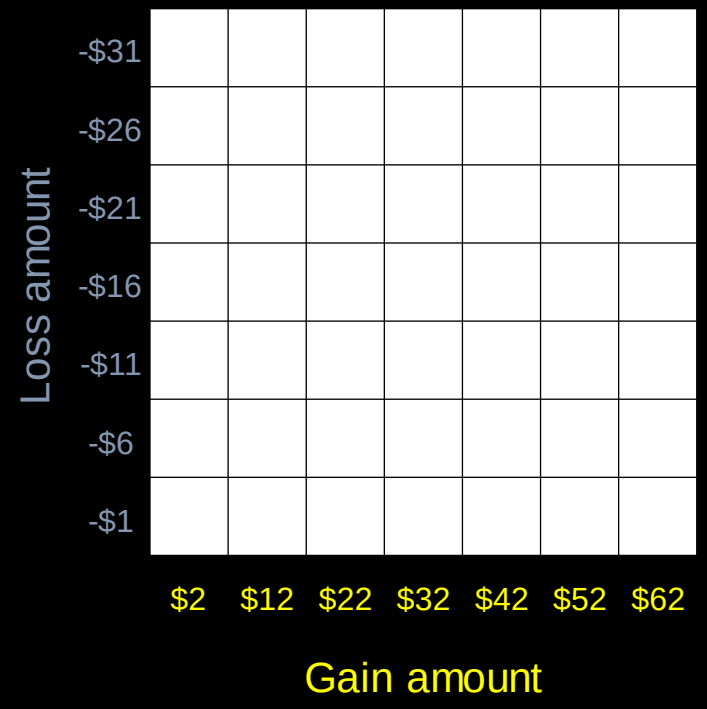


Method

- **Loss aversion:** Gamble acceptance task (Tom et al., 2007)
  - Hypothetical 50-50 gambles, choose to accept or reject.
- Blocks of 49 trials, combinations 7 gain and 7 loss amounts
- Two conditions:
  - (A) 2:1 Gains (e.g., $20 vs -$10)
  - (B) 2:1 Losses (e.g., $10 or -$20)
  - Order: ABA or BAB

Method: “2:1 Gain” Condition

$$V_{Gain} < V_{Loss} = Loss\ Aversion$$



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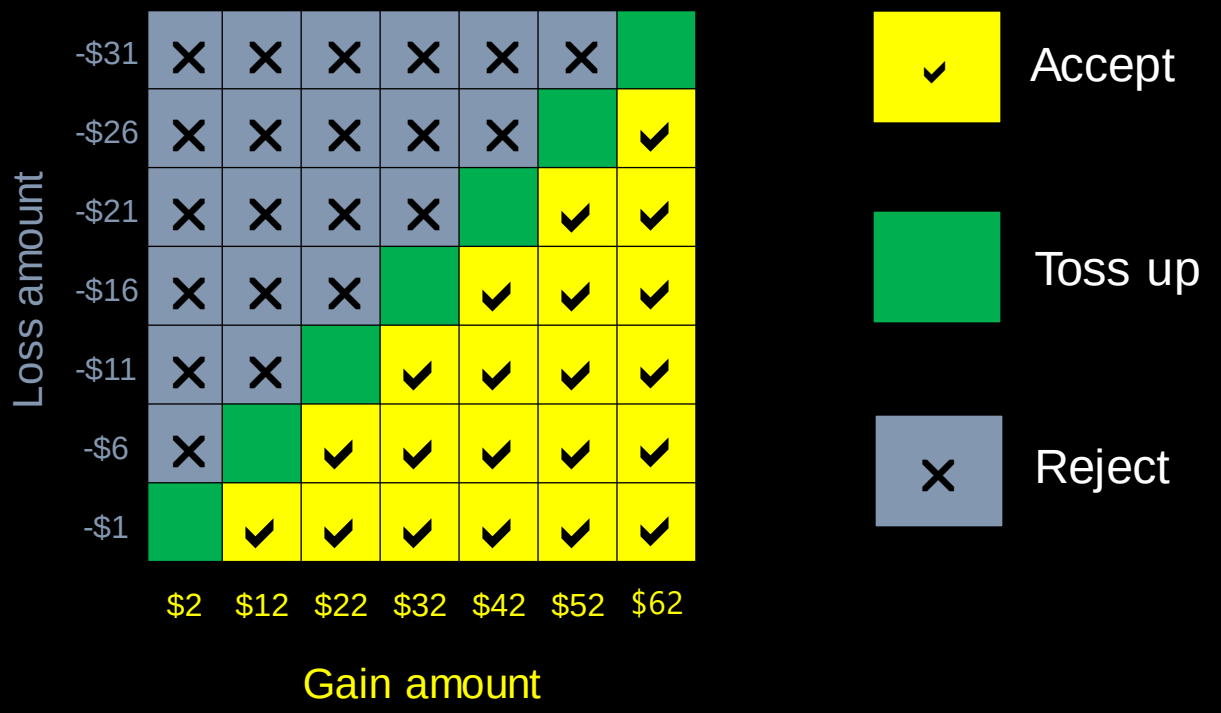
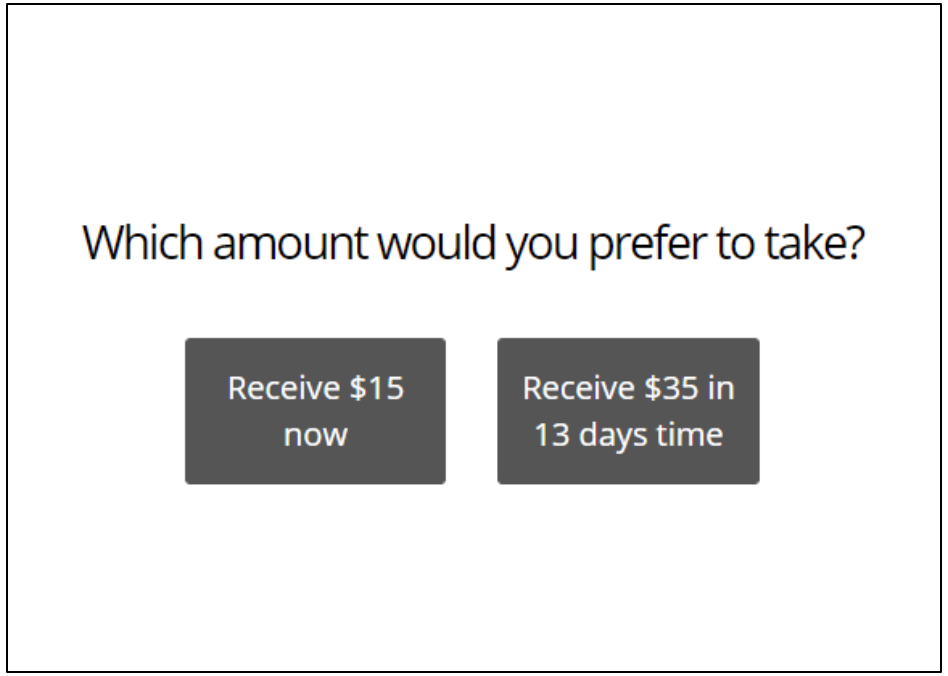


Method

- **Delay Discounting** (Control measure)
  - Monetary choice questionnaire (Kirby et al., 1999)



Results

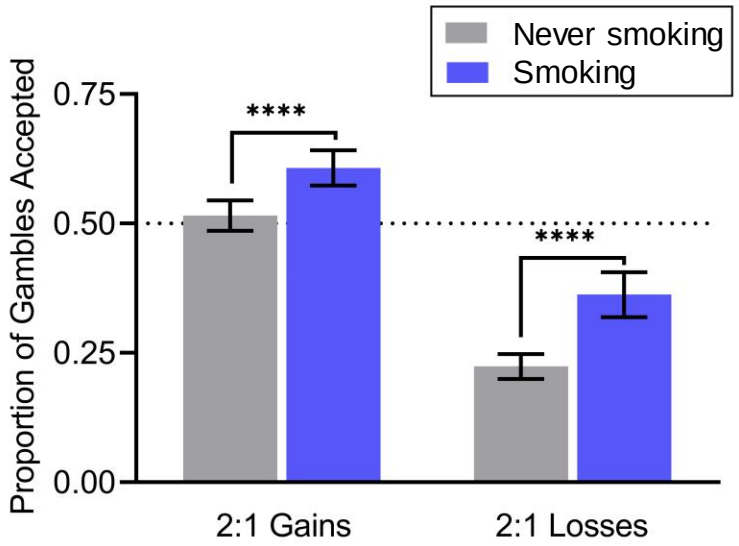
1. *Is low LA associated with cigarette smoking?*

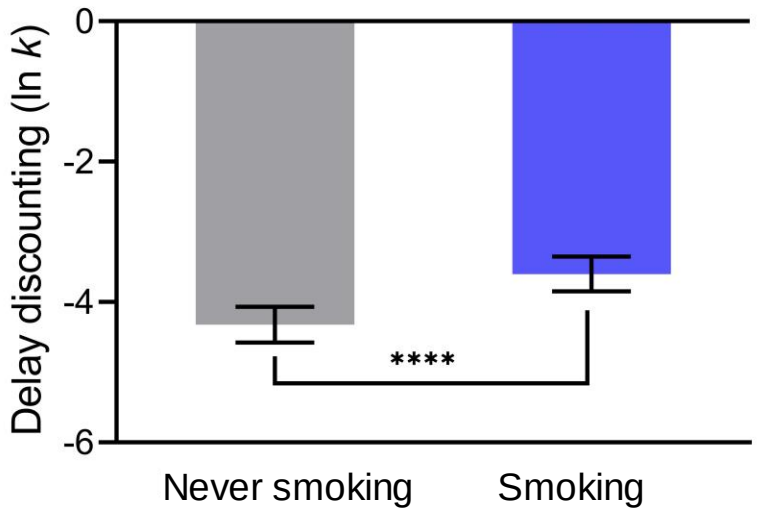
Participant Characteristics

	Smoking	Never-smoking
N	181	237
Age (M ± SD)	37.39 ± 7.61	33.69 ± 9.41
Gender		
Man	71 (39.23)	124 (52.32)
Woman	109 (60.22)	107 (45.15)
Other-identifying	1 (0.55)	6 (2.53)
Education		
High School or less	38 (20.99)	68 (28.69)
Some College	88 (48.62)	80 (33.76)
College	55 (30.39)	89 (37.55)
Cigarette use:		
Cigarettes per day		
11-20	142 (78.45)	
21-30	36 (19.89)	
31 or more	3 (1.66)	
Fagerström test for cigarette dependence (M ± SD)	4.42 ± 1.57	
Alcohol use	161 (88.95)	55 (23.21)
Drug use	99 (54.70)	19 (8.02)

1. *Is low LA associated with cigarette smoking?*

- Those endorsing smoking were less loss averse than those endorsing never smoking.
- Steeper delay discounting among those reporting current smoking [sanity check].





Error bars are 95% confidence intervals, *p<.05, ****p<.0001

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2. *Are low LA and high delay discounting (DD) related to smoking independently?*

Substance use or other problem	Loss Aversion			LA controlling for DD			Delay Discounting			DD controlling for LA		
	F	*p*	df = 1, 411	*F*	*p*	df = 1, 410	*F*	*p*	df = 1, 411	*F*	*p*	df = 1, 410
Cigarette smoking	24.19	<.0001	****	20.53	<.0001	****	20.55	<.0001	****	16.98	<.0001	****
Alcohol	23.38	<.0001	****	21.47	<.0001	****	4.52	0.03	*	2.74	0.10	
Other drugs	58.17	<.0001	****	54.12	<.0001	****	10.04	0.002	**	6.47	0.01	*
Smoking & alcohol	29.91	<.0001	****	26.37	<.0001	****	14.63	0.0002	***	11.25	0.0009	***
Smoking & drugs	67.61	<.0001	****	63.28	<.0001	****	9.61	0.002	**	5.91	0.01	*
Alcohol & drugs	75.00	<.0001	****	70.72	<.0001	****	8.38	0.004	**	4.82	0.03	*
Smoking, alcohol, & drugs	73.03	<.0001	****	68.82	<.0001	****	8.26	0.004	**	4.72	0.03	*
Depressed mood	2.28	0.13		1.98	0.16		0.96	0.33		0.72	0.40	
Sleep disturbance	0.46	0.50		0.37	0.54		0.47	0.49		0.35	0.55	

- Differences LA or DD remained significant when controlling for the other factor.
- Difference in LA also found in alcohol, drug, poly-substance use, even when accounting for DD

*p<.05, **p<.01, ***p<.001, ****p<.0001

3. *How do loss aversion and delay discounting combine to influence cigarette smoking and other substance use?*

- Logistic regression with loss aversion and delay discounting as predictors of use.
  - Included age, gender, and educational attainment covariates.
- Loss aversion predicted use in the whole sample independent of delay discounting.
- Significant interactions:
  - ***Does having low LA/high DD summate with high DD/low LA to increase risk further?***

Measure	Substance(s) used	Odds Ratio	95% Wald Confidence Limits		*p*	
Loss Aversion	Smoking	1.254	1.130	1.391	<.0001	****
	Alcohol	1.265	1.140	1.403	<.0001	****
	Drugs	1.449	1.292	1.624	<.0001	****
	Smoking & Alcohol	1.288	1.162	1.429	<.0001	****
	Smoking & Drugs	1.511	1.338	1.705	<.0001	****
	Alcohol & Drugs	1.534	1.358	1.732	<.0001	****
	Smoking, Alcohol, & Drugs	1.535	1.357	1.736	<.0001	****
Delay Discounting	Smoking	1.277	1.132	1.439	<.0001	****
	Alcohol	1.097	0.981	1.227	0.10	
	Drugs	1.187	1.041	1.353	0.01	*
	Smoking & Alcohol	1.224	1.085	1.380	0.001	**
	Smoking & Drugs	1.194	1.038	1.374	0.01	*
	Alcohol & Drugs	1.165	1.017	1.335	0.03	*
	Smoking, Alcohol, & Drugs	1.173	1.018	1.352	0.03	*
LA by DD interactions	Smoking				0.001	**
	Alcohol				0.02	*
	Drugs				0.002	**
	Smoking & Alcohol				0.0004	***
	Smoking & Drugs				<.0001	****
	Alcohol & Drugs				0.001	**
	Smoking, Alcohol, & Drugs				0.0001	***

3. *How do loss aversion and delay discounting combine to influence cigarette smoking and other substance use?*

- High/Low are +/-1 SD
- Having **low LA** was associated with greater risk of use above and beyond **high DD**.

- High **DD** did not increase risk further when **LA** was low.

Effect	Level	Substance(s) used	Odds Ratio	95% Wald Confidence Limits		*p*	
Loss Aversion	High DD	Smoking	1.038	0.903	1.192	0.60	
		Alcohol	1.123	0.978	1.289	0.10	
		Drugs	1.226	1.063	1.414	0.01	*
		Smoking & Alcohol	1.064	0.929	1.219	0.37	
		Smoking & Drugs	1.199	1.037	1.387	0.01	*
		Alcohol & Drugs	1.263	1.089	1.465	0.002	**
		Smoking, Alcohol, & Drugs	1.222	1.054	1.417	0.01	*
Loss Aversion	Low DD	Smoking	1.550	1.299	1.849	<.0001	****
		Alcohol	1.434	1.221	1.685	<.0001	****
		Drugs	1.853	1.489	2.308	<.0001	****
		Smoking & Alcohol	1.644	1.358	1.989	<.0001	****
		Smoking & Drugs	2.340	1.750	3.130	<.0001	****
		Alcohol & Drugs	2.129	1.638	2.765	<.0001	****
		Smoking, Alcohol, & Drugs	2.369	1.763	3.185	<.0001	****
Delay Discounting	Low LA	Smoking	1.063	0.901	1.255	0.47	
		Alcohol	0.946	0.795	1.125	0.53	
		Drugs	1.022	0.859	1.216	0.81	
		Smoking & Alcohol	1.007	0.850	1.193	0.94	
		Smoking & Drugs	0.977	0.804	1.187	0.81	
		Alcohol & Drugs	0.975	0.808	1.175	0.79	
		Smoking, Alcohol, & Drugs	0.962	0.791	1.171	0.70	
Delay Discounting	High LA	Smoking	1.700	1.378	2.097	<.0001	****
		Alcohol	1.260	1.067	1.488	0.01	*
		Drugs	1.658	1.284	2.141	0.0001	***
		Smoking & Alcohol	1.675	1.348	2.081	<.0001	****
		Smoking & Drugs	2.135	1.543	2.954	<.0001	****
		Alcohol & Drugs	1.794	1.340	2.401	<.0001	****
		Smoking, Alcohol, & Drugs	2.087	1.501	2.902	<.0001	****

Summary

- Study 1 found that Low LA was associated with:
  - Cigarette smoking, alcohol use, other drug use
  - Poly use: Smoking and alcohol, smoking and drug use, alcohol and drug use, smoking, alcohol, and drug use
- Not accounted for by DD or sociodemographic factors (age, gender, educational attainment).
- Like high DD, low LA may be associated with risk for unhealthy behavior.
- *Loss aversion may be more important than previously thought.*

Study 2: Is low LA independent of low density of alternative reinforcers?

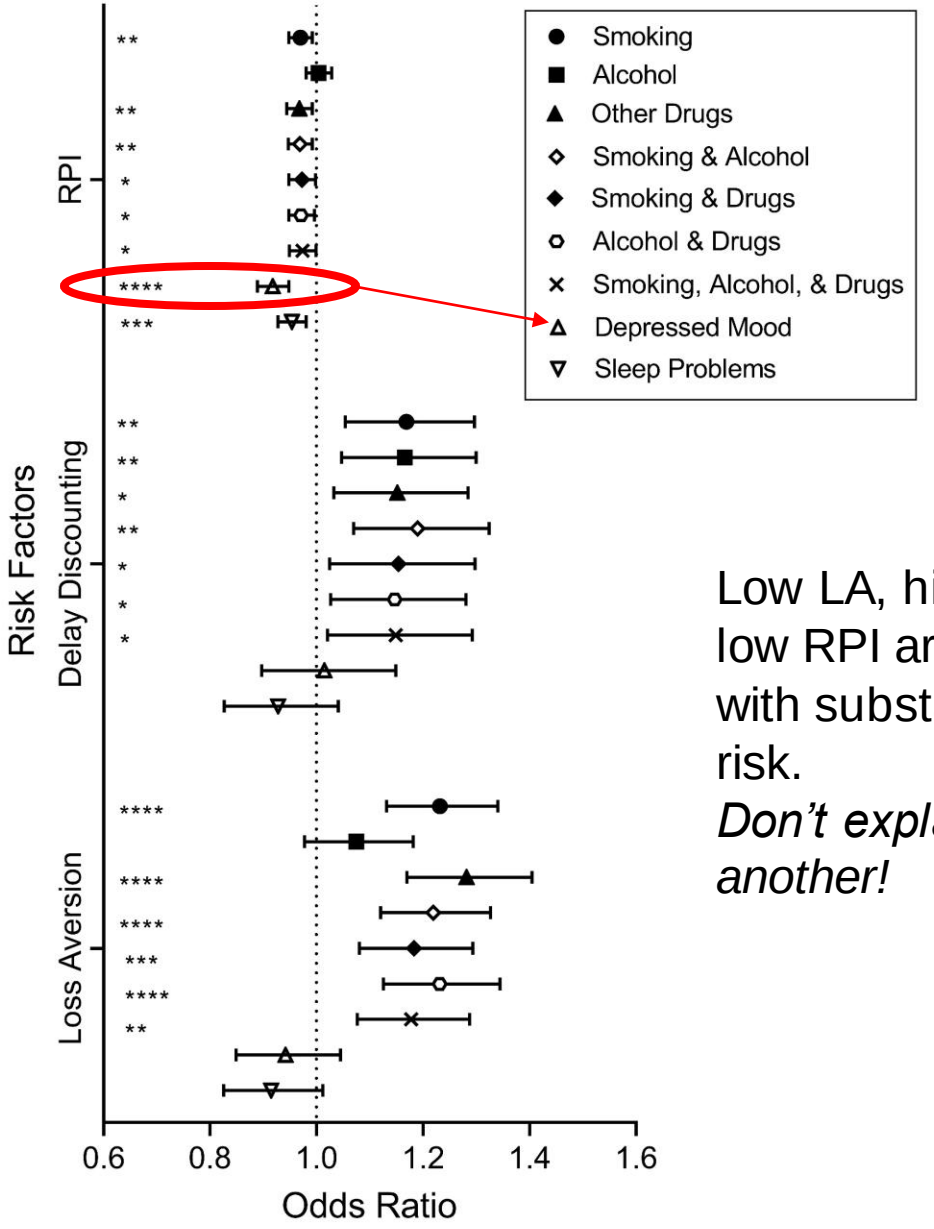
- Behavioral theories of addiction
  - Relative density drug and nondrug rewards (e.g., Higgins et al., 2004)
  - Increase nondrug reward, decrease drug use
    - Theoretical basis for contingency management (Higgins et al., 1991)
- How to measure environmental reward density?
  - Pleasant events scale (Lewinsohn, 1973)
    - 320 items completed twice!
  - Low reward density in cocaine users compared to nonusers (Van Etten et al., 1998).
  - Individuals that abstain from cocaine use successfully have greater reward density (Rogers et al., 2008).
  - Reward Probability Index
    - 20 items, 11 general reward experience (Reward Probability), 9 general aversive experience (Environmental Suppressors)
    - Alcohol problem severity (Joyner et al., 2016)
- Repeated Study 1, new MTurk sample included Reward Probability Index (RPI)

Study 2

Higher environmental reward

Higher DD rate (ln *k*)

Lower LA (proportion accepted)



Low LA, high DD, and low RPI are associated with substance use risk.

Don't explain one another!

**p*<.05
***p*<.01
****p*<.001
*****p*<.0001

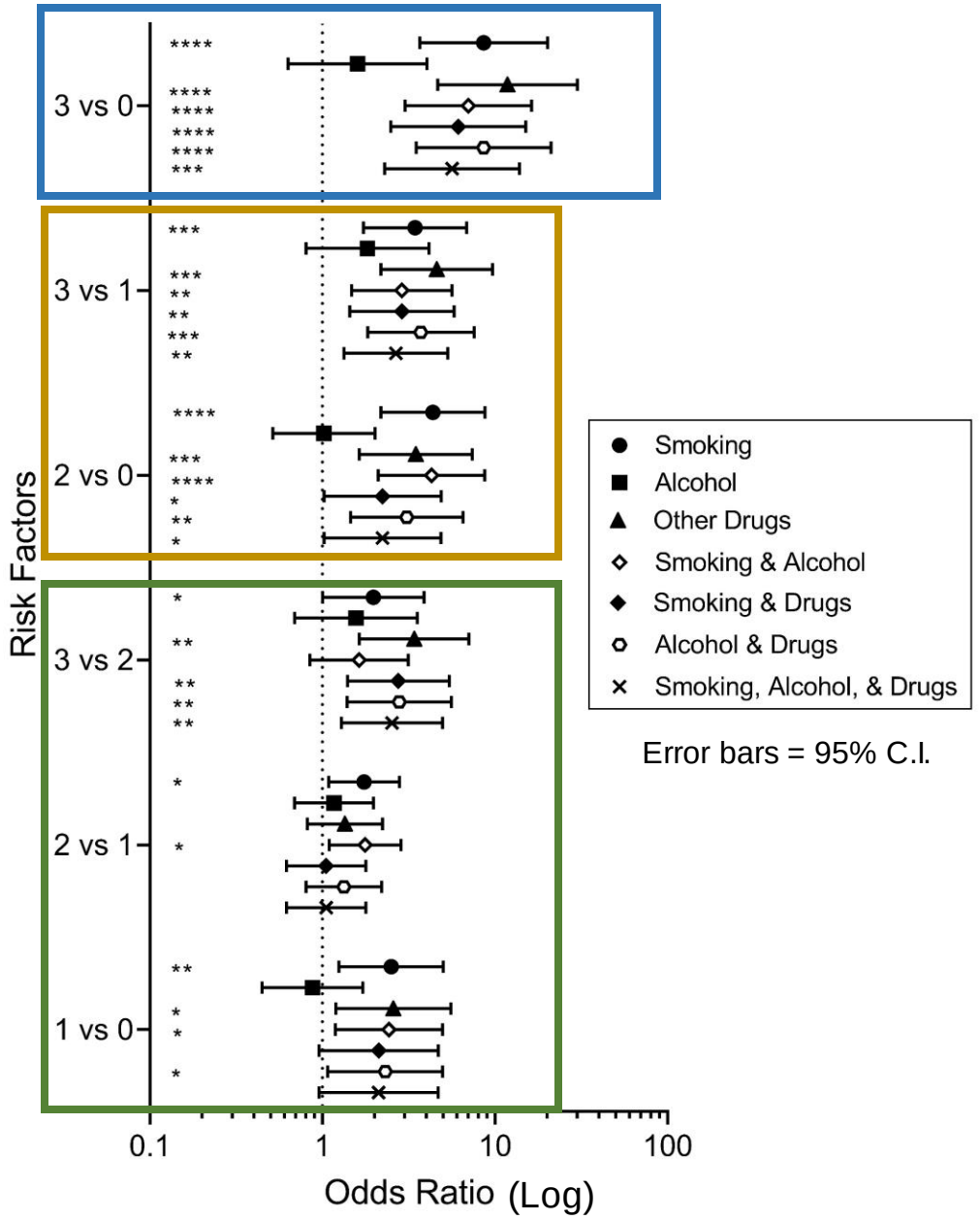
Error bars = 95% C.I.

Thrailkill, DeSarno, & Higgins (2022b) *Preventive Medicine*

Study 2

- High/Low are +/- 1 SD.
- How do Low LA, High DD, and Low environmental reward influence risk in ***combination***?

- All three factors contribute to risk for smoking and other substance use.



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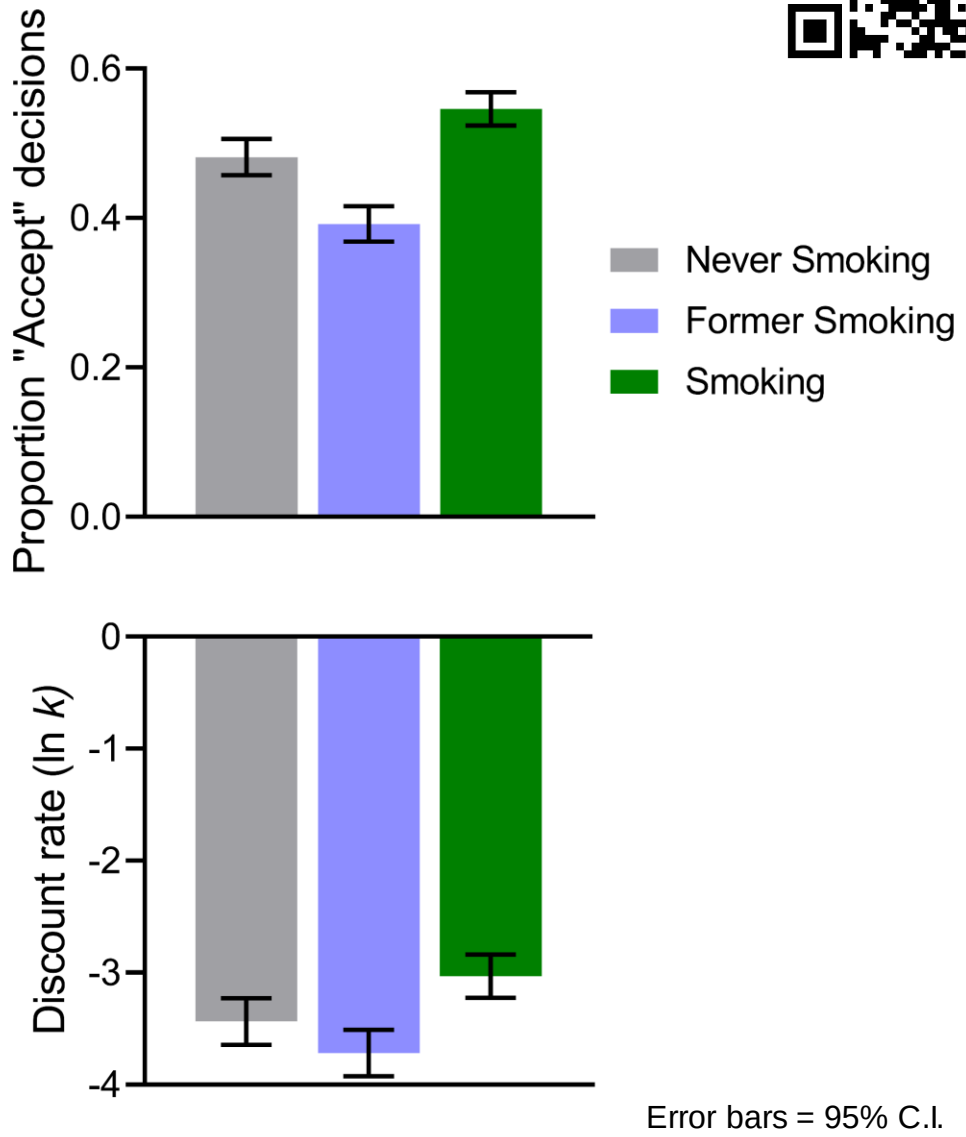
Study 3

- How does LA differ by smoking status?
- Former smoking status (Bickel et al., 1999)
  - *n*=984; NS=306; S=361; FS=317
  - LA in former smoking was similar to never smoking.
  - Replicated seminal findings with DD (Bickel et al., 1999).
- *Raises familiar questions:*
  - *Does LA increase after quitting?*
  - *Does higher LA allow one to quit in the first place?*



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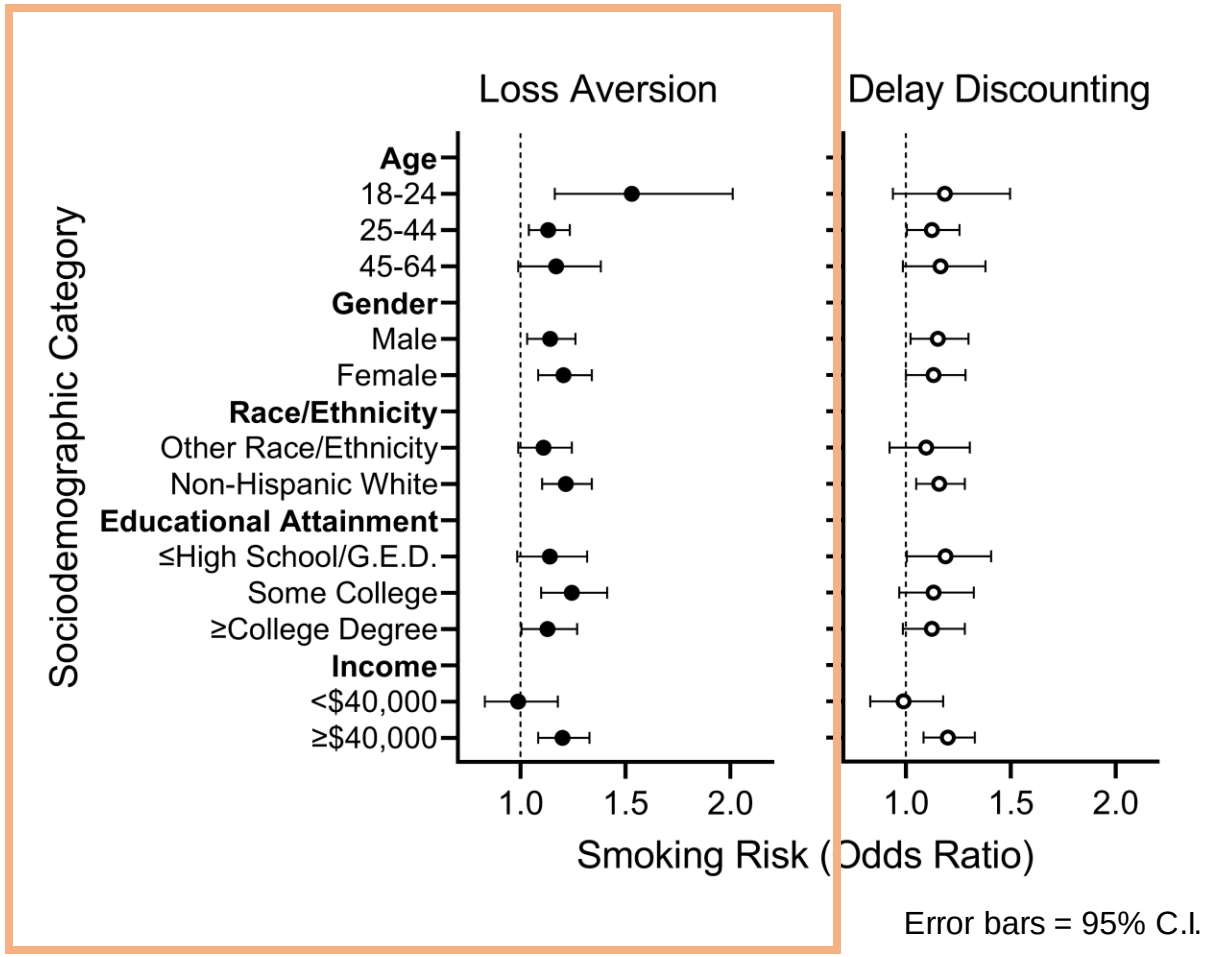
Study 4

- Studies 1-3:
  - Age, Gender, Educational Attainment included as covariates.
- Is LA significantly associated with smoking risk across levels of age, gender, race/ethnicity, educational attainment, and income?
  - These variables are related smoking (e.g., Fiore et al., 1989; Higgins et al., 2009).
- MTurk sample (n=646)
- Consistent relationship with increased risk for cigarette smoking*.

  *Interacted with income.



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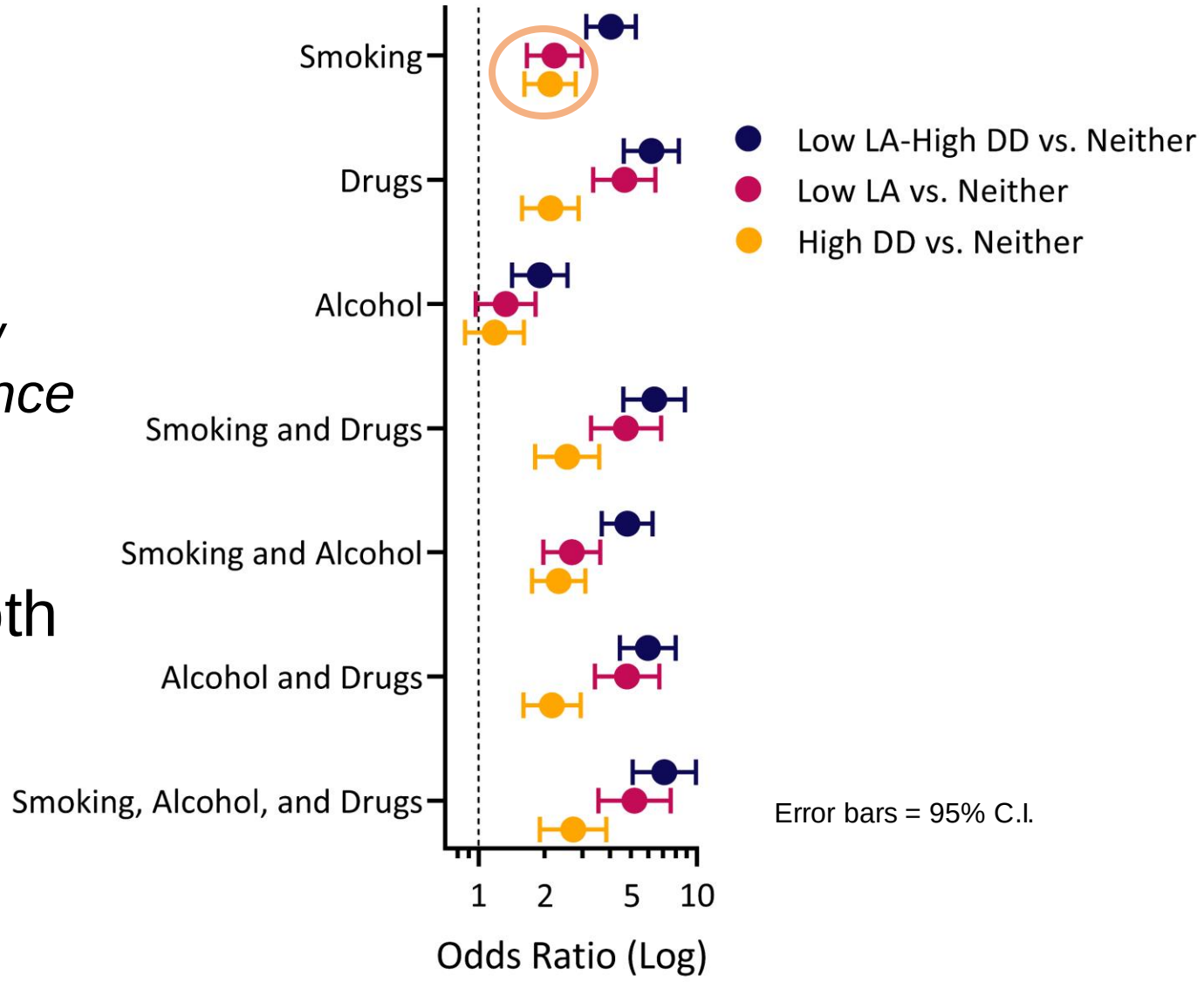
Study 5

- Risk factor profiles:
  - *How does the presence/absence of Low LA and/or High DD influence risk?*
- Compared to having neither, having one or both of low LA and high DD increases risk.



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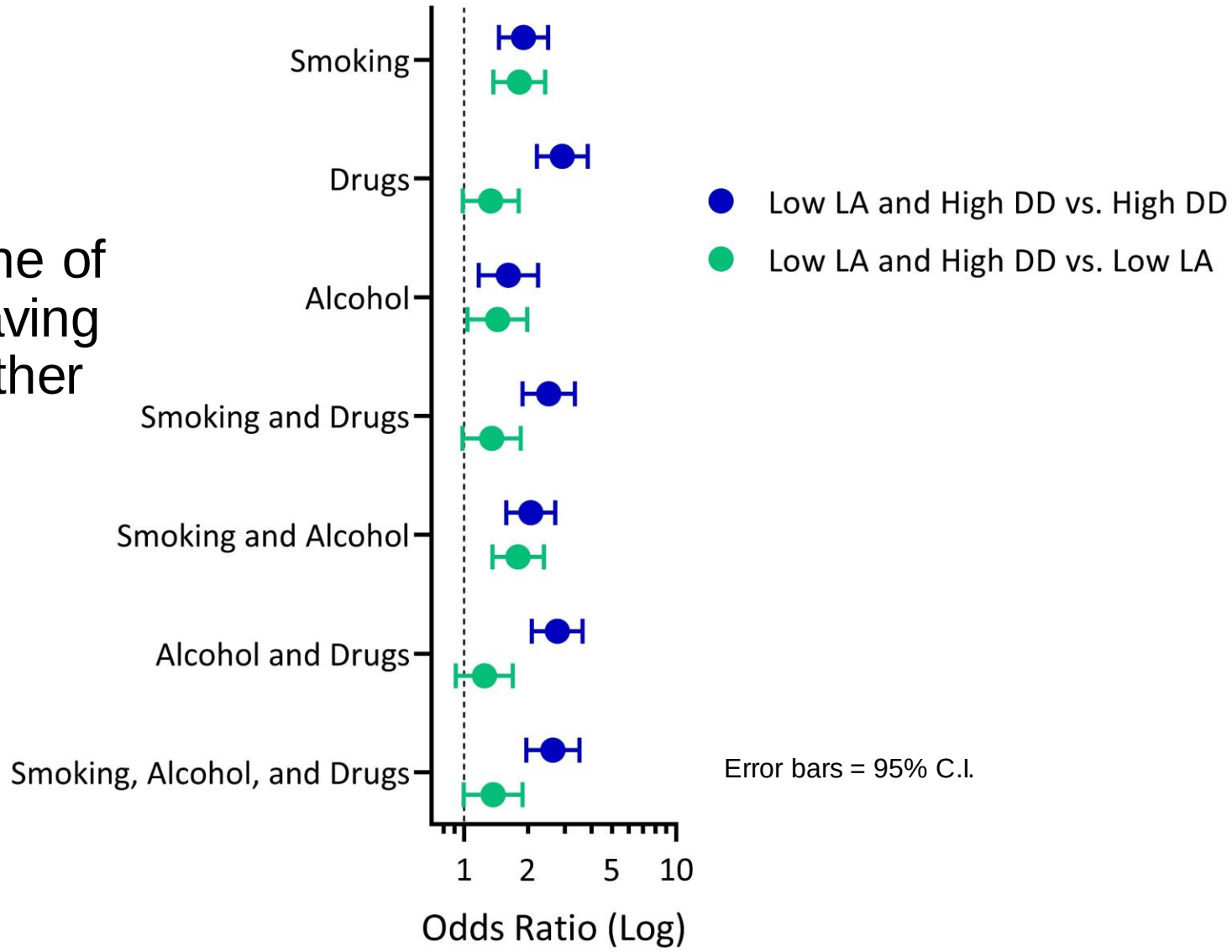
Study 5

- Risk factor profiles:
  - Compared to having one of Low LA or High DD, having Both increases risk further (co-occurrence).



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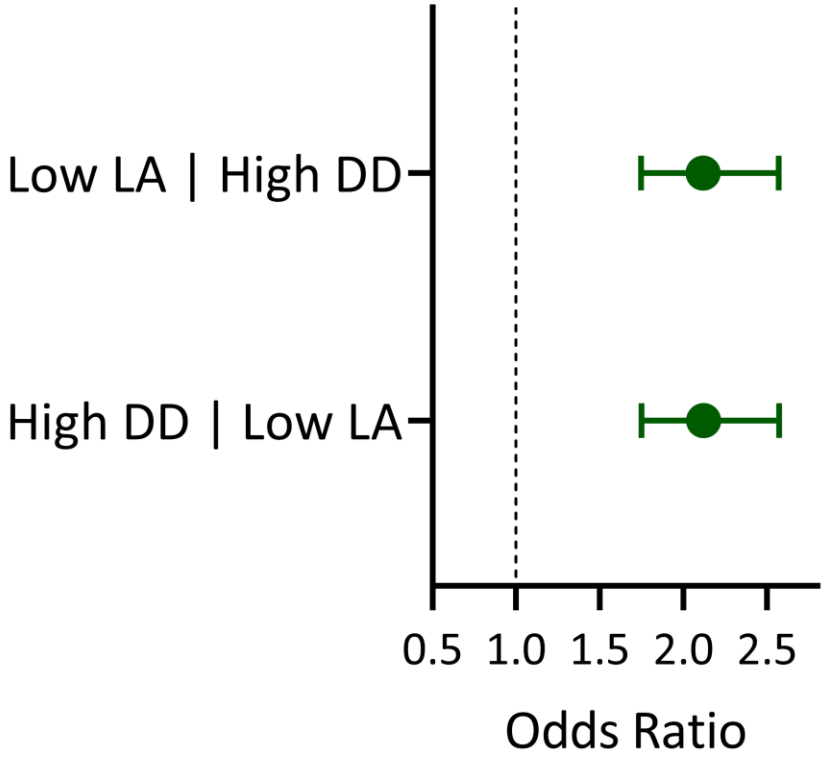
Study 5

- Risk factor profiles:
- *Does having one of **low LA** or **high DD** predict having the other?*
  - Do these factors "**cluster**"?
  - **Yes**, having either Low LA or High DD is associated with approximately **double** the odds of the presence of the other risk factor.



Error bars = 95% C.I.

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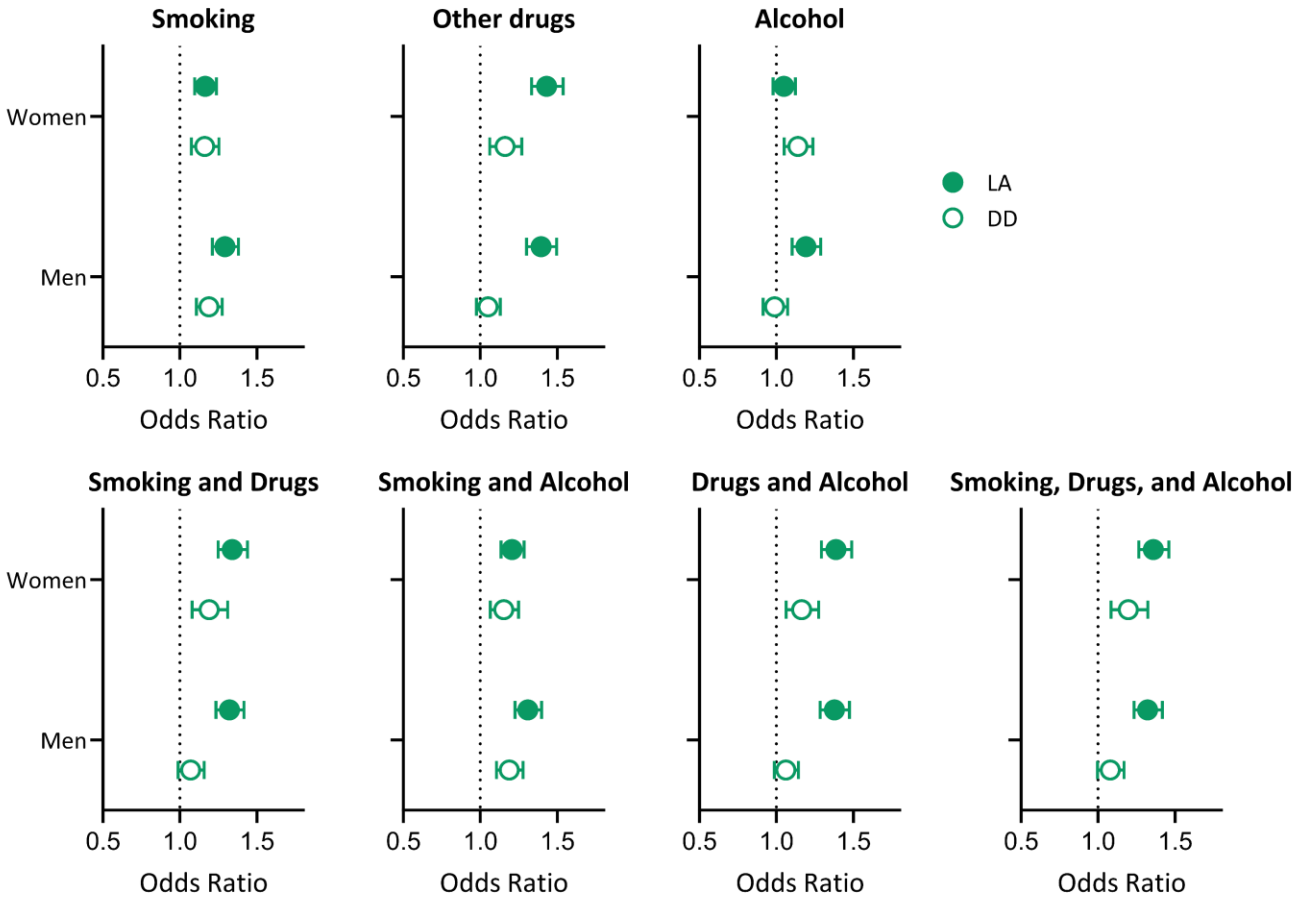
Study 5

- *Might low LA influence risk differently in Women?*
  - *Odds Ratios from models with LA, DD, education and age included.*
- *Lower LA related to risk similarly in Women and Men*



Summary

- Low loss aversion in behavior is related to substance use risk.
- Low LA is distinct from high DD and other important factors (low environmental reward; sociodemographics).

Much to do:

  - Finer grained analysis of severity of use, subpopulations, and at-risk demographics.
  - How **general** is the relationship? Does low loss aversion contribute to risk for other maladaptive behaviors?
  - National representative samples? Stability over time?
- Is low loss aversion **causally** related to use?
  - What contributes to low loss aversion?
  - Malleability and translation to malleability of use behavior.
  - Prevention/Intervention target.
- What does loss aversion tell us about the reinforcement process?
  - Focus on reinforcing events that do occur. What about those that do not?
  - Expectation violation – less sensitive to reinforcer omission?
  - Relative value – Losses “mean” less? Allowed to accumulate?

Thank you

Collaborators

- Stephen Higgins
- Michael DeSarno

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