



a place of mind

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Djavad Mowafaghian
CENTRE FOR BRAIN HEALTH

What are the odds?

Sensory game features, decision making and arousal

Mariya V. Cherkasova

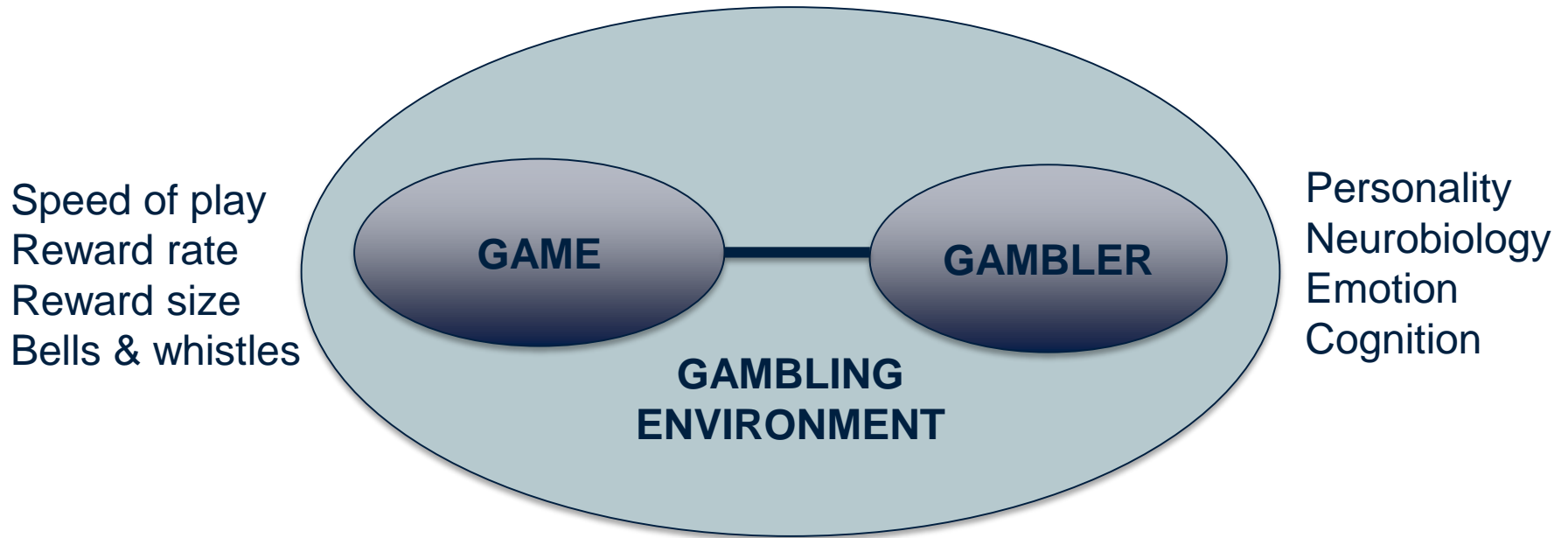
University of British Columbia



Sensory Game Features



Harmless Fun or Addiction by Design?

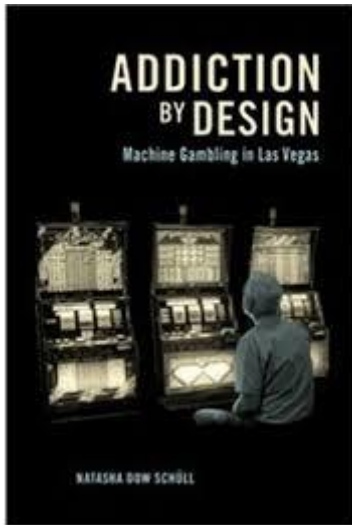




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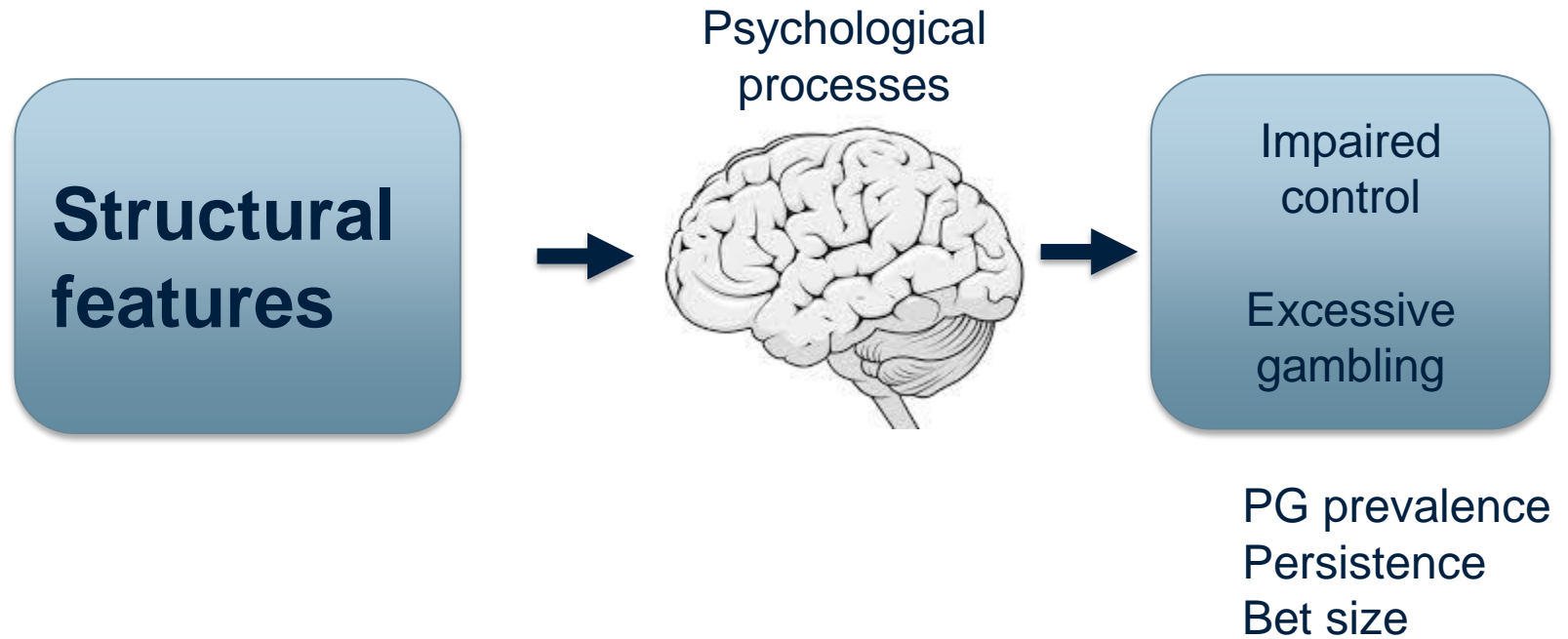
The Machine Zone



"It's like being in the eye of a storm, is how I'd describe it. Your vision is clear on the machine in front of you but the whole world is spinning around you, and you can't really hear anything. You aren't really there— you're with the machine and that's all you're with."

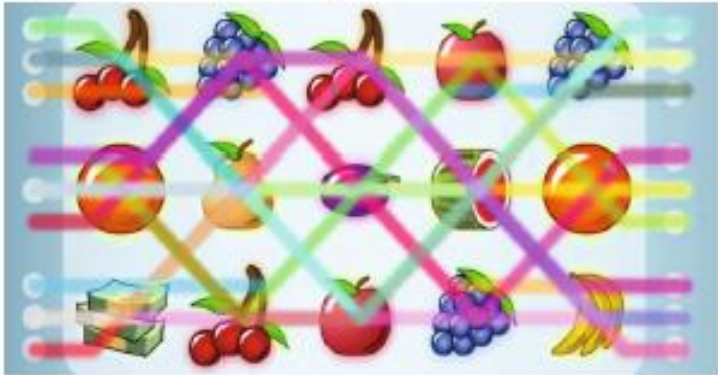


Sensory reward features

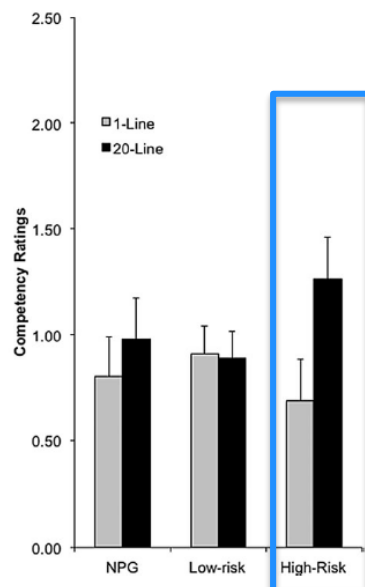
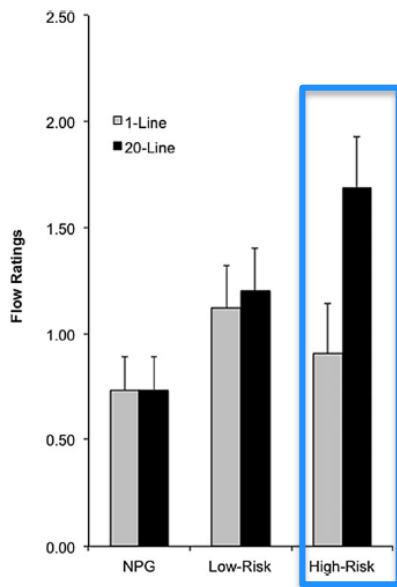


Structural game characteristics

Multiple Lines

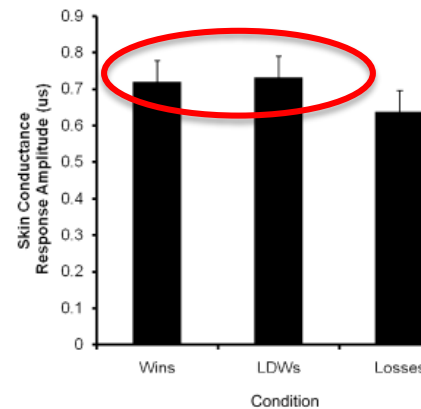


Losses Disguised as Wins

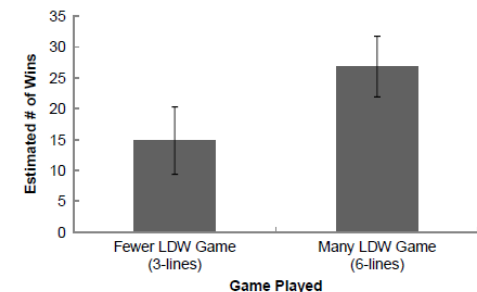


Dixon et al 2014

Novice players



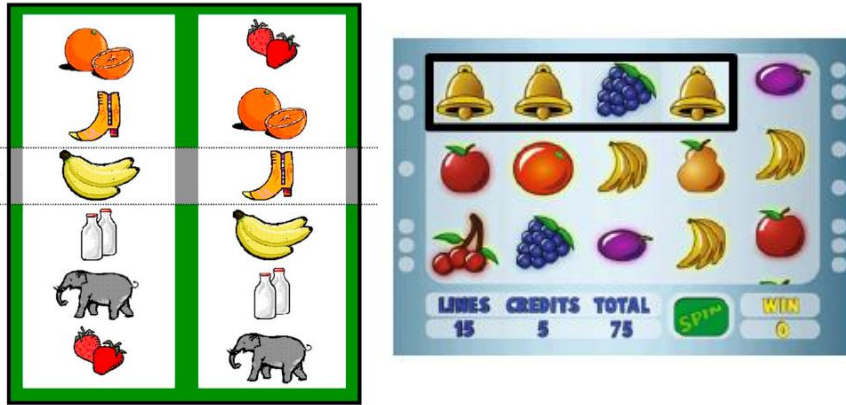
Dixon et al 2010



Jensen et al 2013

Structural game characteristics

Near misses



- Experienced as frustrating
- Increase urge to play and gambling persistence
- Lead to overestimate frequency of winning
- Activate the reward circuitry
- Increase arousal

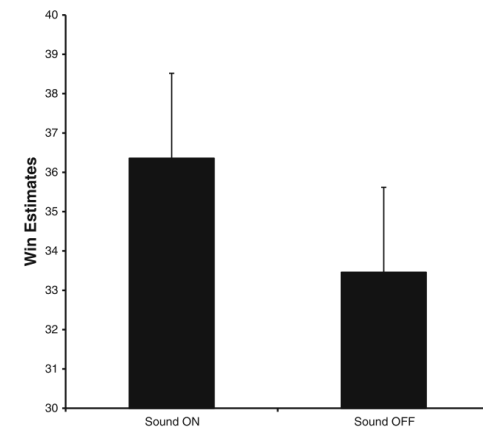
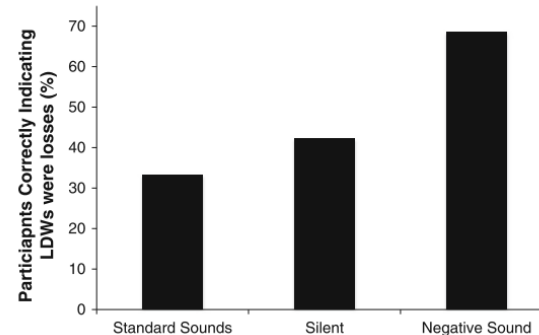
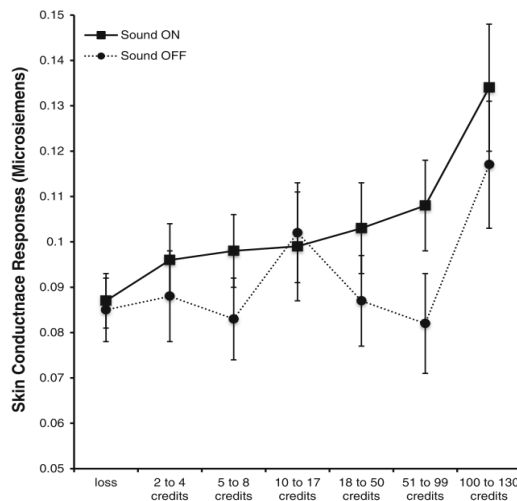
Stop buttons



- Foster illusion of control in novice players (Ladouceur & Sevigny, 2005)
- 13.6 % of gamblers held erroneous beliefs despite casino signage (Dixon et al 2018)
- Associated with gambling persistence (Ladouceur & Sevigny, 2005)

Sensory reward features

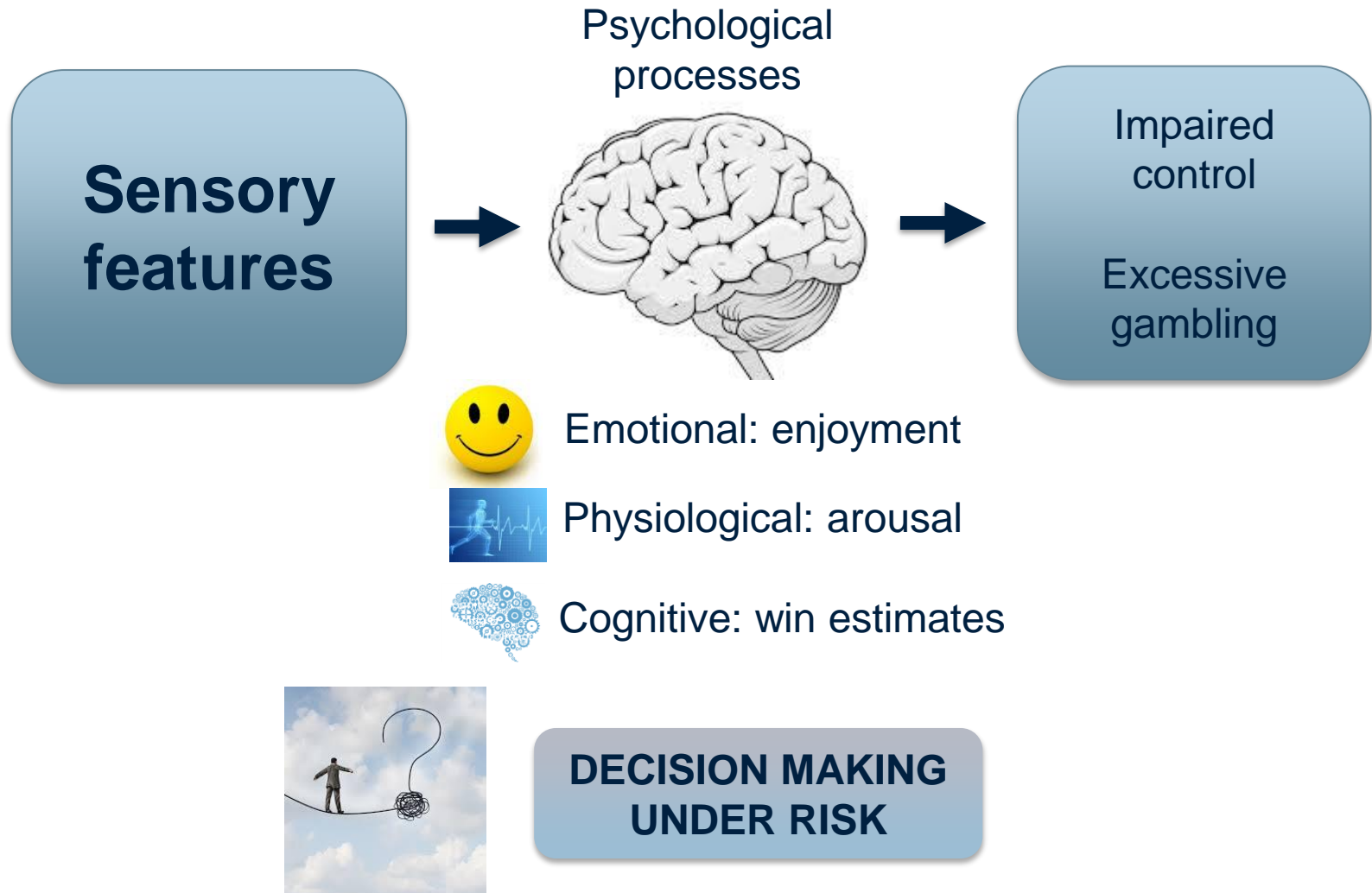
- Sensory features are attractive to gamblers (*Griffiths 1990; Dixon et al 2010, Livingstone & Woolley 2008; Loba et al 2001*)
 - particularly to pathological gamblers
 - some gamblers dislike the sounds (*Livingstone & Woolley 2008*)



Slots sounds are arousing
(*Dixon et al 2014*)

Slots sounds help disguise losses as wins
(*Dixon et al 2010, 2014, 2015*)

Sensory reward features



Risky decision making in the lab: the Iowa Gambling Task



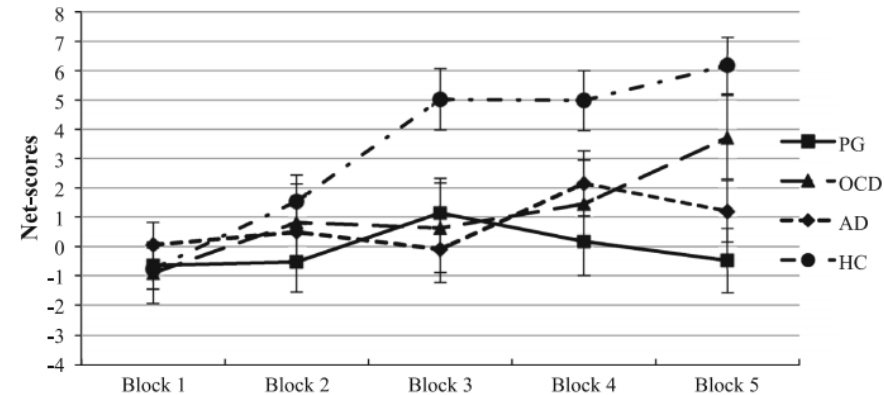
Deck 1

Deck 2

Deck 3

Deck 4

Select a card



Bottesi et al 2015

- Decision making deficits in addictions, including gambling (e.g. Kovacs et al 2017, Bechara et al 2001)
- Decision making “recovers” along similar time frame as craving diminishes (e.g. Wang et al. 2013)
- Risky decision making is particularly good predictor of treatment failure (e.g. Stevens et al. 2013)

Sensory features & decision making in rodents



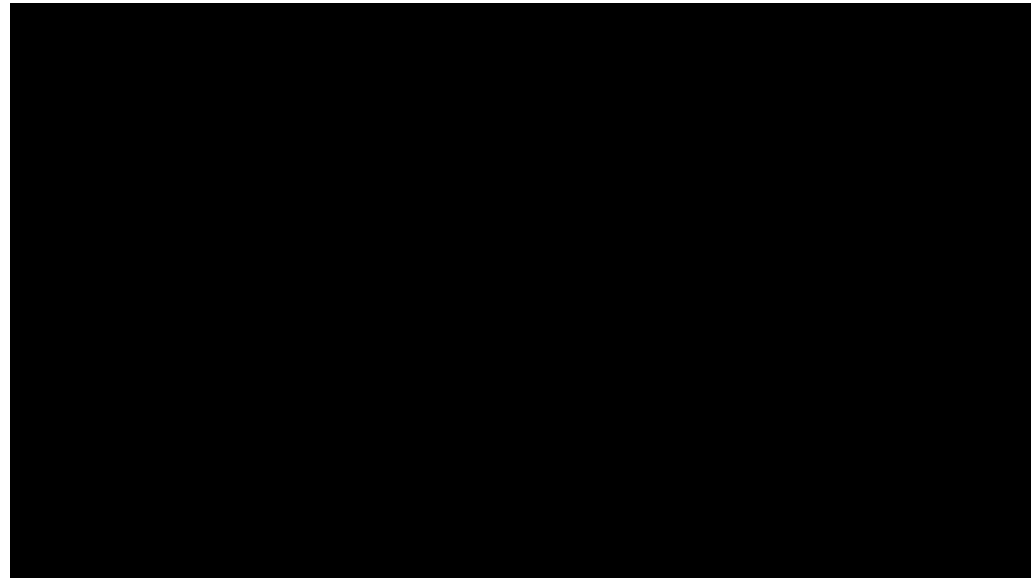
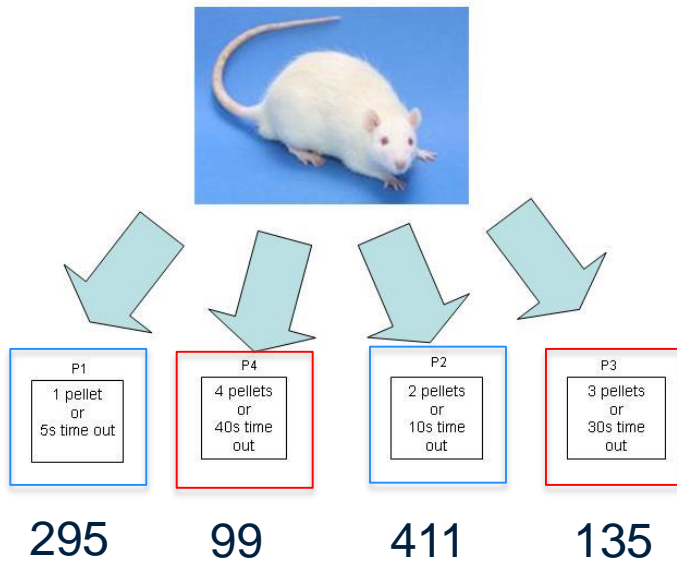
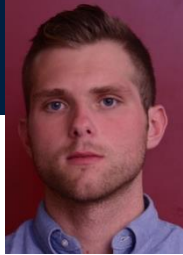
Dr. Catharine A Winstanley

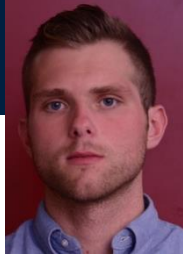


CRAIG SWANSON @ WWW.PERSPECTIVITY.COM

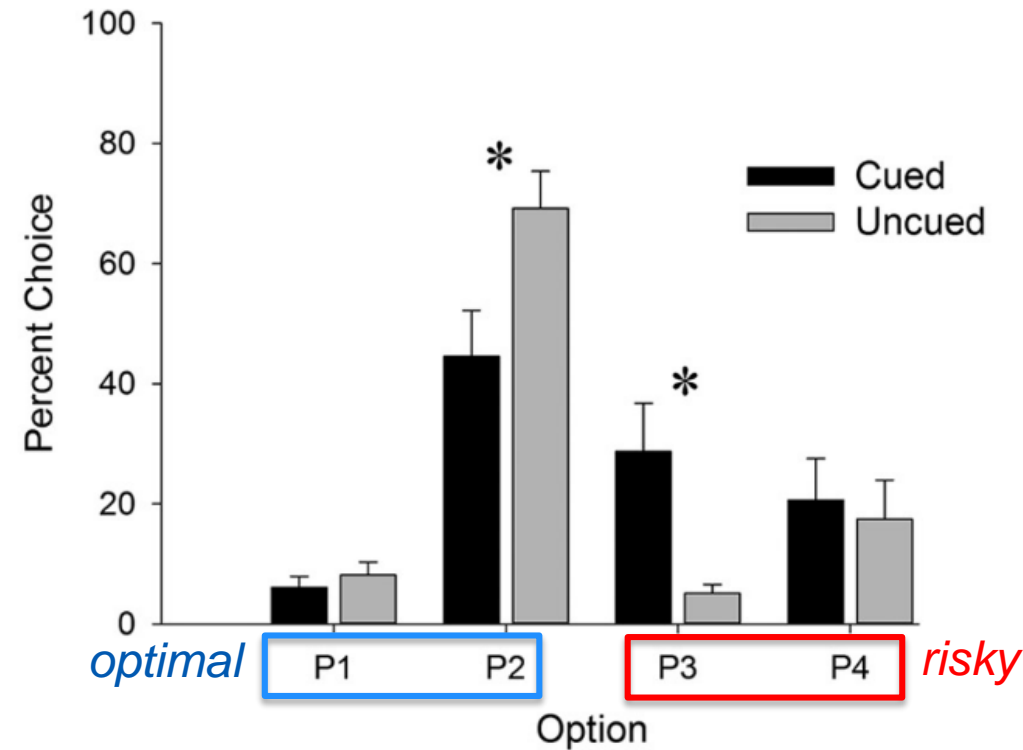
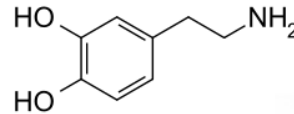


The rodent gambling task

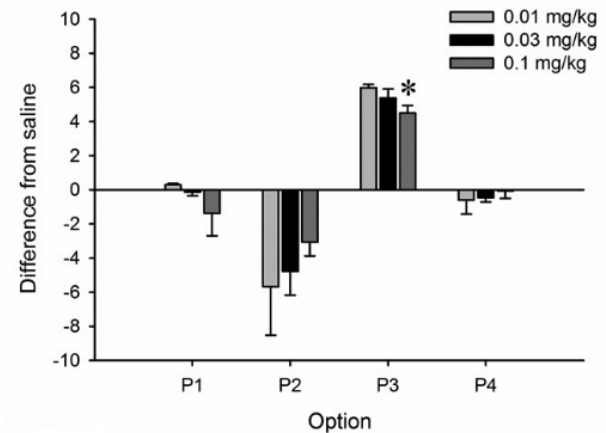




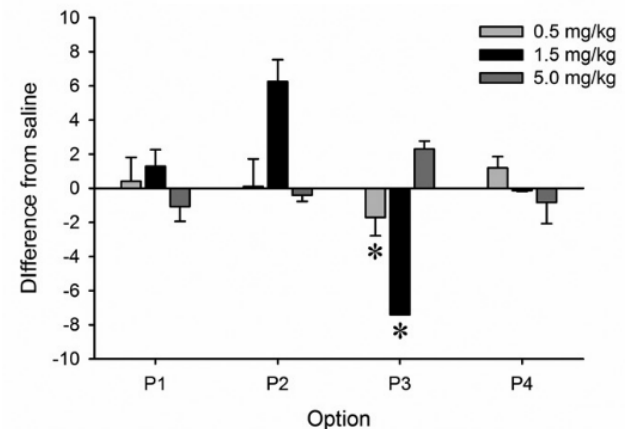
Sensory cues promote risky choice on the rGT



B D3 Agonist



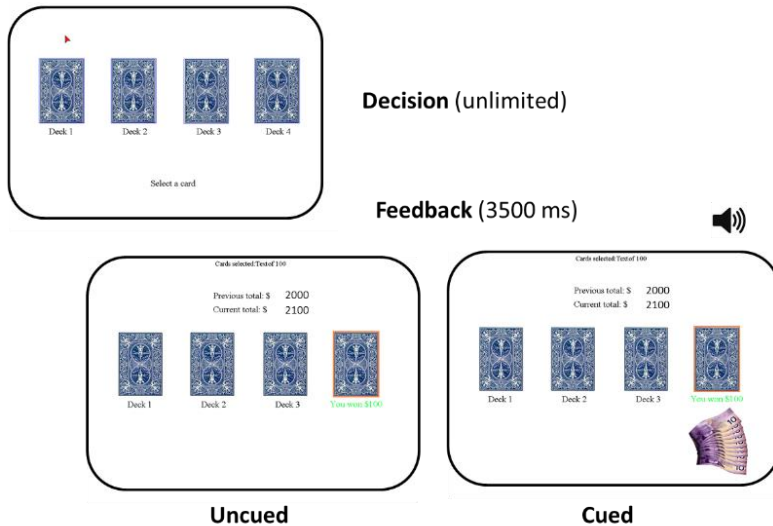
E D3 Antagonist



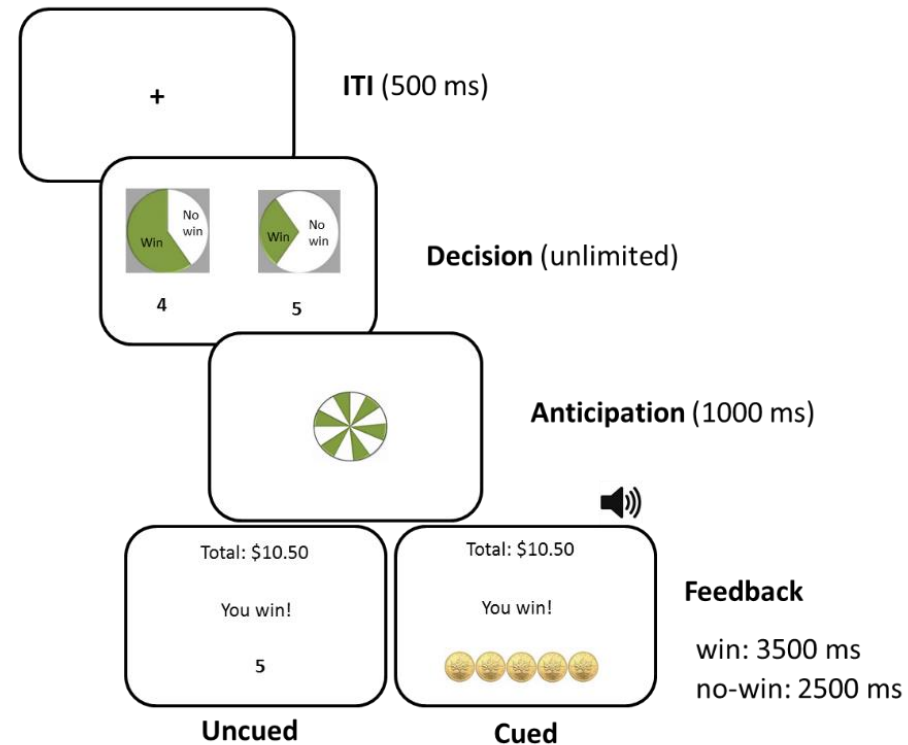


Studies in healthy human volunteers

A: Iowa Gambling Task



B: Vancouver Gambling Task





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Vancouver Gambling Task (VGT)



5



2



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Vancouver Gambling Task (VGT)

Total: 5

You won!

5



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Vancouver Gambling Task (VGT)

Total: \$5



Vancouver Gambling Task (VGT)

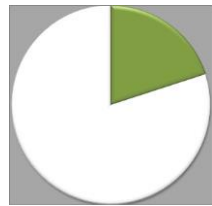


X



=

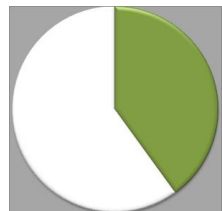
Expected
value (EV)



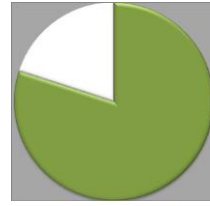
EV=.6



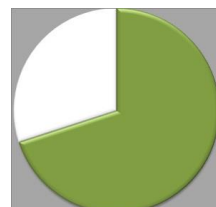
EV=.9



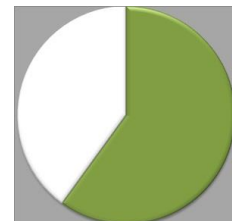
EV=1.6



EV=1.6



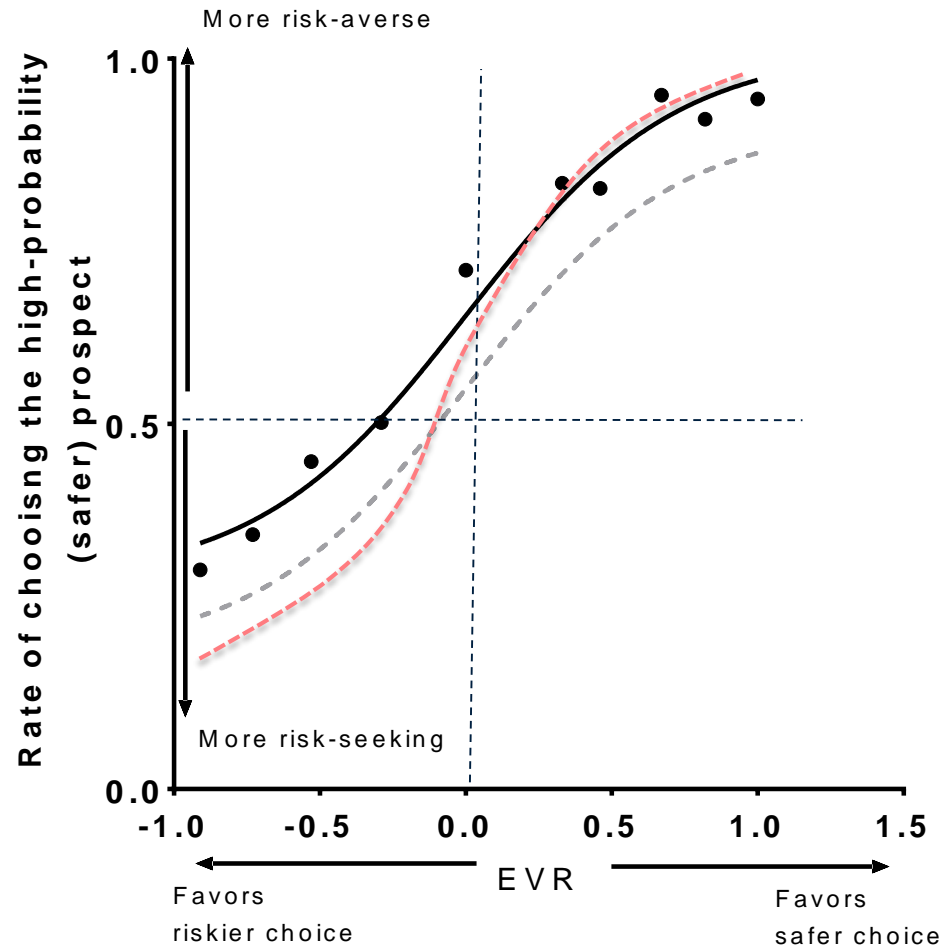
EV=.7



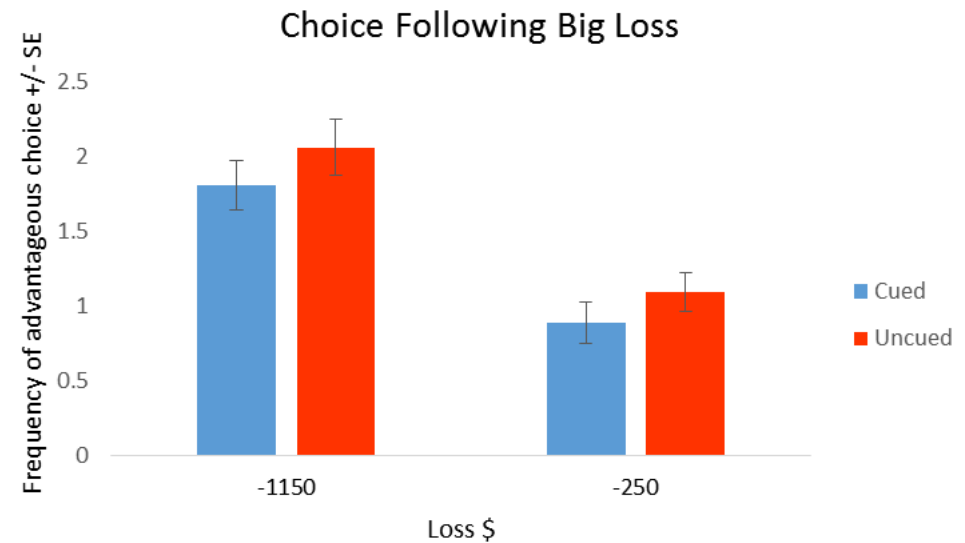
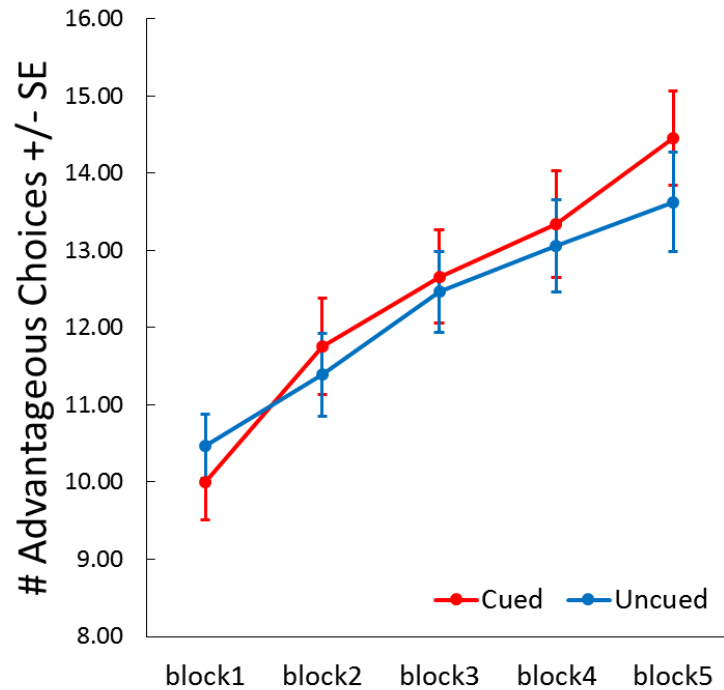
EV=.6



Vancouver Gambling Task (VGT)



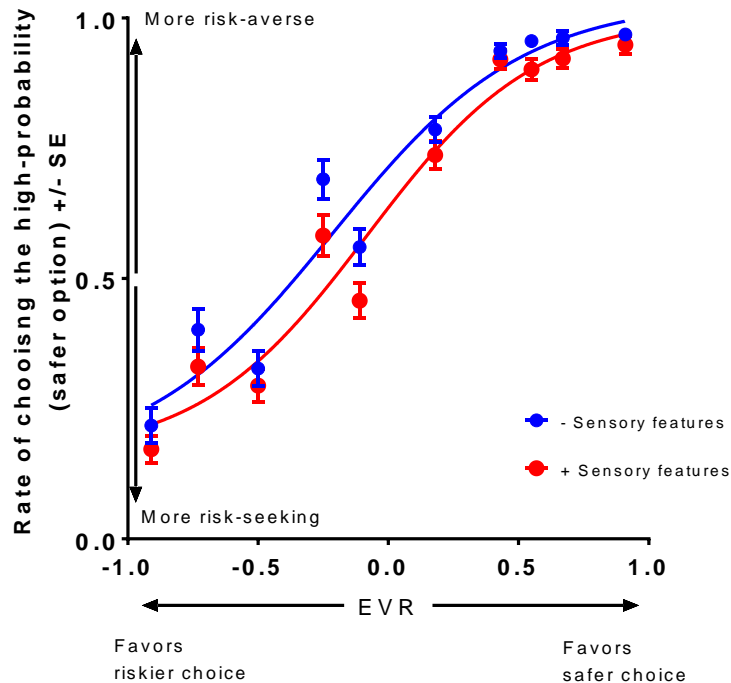
Sensory features & decision making: IGT



Between-subjects design, n=131

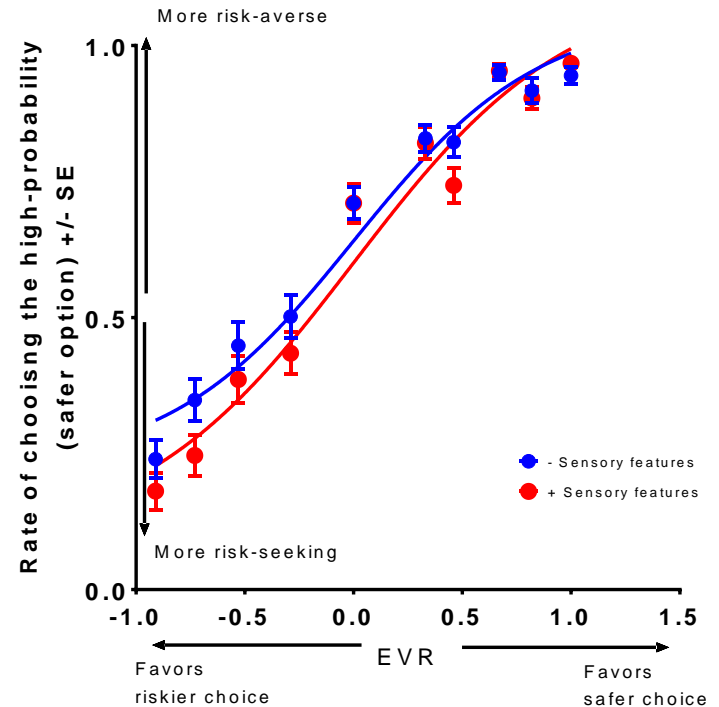
Sensory features & decision making: VGT

Study 1: between-subject
n=131



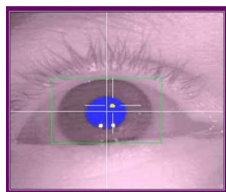
Sensory Features: $b = 0.58$, $SE = 0.22$, $z = 2.64$, $p = 0.008$

Study 2: within-subject
n=58

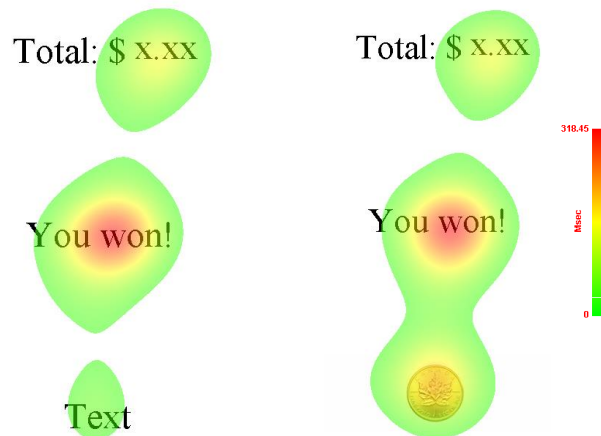


Sensory Features: $\beta = .27$, $SE = .11$, $z = 2.51$, $p = .02$
Magnitude x SF: $\beta = .63$, $SE = .17$, $z = 3.66$, $p = .0002$

Sensory features & attention

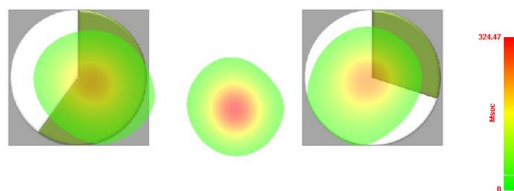


Feedback

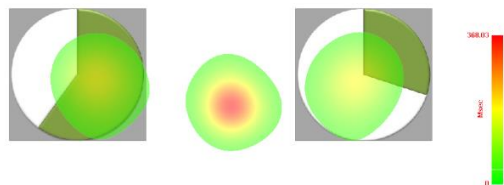


Study 1 Decision

- Sensory features



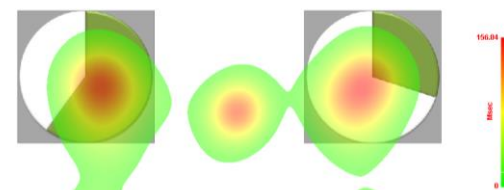
4 + Sensory features



4 5 $p = .03$

Study 2 Decision

- Sensory features



4 + Sensory features



4 5 $p < .0005$

Sensory features, attention & risky choice



1. Does attending less to odd and/ or more to the amount promote riskier choice?



2. Is this a mechanism whereby sensory features promote risky choice?

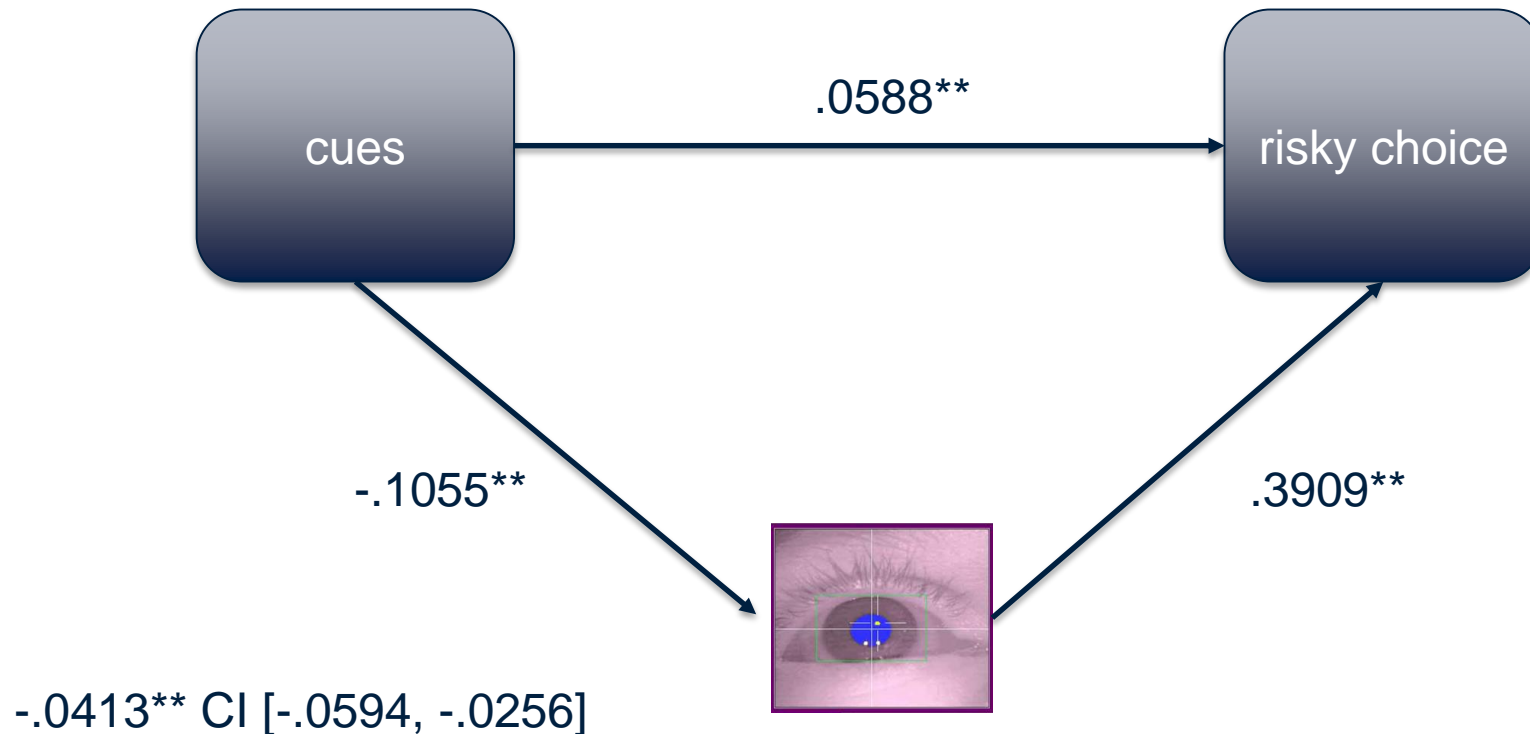
| | β | SE | z | p |
|-------------------------|---------|------|-------|-------------|
| Study 1: odds | -0.26 | 0.14 | 1.95 | 0.052 . |
| Study 2: odds | -1.49 | 0.14 | 11.01 | <0.0005 *** |
| Study 1: amounts | 0.33 | 0.14 | -2.37 | 0.02 * |
| Study 2: amounts | 0.62 | 0.17 | 3.77 | 0.0001 *** |

Fixations predicting risky choice

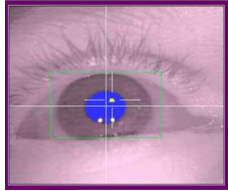
Sensory features, attention & risky choice



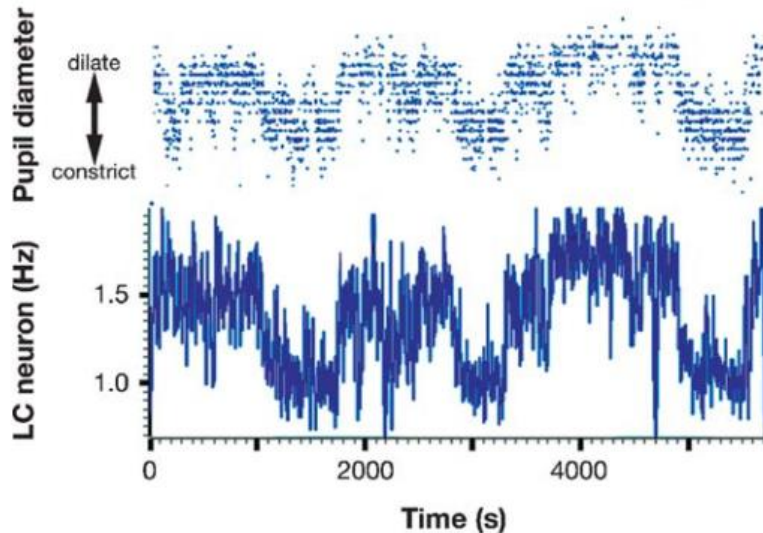
1. Does attending less to odd and/ or more to the amount promote riskier choice?
2. Is this effect modulated by the sensory features?



Sensory features & arousal

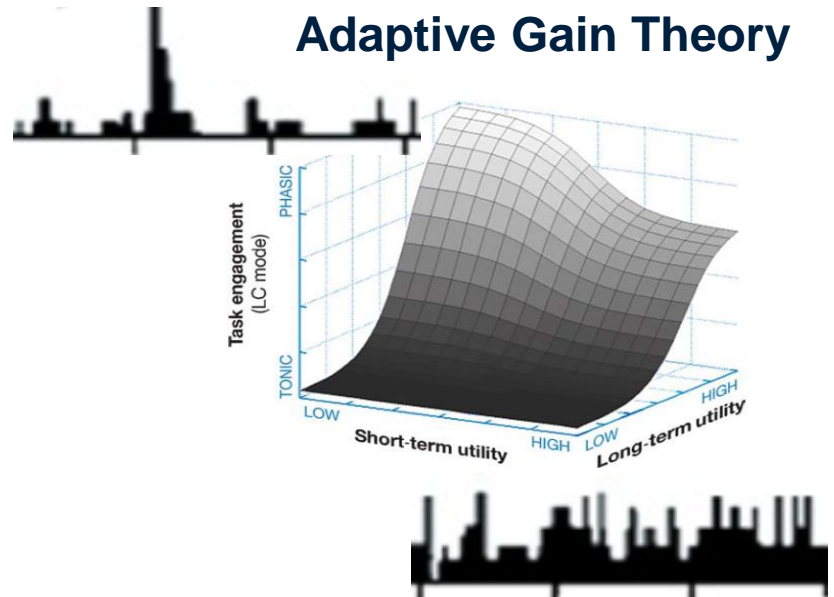


- Gambling associated with increases in arousal (Sharpe 2002)
 - Greater in PG (e.g. Goudriaan et al 2004)
- Gambling cues elicit arousal in gamblers (Baudinet & Blaszczyński 2013)
- Impaired decision making related to aberrant arousal patterns in problem gamblers (Goudriaan et al, 2006)



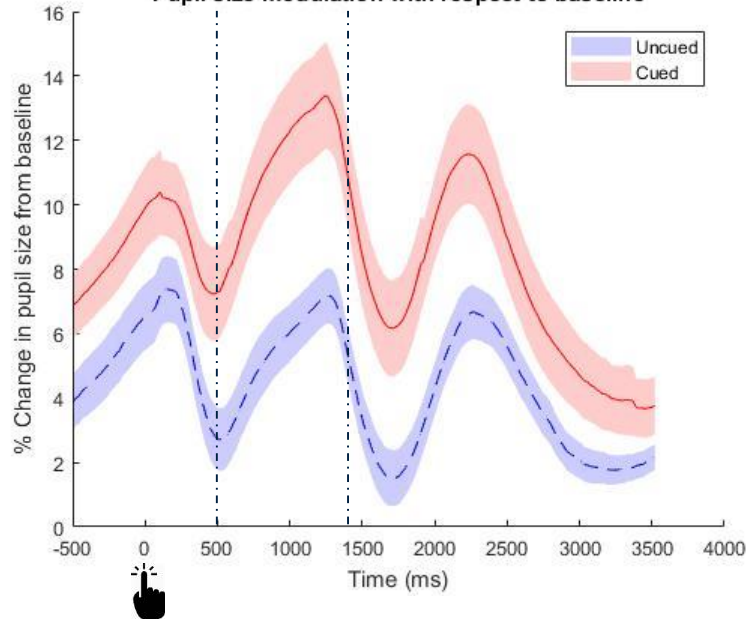
Aston Jones & Cohen, 2005

Adaptive Gain Theory



Sensory features & arousal

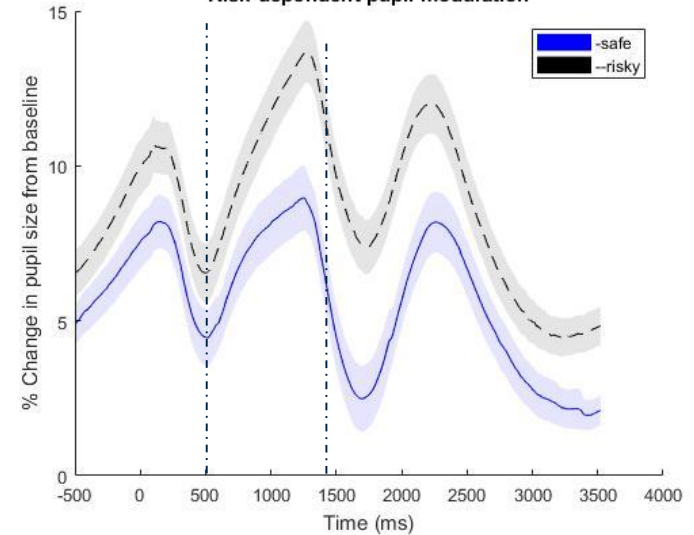
Pupil size modulation with respect to baseline



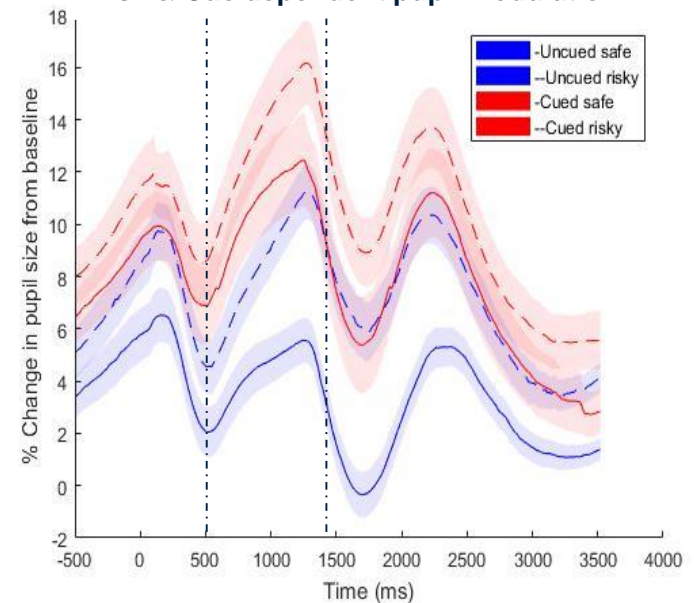
baseline



Risk-dependent pupil modulation



Risk & Cue dependent pupil modulation



Individual vulnerability



- ~ 73% of people in BC report having gambled in the past year
- Prevalence of problem gambling 4.9%
- Prevalence of gambling disorder .9%

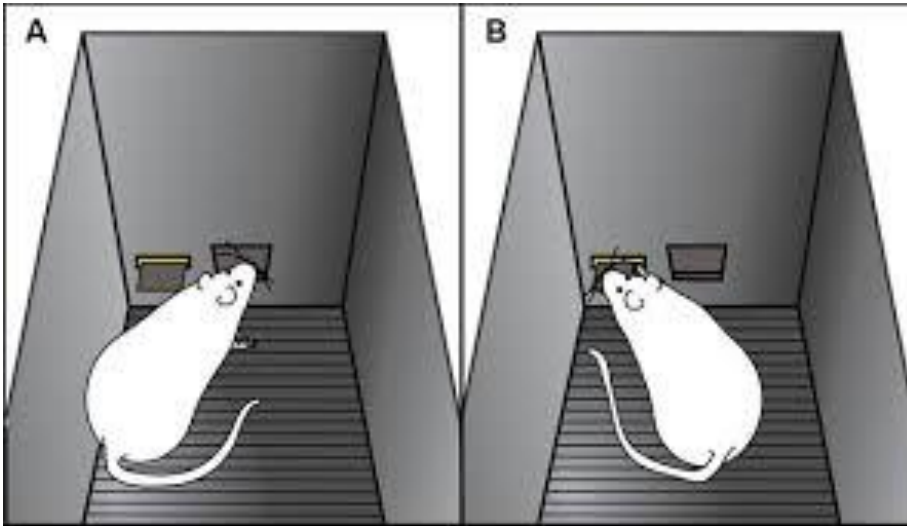


Individual susceptibility to sensory features

- Can we identify individuals who are especially susceptible to risk-promoting effects of sensory features?

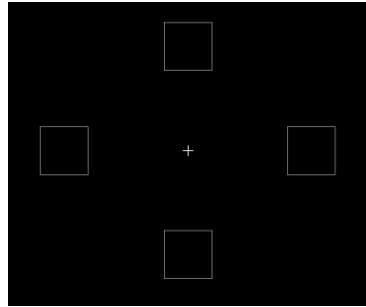
Individual differences in cue sensitivity: rodents

Sign & Goal Tracking

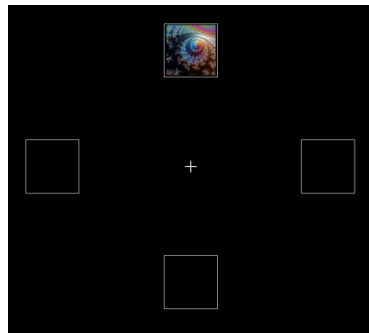


- Individual variation in attribution of motivational value to reward-predictive cues (Robinson & Fligel 2009; Meyer et al, 2012)
- Linked to addiction vulnerability in animal models
 - Sign-trackers seek drugs and relapse in the presence of discrete drug cues (e.g. Saunders & Robinson 2010, 2011)
 - Goal-trackers more responsive to contextual cues (Saunders & Robinson 2012)

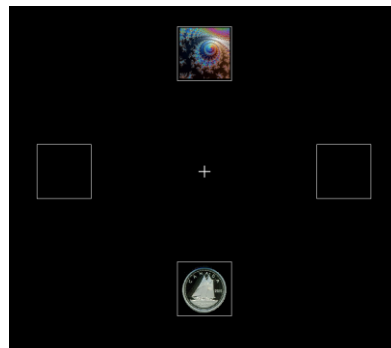
Individual differences in cue sensitivity: humans



~2s

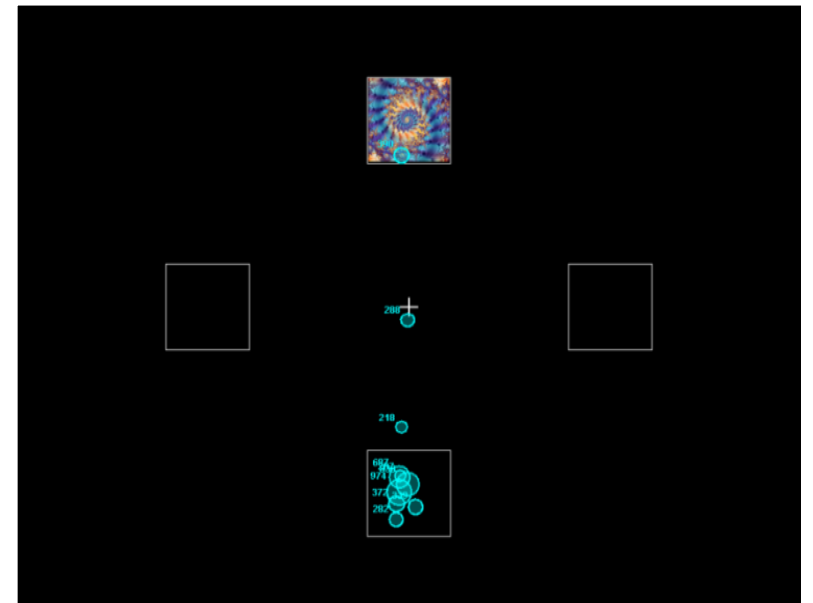
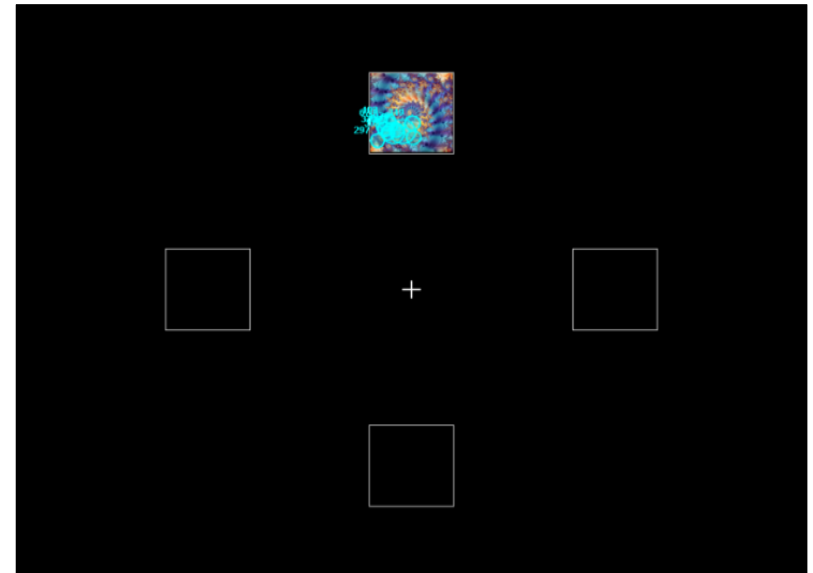


5s

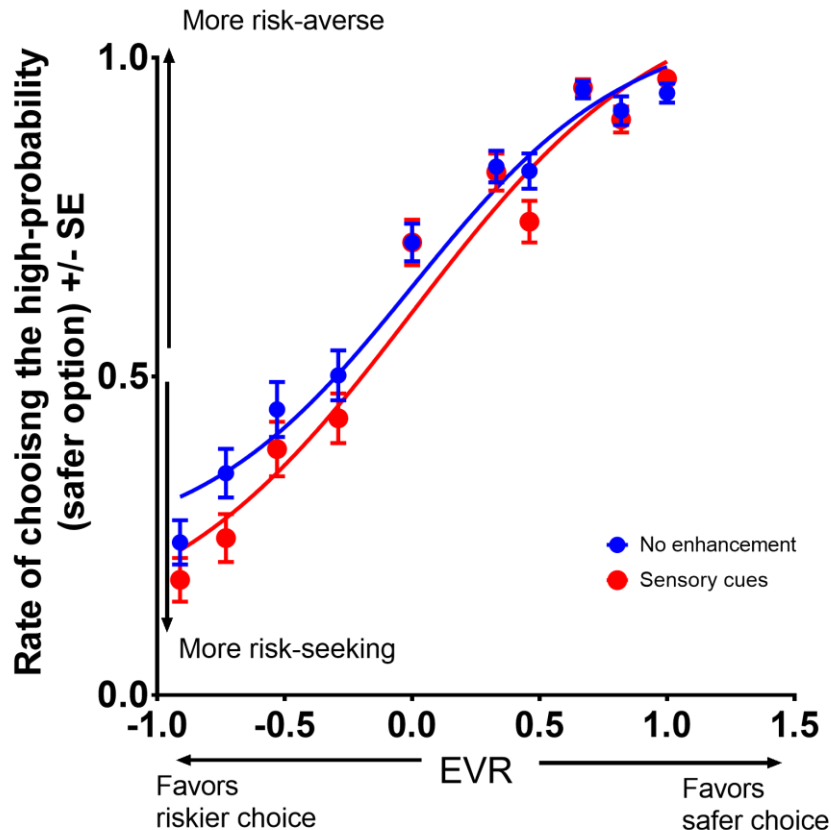


**Sign-tracker
(ST)**

**Goal-tracker
(GT)**

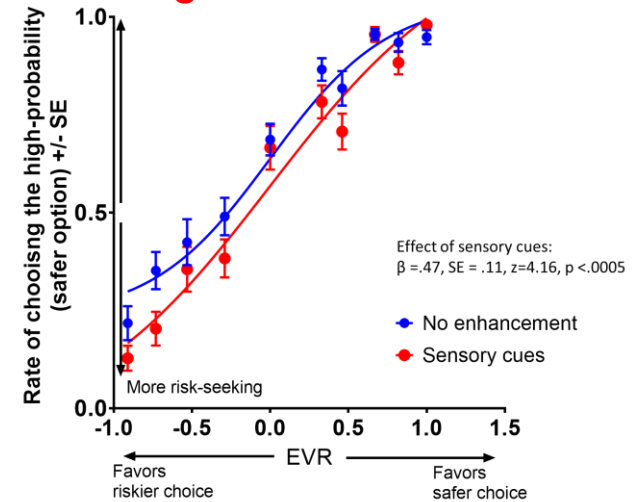


Cue reactivity of choice

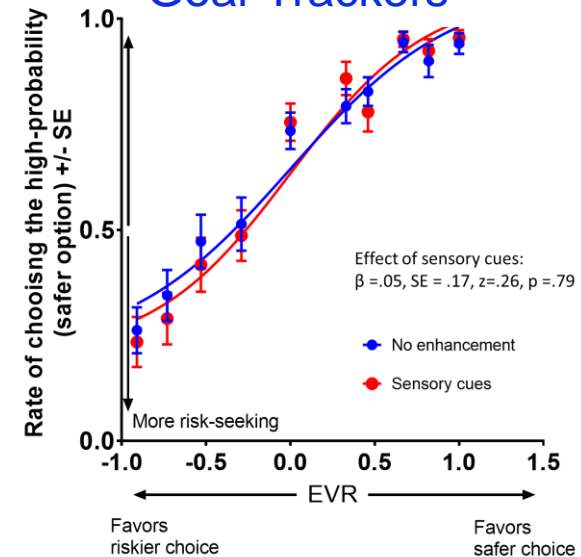


Study 2: n=58

Sign-Trackers



Goal-Trackers





Interim summary

- Sensory features promote risky choice in both rodents and healthy human volunteers
- Attentional mechanisms may be involved
- Risk-promoting effects are more apparent in cue-sensitive individuals
- Sensory features promote arousal
 - Independent of the risk-promoting effects

RELEVANCE TO PROBLEM GAMBLING ?

Effects of sensory features in problem gamblers

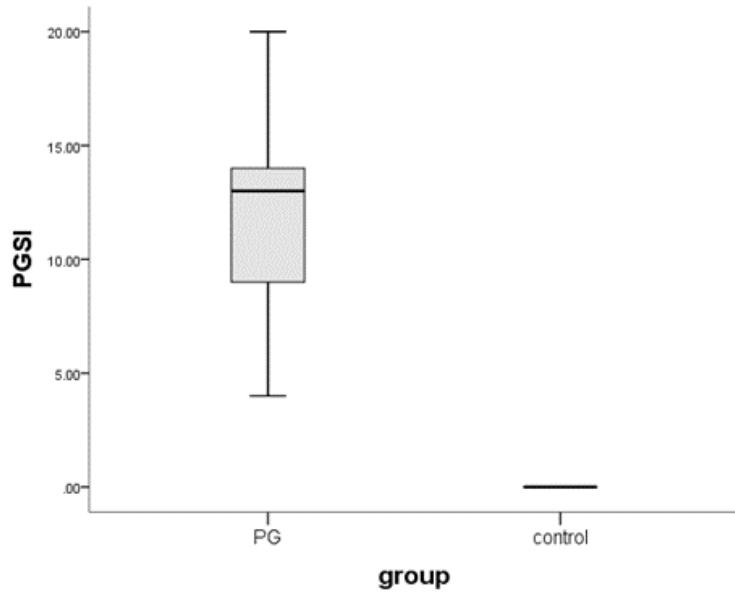
Inclusion / exclusion criteria

- Problem gambling severity index (PGSI, *Ferris & Wynne, 2001*) ≥ 3
- No neurological conditions
- No mental health problems requiring hospitalization
- No change in medication within 6 weeks

| | Gamblers | Controls |
|-------------|-------------------|-------------------|
| n | 27 | 24 |
| Males | 11 | 9 |
| Females | 16 | 15 |
| Age | 46.85 \pm 11.89 | 46.21 \pm 12.66 |
| PGSI | 11.96 \pm 4.4 | 0 |
| GD | 15 | 0 |
| Ψ Meds | 14 | 1 |
| Gambling tx | 11 | 0 |

Clinical characteristics

Severity

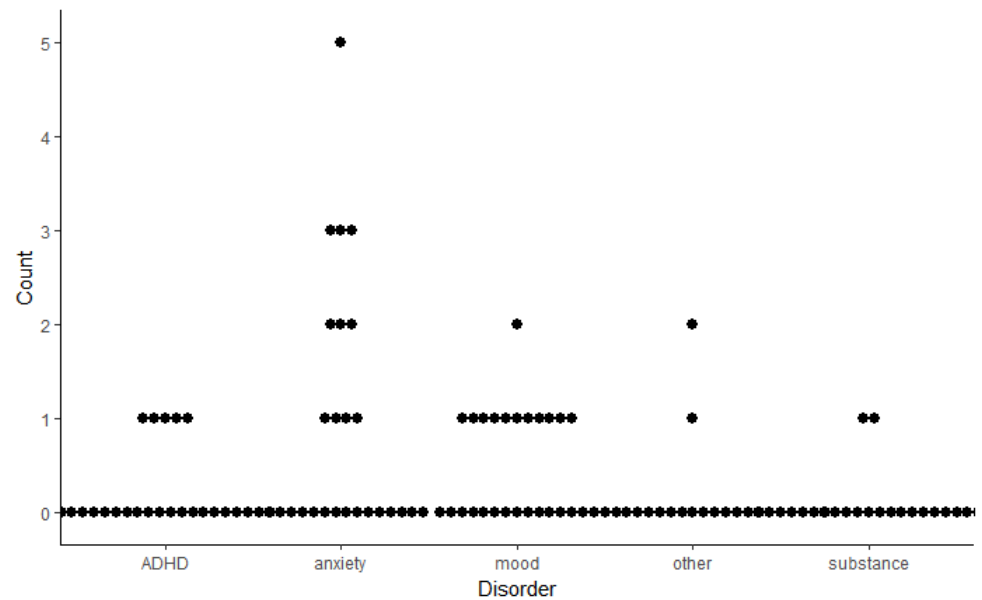


Games



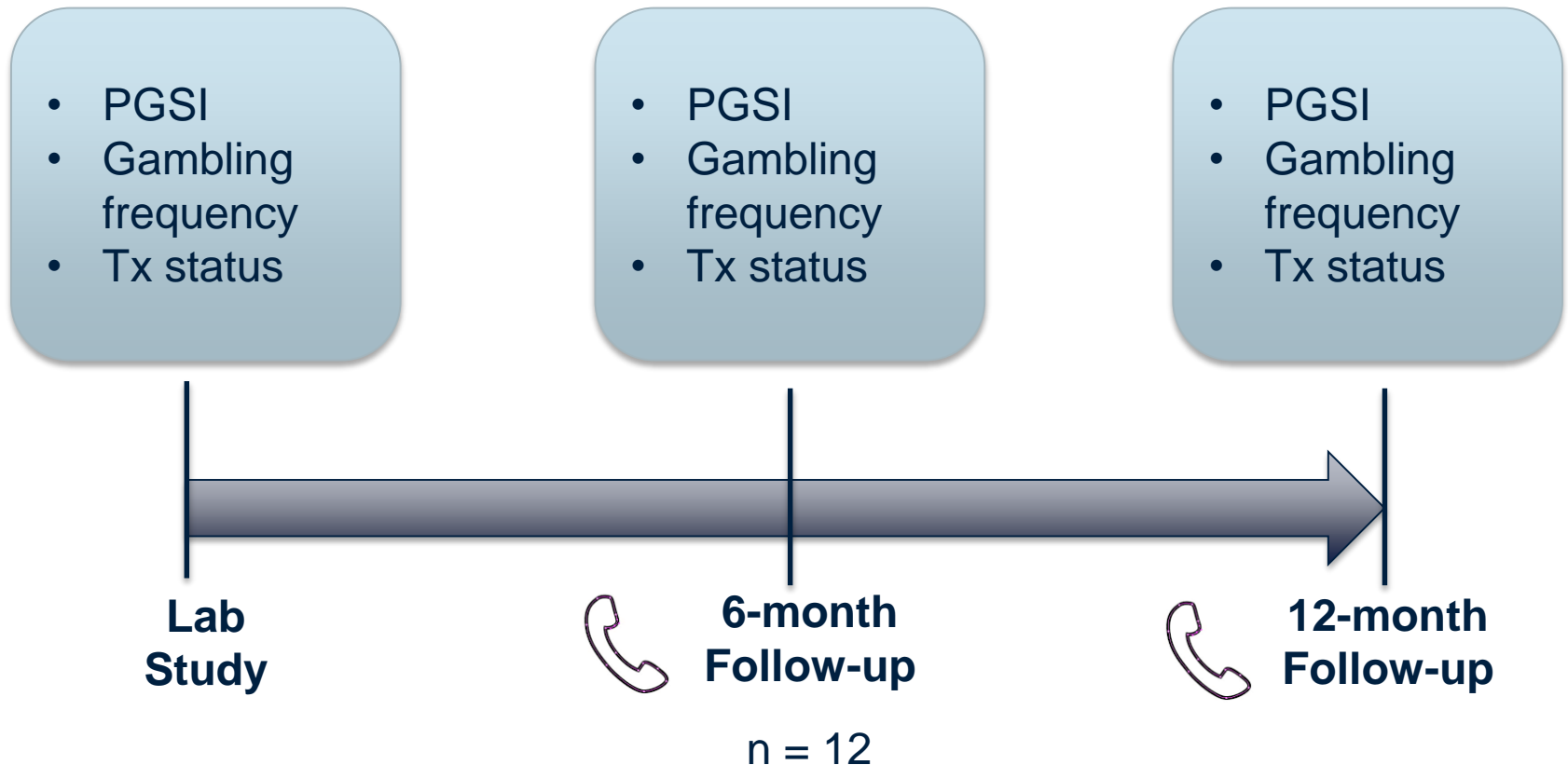
■ Primarily slots ■ Slots + ■ No slots

Current Comorbidity

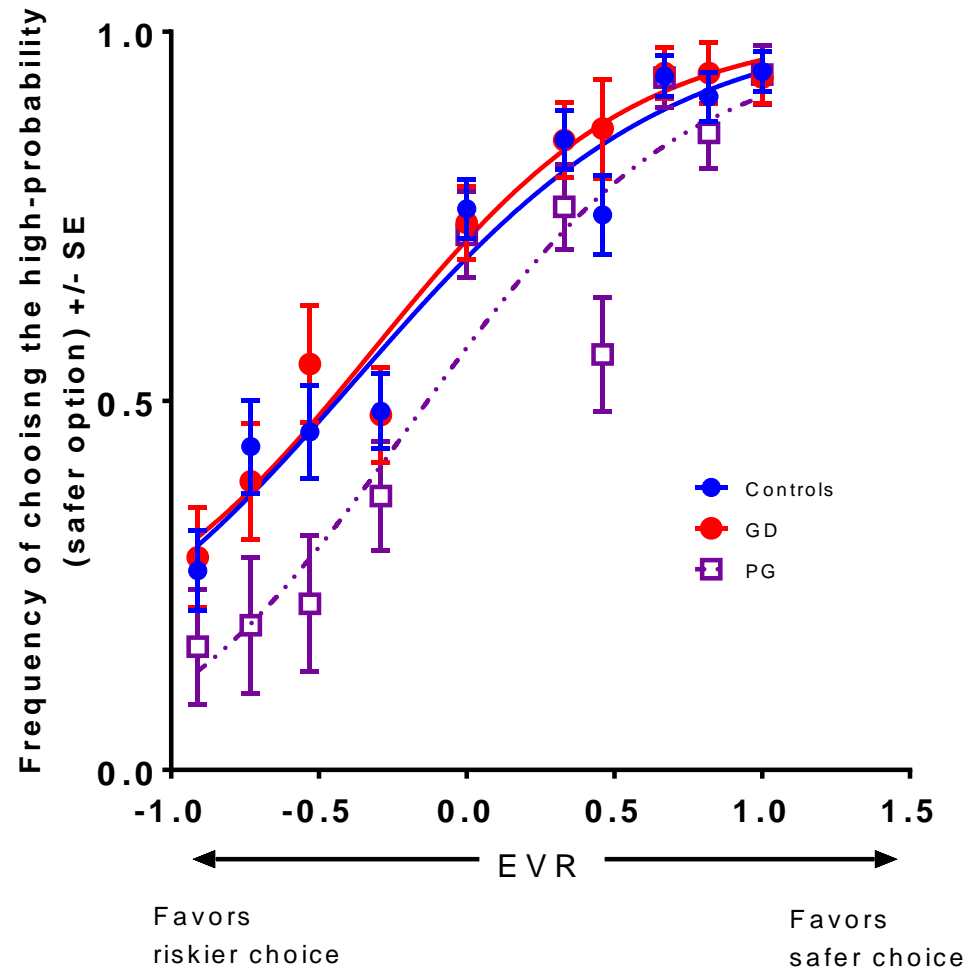


Longitudinal clinical follow-up

Can we predict clinical course from decision making and reactivity to sensory features?



Heterogeneity of risk attitudes





Conclusions & future directions

- Are problem gamblers more susceptible to the effects of sensory features
- Do these features differentially modulate arousal in problem gamblers?
- How is response to sensory features related to individual differences and clinical heterogeneity in problem gambling?
- How is it related to clinical course?
- What are the neural substrates?



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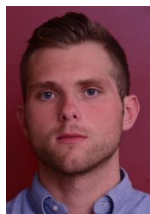
Acknowledgments



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Alaa Akl

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- Allison Rice
- Denis Dion

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Game Sense

Centre for Gambling Research



Luke Clark



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