Risky decision making is associated with residential choice in healthy older adults.

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Background

- The BART has been shown to be a valid predictor of risk behaviors in a variety of populations[1,2,3].
- Computational models have been developed to examine the cognitive processes underlying performance on the BART[4].
- Age-related deficits in risky decision-making have been linked to learning [5].
- Older adults have been found to be more risk-avoidant than young adults on the BART[6,7], however this may change under conditions of high risk[8].

Aim

We sought to examine differences in risky decision making between two groups of healthy older adults using both traditional measures of risk taking and computational modeling.

Methods

Balloon Analogue Risk Task (BART)[1,9]

- Participants are asked to press one button to inflate the balloon or another button to "cash out" for that trial.
  - If pump is successful, 10 points are added to a temporary bank.
  - If balloon explodes, all points in temporary bank are lost.
  - If participant cashes out, all points in temporary bank are added to Total Points.
- 30 balloons (trials)
- Average explosion point was set to 64 pumps in program.

Wallsten, et al., Model 3[4,9]

- Wallsten and colleagues (2005) developed 24 different "cognitive" computational models of BART behavior.
- They tested 8 of these models on a sample of young adults.
- The winning model (Model 3) has the following characteristics:
  - Assumes stationary outcome probabilities.
  - Update probabilities in a Bayesian fashion.
  - Evaluates choice policies prior to each balloon.
  - Maintain constant response sensitivity.
- Age has been shown to be a significant predictor of participants' *a priori* estimates that the balloon would not explode on the first pump[7].
  - Older adults were more risk averse at the beginning of the task than young adults.
  - Older adults were less confident in their initial estimates than young adults.

Groups

- **Senior Living Community (SLC)** older adults
  - Tested at Friendship Terrace Senior Living Community
- **Independent, Community-Dwelling (ICD)** older adults
  - Tested at The Catholic University of America
  - Median split on age (M = 69.00)

Group	*N*	Age*	Education	BDS	NAART	Gender
ICD "Old-Old"	22	74.68	16.41	6.59	12.25††	13F, 9M
ICD "Young-Old"	20	64.95	16.85	7.10	10.00	13F, 7M
SLC	23	79.91†	15.52	6.22	13.43	17F, 6M
		$F(2,64)$ = 24.95, p <.001	$F(2,62)$ = 1.40, p = .254	$F(2,62)$ = .843, p = .435	$F(2,62)$ = 1.12, p = .332	$X^2(2, N = 65)$ = 1.12, p = .571

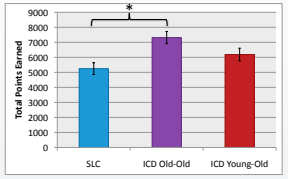
*significant difference between groups
†Missing one participant's age
††Missing two participant's NAART scores

Results

Traditional Measures of Risk Taking

Total Number of Points

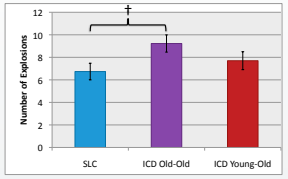
- Total number of points earned during the task.



- SLC older earned significantly less points than ICD Old-Older adults.
  - Group: $F(2,62) = 6.75$, $p = .002$

Number of Explosions

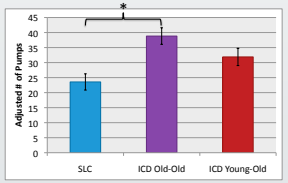
- Number of times a balloon exploded.



- SLC older adults popped marginally less balloons than ICD Old-Older adults.
  - Group: $F(2,62) = 2.78$, $p = .070$

Adjusted Number of Pumps

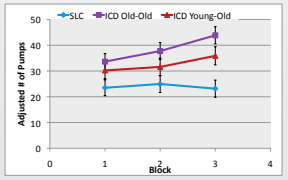
- Average number of times pumped on each balloon.
- Trials where the balloon exploded excluded



- SLC older adults pumped significantly less on trials than ICD Old-Older adults.
  - Group: $F(2,62) = 7.90$, $p = .001$

Adjusted Number of Pumps by Block

- 30-balloon session broken into 3 10-balloon blocks



- Group differences in learning.
  - Group*Block: $F(4,122) = 2.14$, $p = .088$, $\eta_p^2 = .065$
- ICD Old-Older adults increased risk-taking across blocks while other groups did not.
  - ICD Old-Old Block: $F(2,42) = 6.06$, $p = .005$, $\eta_p^2 = .224$
  - ICD Young-Old Block: $F(2,38) = 1.68$, $p = .201$, $\eta_p^2 = .081$
  - SLC Block: $F(2,42) = .44$, $p = .650$, $\eta_p^2 = .020$

Computational Modeling

Model Parameters

θ (beta)
- Behavioral consistency parameter
- Higher values reflect more deterministic responding.

γ^+ (gamma)
- Reward sensitivity parameter
- Higher values reflect more pumping.

α (alpha) and μ (mu)
- Two learning-related parameters
- Used to calculate a beta distribution of *a priori* probability characterized by q_1 and var(q_1).

$q_1 = \alpha_0 / m_0$
- The subject's initial estimate of the likelihood that the balloon will *not* explode.
- Higher values means the subject is more risk-seeking on the first pump.

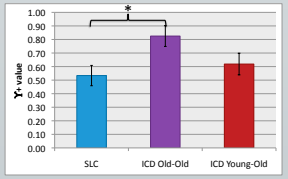
var(q_1) = $(\alpha_0 (m_0 - \alpha_0)) / (m_0^2 (m_0 + 1))$
- The subject's confidence in the their initial estimate.
- Higher values mean the subject is *less* confident in their initial estimate.

Model Results

- Model fit using maximum likelihood estimation.

q_1
- Older age is associated with more risk-avoidant initial estimates.
  - Age and q_1: $R^2 = -.328$, $p = .008$

var(q_1)
- Older age is associated with less confidence in initial estimate.
  - Age and var(q_1): $R^2 = .353$, $p = .004$



γ^+ (gamma)
- SLC are significantly less sensitive to gains than ICD Old-Older adults.
  - γ^+ Group: $F(2,62) = 3.87$, $p = .026$

Discussion

- Using traditional measures of risk taking, we found SLC older adults were more risk-averse than ICD older adults.
  - This effect is driven by the ICD old-older adults.
  - This could be due to reduced learning during the task.
- Using computational modeling, we found SLC older adults were less sensitive to gains than ICD older adults.
- There was also a significant relationship between age and the participant's initial estimate of risk within the entire sample.
  - Older age was associated with greater risk-aversion at the beginning of the task.
  - Older age was associated with less confidence in this initial risk estimate.
  - This replicates a previous study that found similar relationships in a sample of young and older adults[7].
- Suggests the living choices made by older adults could be influenced by their risk-taking propensity.
- Further analysis suggests differences in risk taking could be related to learning deficits, driven by a difference in reward sensitivity.

Future Directions

- Replicate these results in a larger sample.
  - Potentially examine other groups of older adults who make other kinds of residential choices (i.e. Capital Hill Village)
- Investigate other measures along with the BART.
  - Decision making tasks that encourage risk-aversion (i.e. IGT).
  - Pure learning tasks without rewards (i.e. TLT).
- Investigate other computational models designed for the BART.
  - Expectancy-Valence Model for BART[7]
  - Walsten, et al., Model 1[4]
- Use hierarchical Bayesian modeling to fit parameters[8].

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