Neuroimaging of Financial Vulnerability in Old Age

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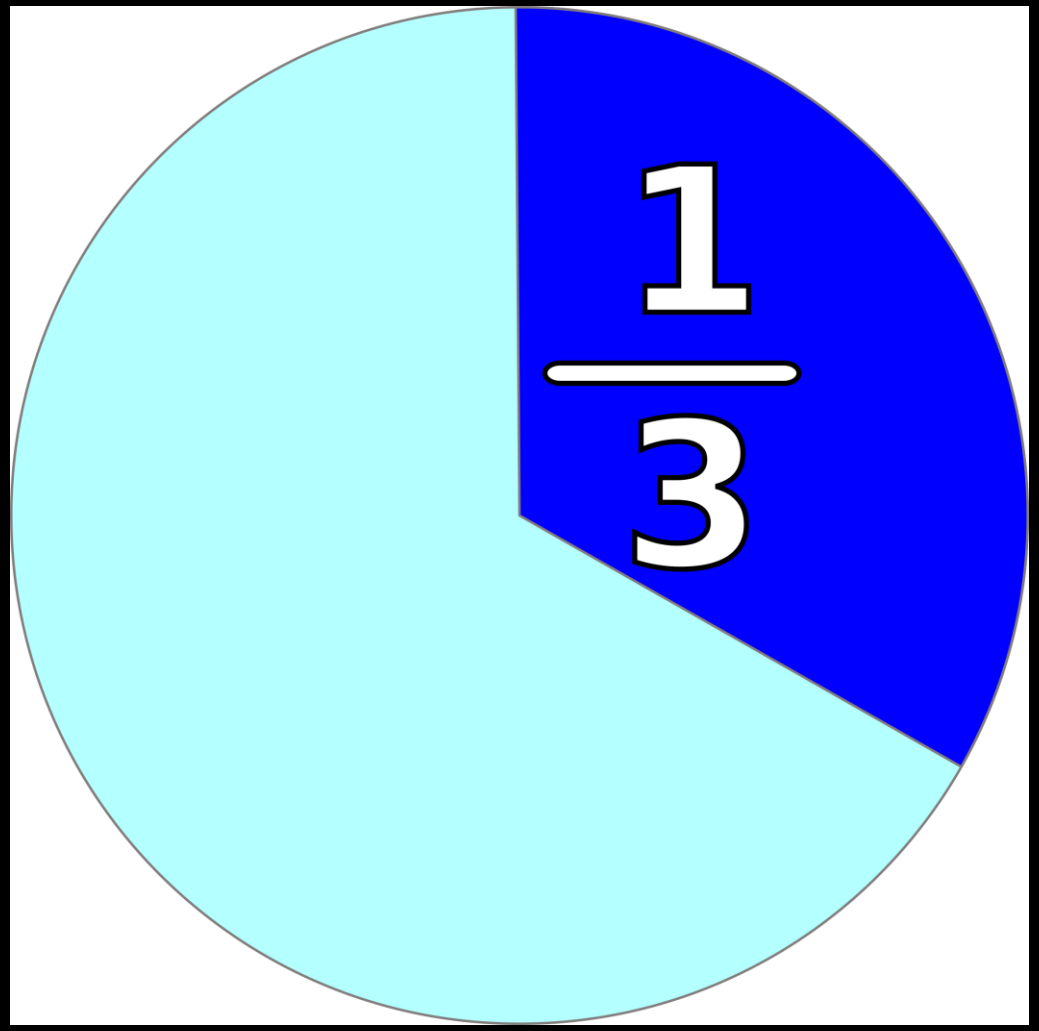
USC Judith D. Tamkin Symposium
February 27, 2020

Background



Laibson, 2011

Background

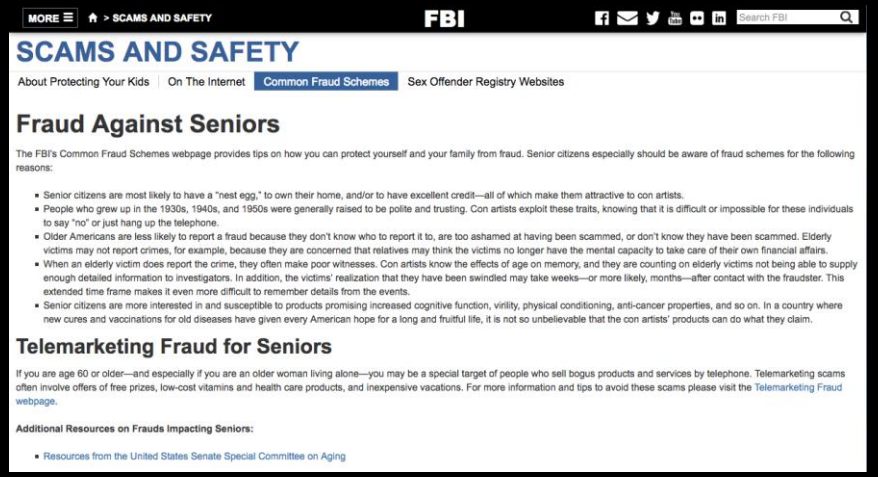
Metlife, Inc., 2011;True Link Financial, Inc., 2015

Background

- Adults over the age of 65 hold 18.1 trillion of the 53.1 trillion (approximately 1/3rd) in U.S. household net worth (Laibson, 2011).

- A portion of older adults lose more than $3 billion annually to financial scam or fraud (Metlife Inc., 2011), and some estimate this to be as high as $36 billion (True Link Financial, 2015).

- The problem of financial and healthcare fraud targeted at elderly persons is so significant that the FBI maintains a website dedicated to the problem:



Rationale

If an older adult becomes a victim of a scam, the burden is not only experienced by the older adult, but is often displaced upon family members, caregivers, and society.

Therefore, understanding the susceptibility of older persons to fraud is a significant public health and policy concern, as this understanding may inform prevention and intervention strategies to promote health and wellbeing of older adults.

- *How can we understand this?*

Brain Structure Changes As We Age

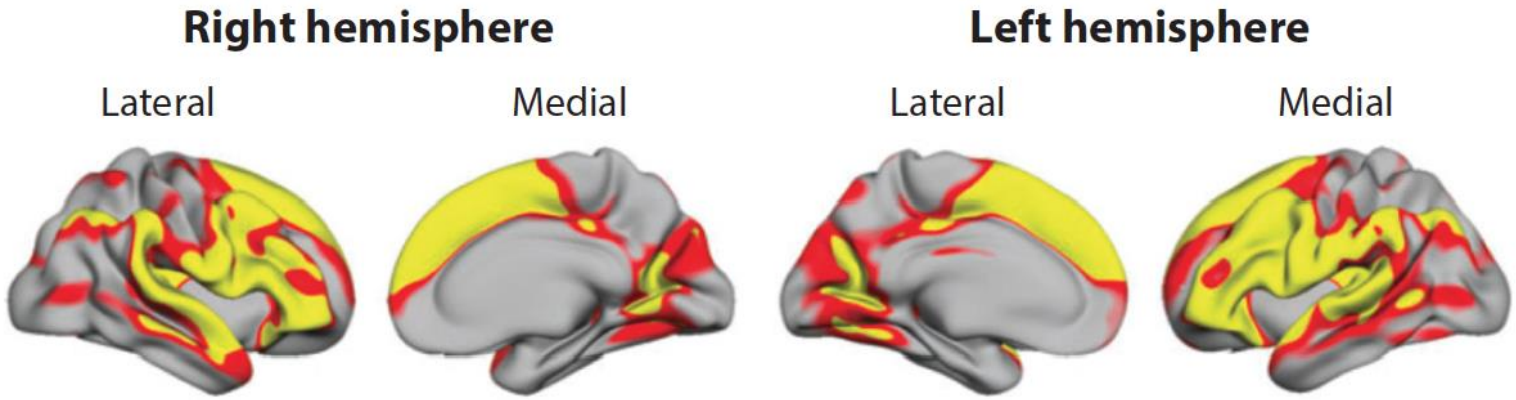
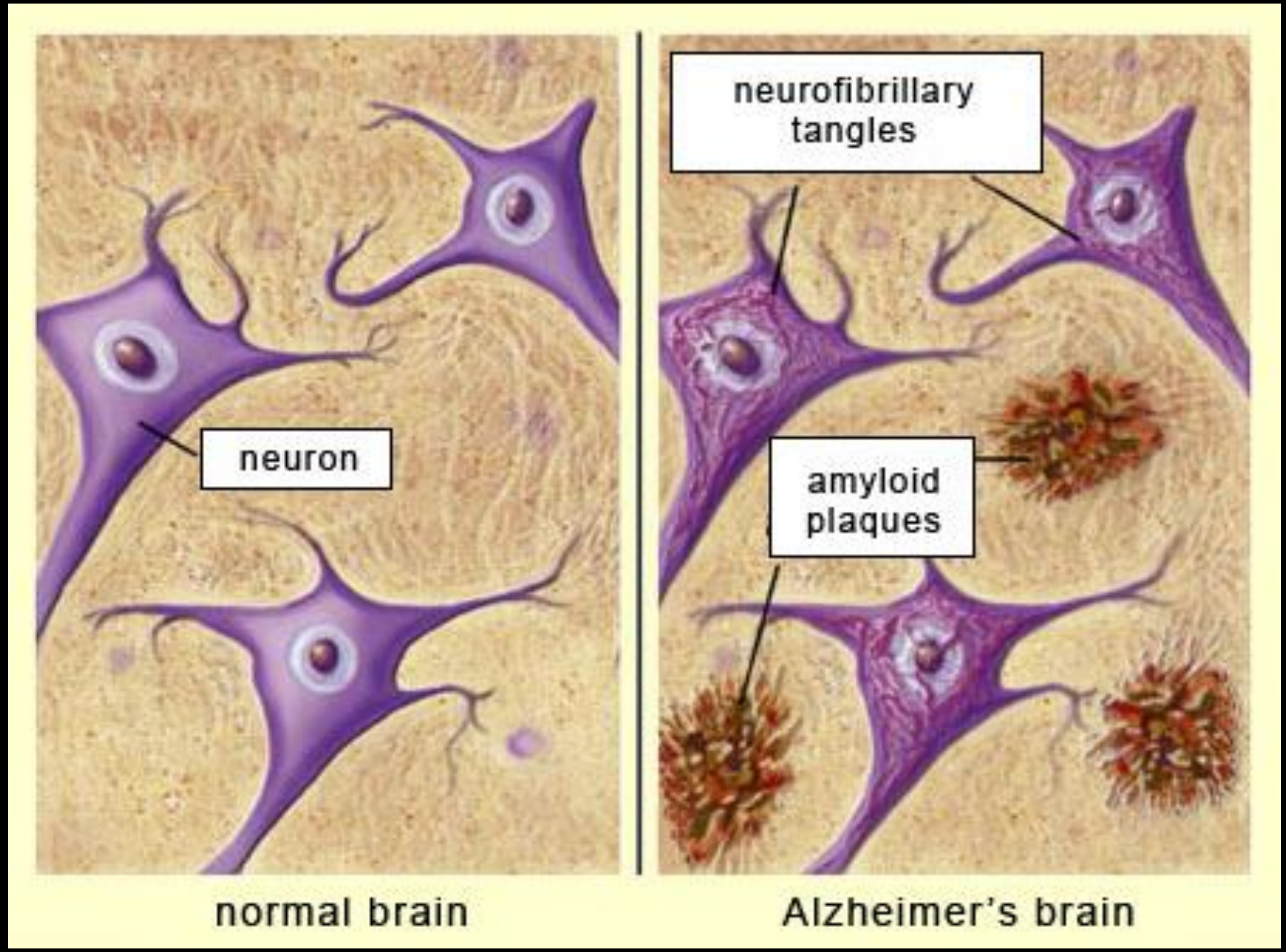
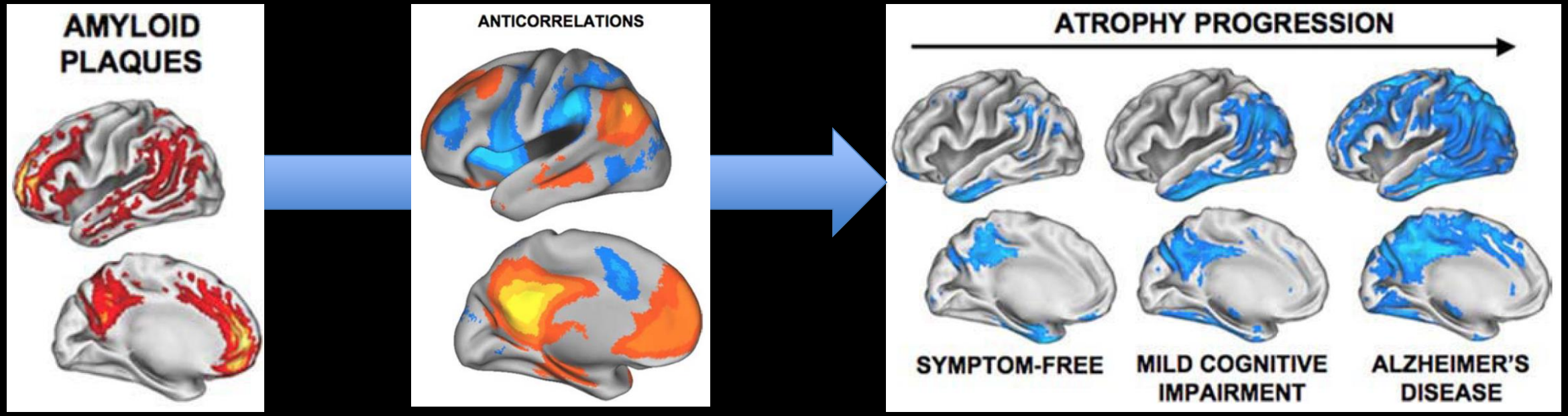


Figure 2

Brain regions shown in yellow are those that exhibited the largest decline in cortical thickness with age across a sample of 883 participants ranging in age from 18 to 94 (Fjell et al. 2009b).


neuron
neurofibrillary tangles
amyloid plaques
normal brain
Alzheimer's brain

Age-Associated Neuropathology



Buckner et al., 2008; Buckner et al., 2005; Lustig et al., 2003

18008 • The Journal of Neuroscience, November 13, 2013 • 33(46):18008–18014

Neurobiology of Disease

Changes in Brain Function Occur Years before the Onset of Cognitive Impairment

Lori L. Beason-Held,[1] Joshua O. Goh,[1,2] Yang An,[1] Michael A. Kraut,[3] Richard J. O'Brien,[4] Luigi Ferrucci,[1] and Susan M. Resnick[1]

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Peters and Buchel, 2011
+ Age-Associated Neuropathology

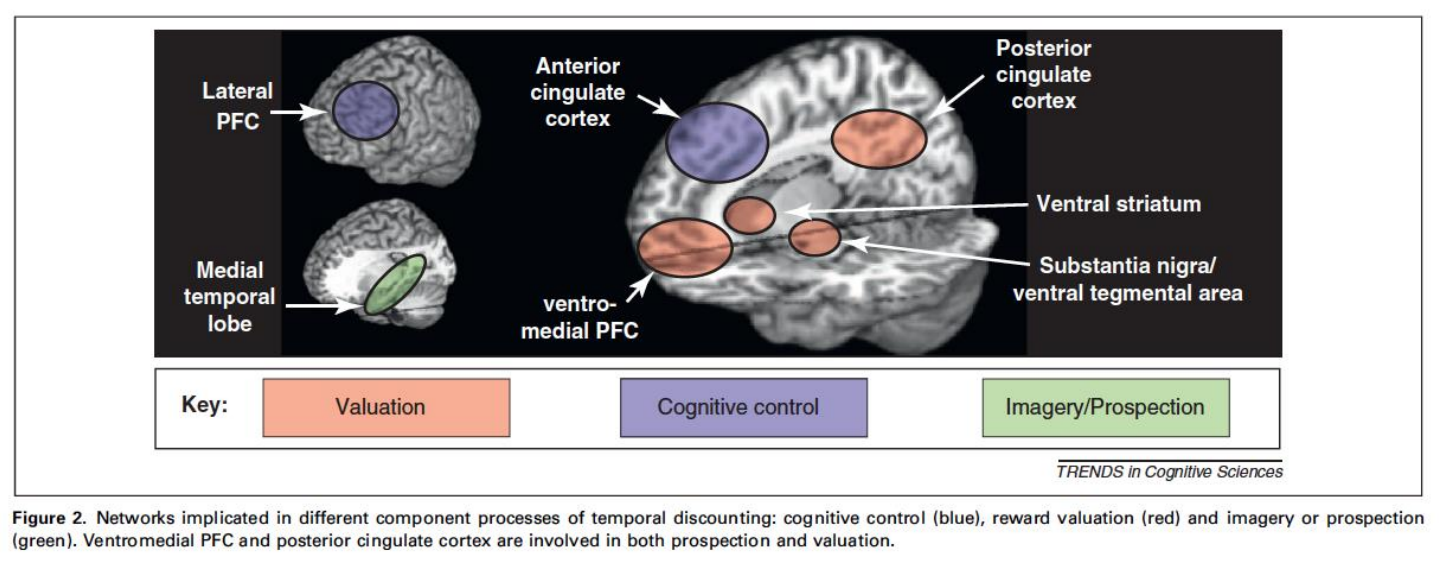
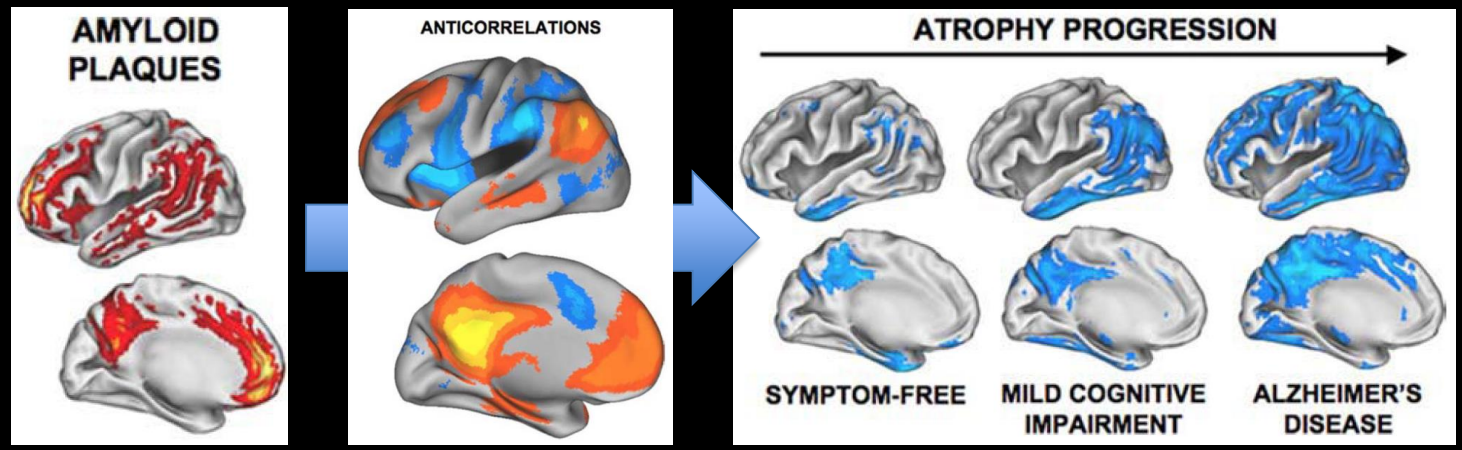
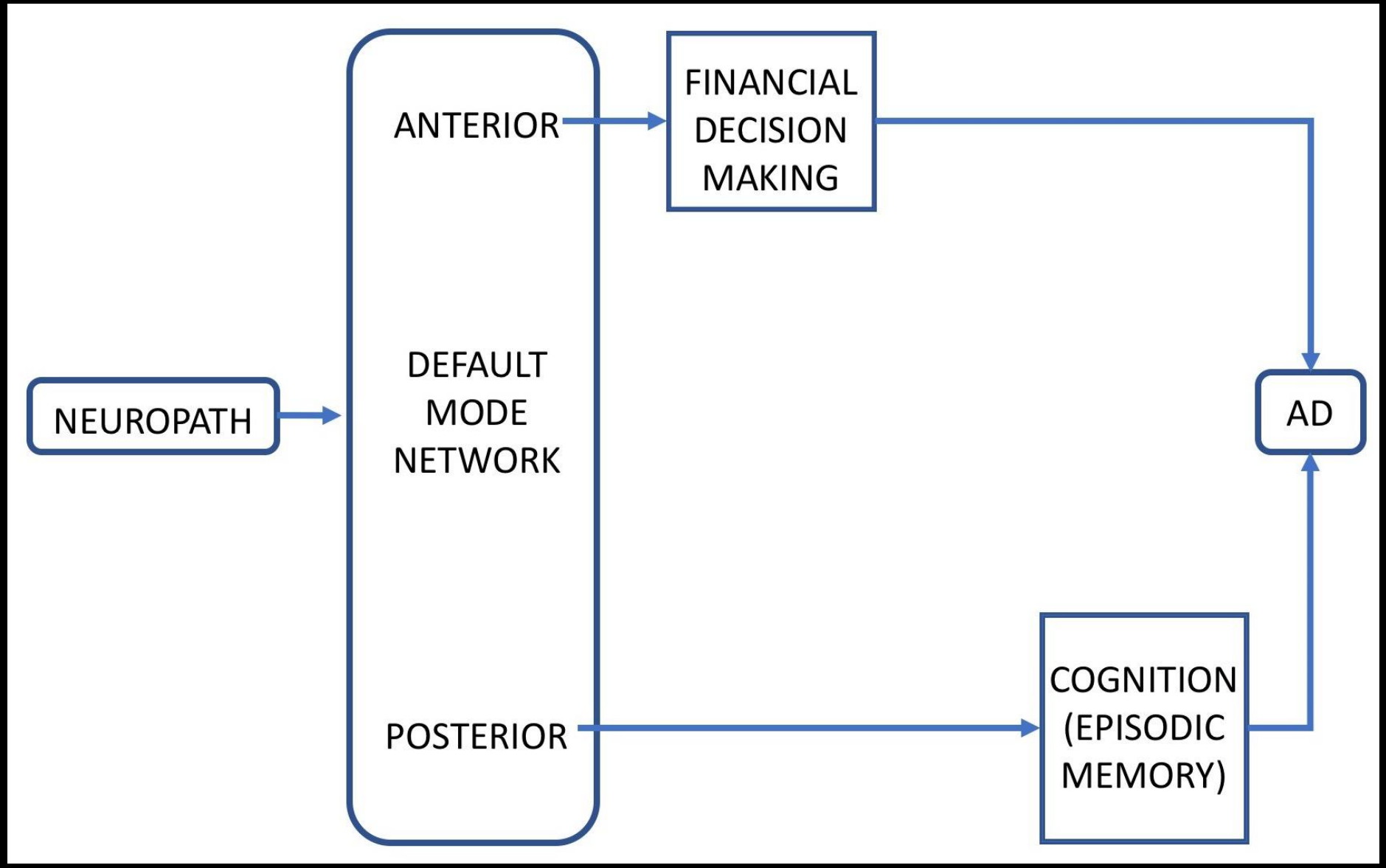


Figure 2. Networks implicated in different component processes of temporal discounting: cognitive control (blue), reward valuation (red) and imagery or prospection (green). Ventromedial PFC and posterior cingulate cortex are involved in both prospection and valuation.

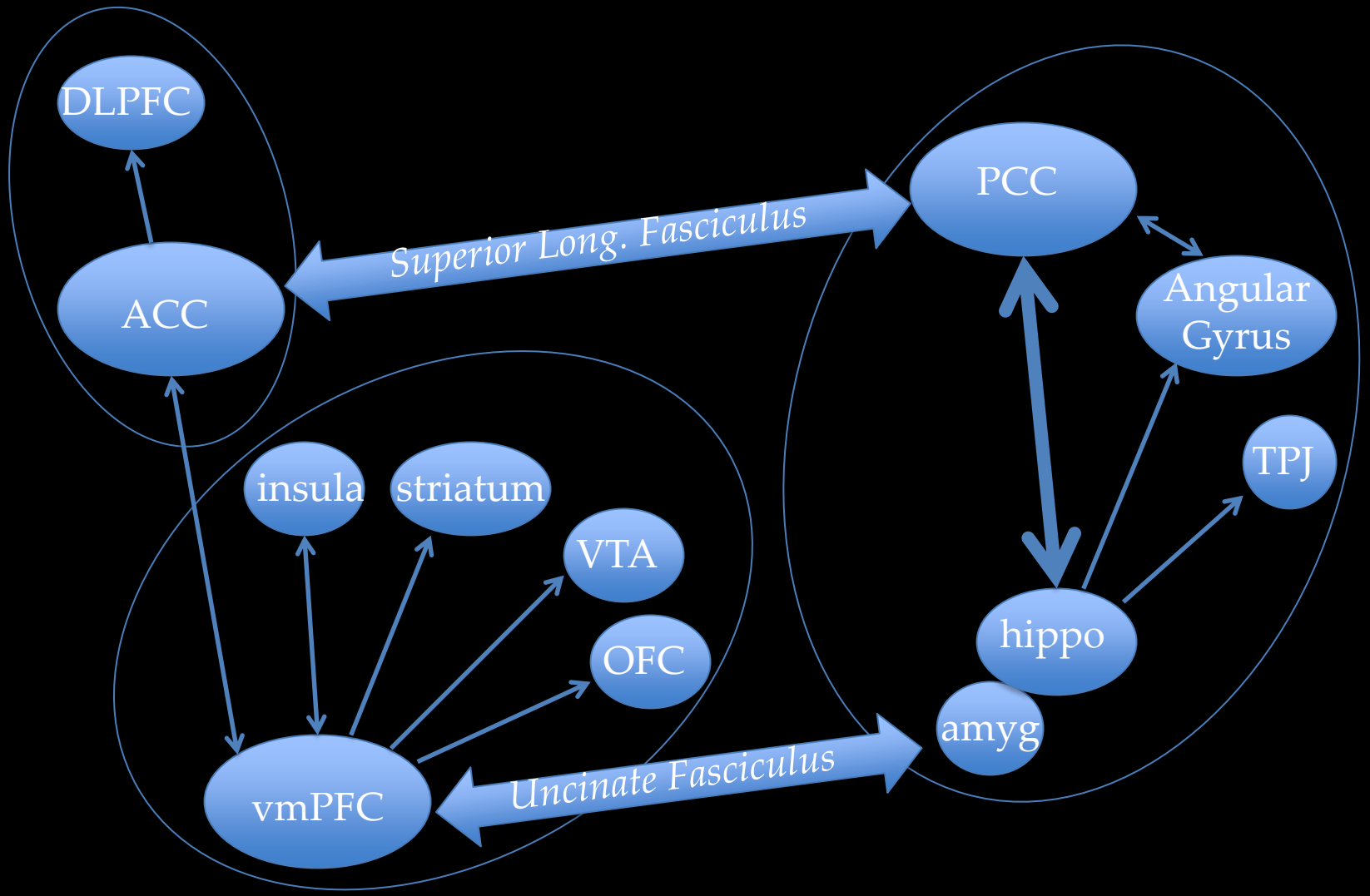


Buckner et al., 2008; Buckner et al., 2005; Lustig et al., 2003

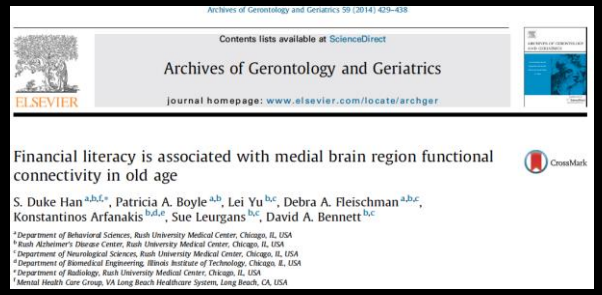
Model of Financial Vulnerability in Old Age



Model of Financial Vulnerability in Old Age



Neuroimaging Work to Date with Rush ADC Cohorts



Archives of Gerontology and Geriatrics 59 (2014) 429–438

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

Financial literacy is associated with medial brain region functional connectivity in old age

S. Duke Han [a,b,f,*], Patricia A. Boyle [a,b], Lei Yu [b,c], Debra A. Fleischman [a,b,c], Konstantinos Arfanakis [b,d,e], Sue Leurgans [b,c], David A. Bennett [b,c]

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Experimental Gerontology 48 (2013) 1489–1498

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Experimental Gerontology

journal homepage: www.elsevier.com/locate/expgero

Ventromedial PFC, parahippocampal, and cerebellar connectivity are associated with temporal discounting in old age

S. Duke Han [a,b,c,f,*], Patricia A. Boyle [a,b], Lei Yu [b,c], Debra A. Fleischman [a,b,c], Konstantinos Arfanakis [b,d,e], David A. Bennett [b,c]

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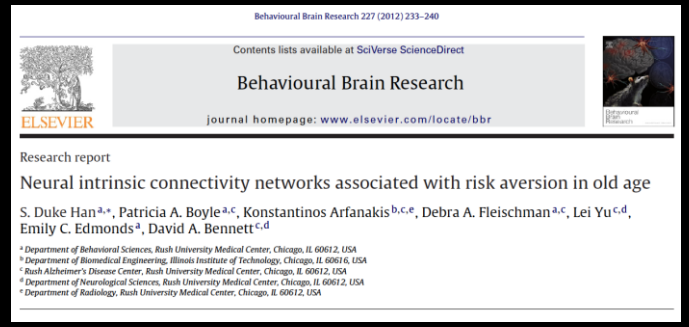
Brain Imaging and Behavior (2016) 10:524–532
DOI 10.1007/s11682-015-9422-4

ORIGINAL RESEARCH

Grey matter correlates of susceptibility to scams in community-dwelling older adults

S. Duke Han [1,2,3,4] · Patricia A. Boyle [1,2] · Lei Yu [1,3] · Konstantinos Arfanakis [6,7] · Bryan D. James [1,5] · Debra A. Fleischman [1,2,3] · David A. Bennett [1,3]



Behavioural Brain Research 227 (2012) 233–240

Contents lists available at SciVerse ScienceDirect

Behavioural Brain Research

journal homepage: www.elsevier.com/locate/bbr

Research report

Neural intrinsic connectivity networks associated with risk aversion in old age

S. Duke Han [a,*], Patricia A. Boyle [a,c], Konstantinos Arfanakis [b,c,e], Debra A. Fleischman [a,c], Lei Yu [c,d], Emily C. Edmonds [a], David A. Bennett [c,d]

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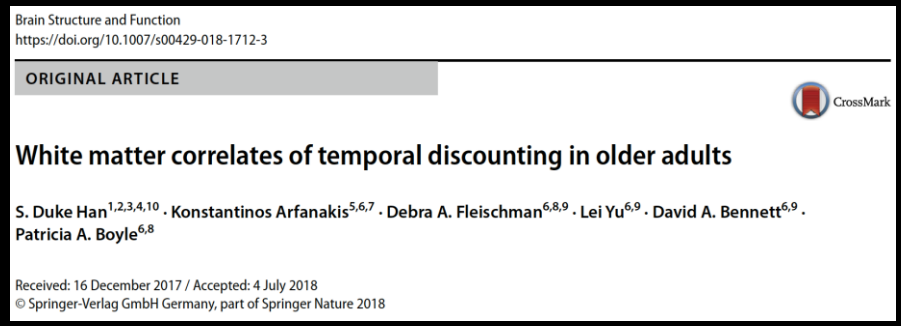
[e] Department of Radiology, Rush University Medical Center, Chicago, IL 60612, USA



Brain Structure and Function
https://doi.org/10.1007/s00429-018-1712-3

ORIGINAL ARTICLE

White matter correlates of temporal discounting in older adults

S. Duke Han [1,2,3,4,10] · Konstantinos Arfanakis [5,6,7] · Debra A. Fleischman [6,8,9] · Lei Yu [6,9] · David A. Bennett [6,9] · Patricia A. Boyle [6,8]

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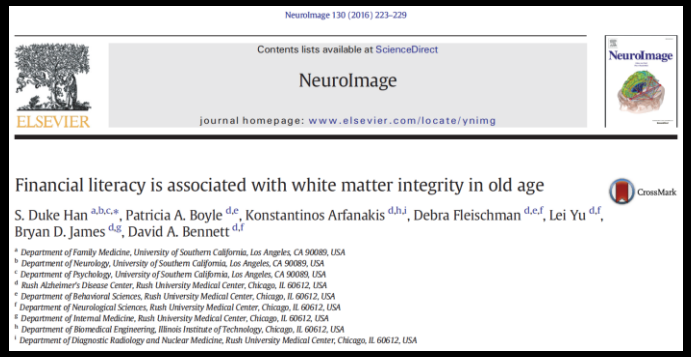

NeuroImage 130 (2016) 223–229

Contents lists available at ScienceDirect

NeuroImage

journal homepage: www.elsevier.com/locate/ynimg

Financial literacy is associated with white matter integrity in old age

S. Duke Han [a,b,c,*], Patricia A. Boyle [d,e], Konstantinos Arfanakis [d,h,i], Debra Fleischman [d,e,f], Lei Yu [d,f], Bryan D. James [d,g], David A. Bennett [d,f]

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Brain Imaging and Behavior
https://doi.org/10.1007/s11682-019-00079-7

ORIGINAL RESEARCH

White matter correlates of scam susceptibility in community-dwelling older adults

Melissa Lamar [1,2] · Konstantinos Arfanakis [1,3,4] · Lei Yu [1,5] · Shengwei Zhang [1] · S. Duke Han [1,2,5,6,7,8,9] · Debra A. Fleischman [1,2,5] · David A. Bennett [1,5] · Patricia A. Boyle [1,2]

Susceptibility to Scams

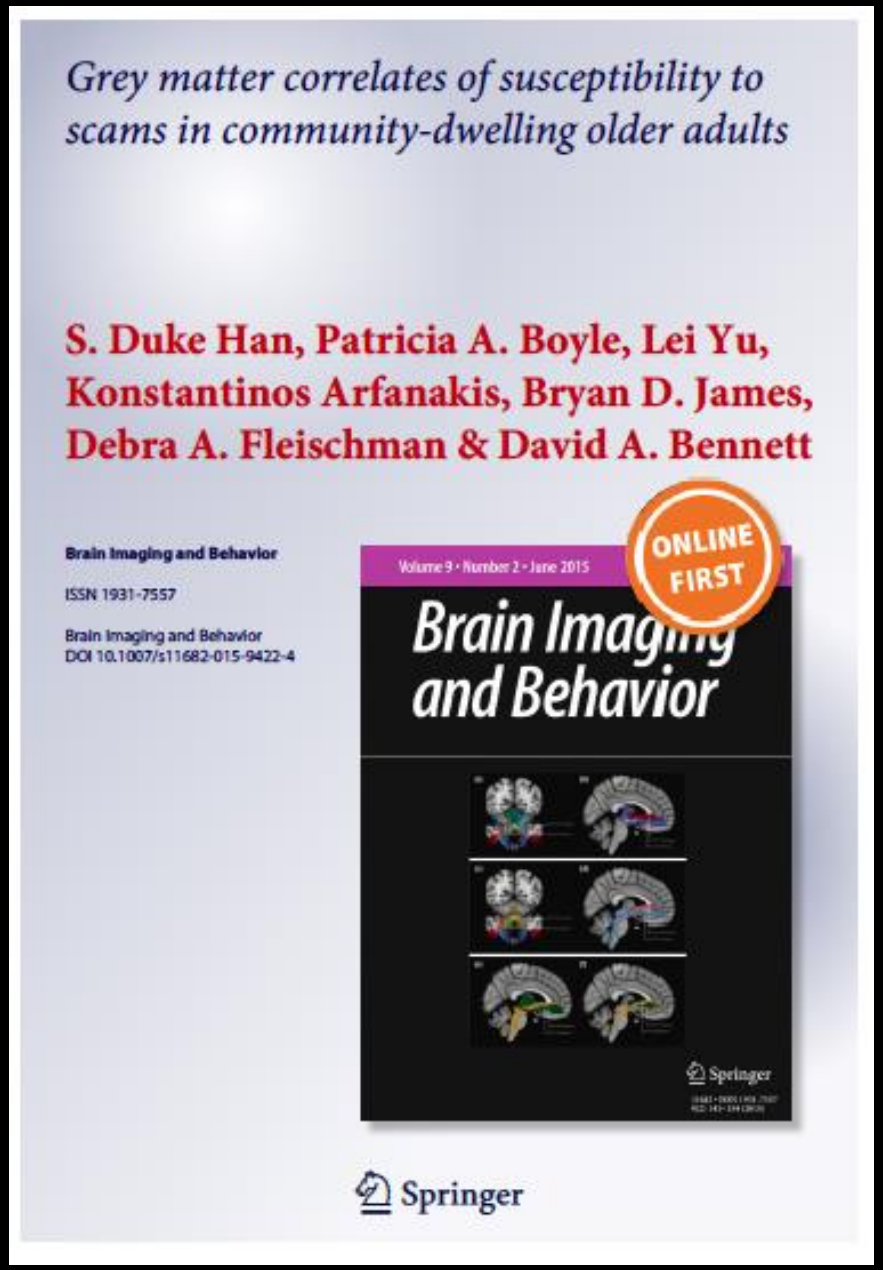
Brain Imaging and Behavior
DOI 10.1007/s11682-015-9422-4

ORIGINAL RESEARCH

Grey matter correlates of susceptibility to scams in community-dwelling older adults

S. Duke Han[1,2,3,4] · Patricia A. Boyle[1,2] · Lei Yu[1,3] · Konstantinos Arfanakis[6,7] · Bryan D. James[1,5] · Debra Fleischman[1,2,3] · David A. Bennett[1,3]

- Voxel-based morphometry (VBM) to assess grey matter density at the voxel level
- N=348 nondemented older adults
- Mean age=81.55, s.d.=7.25; mean number of years of education=15.30, s.d=2.91; 74.10% female



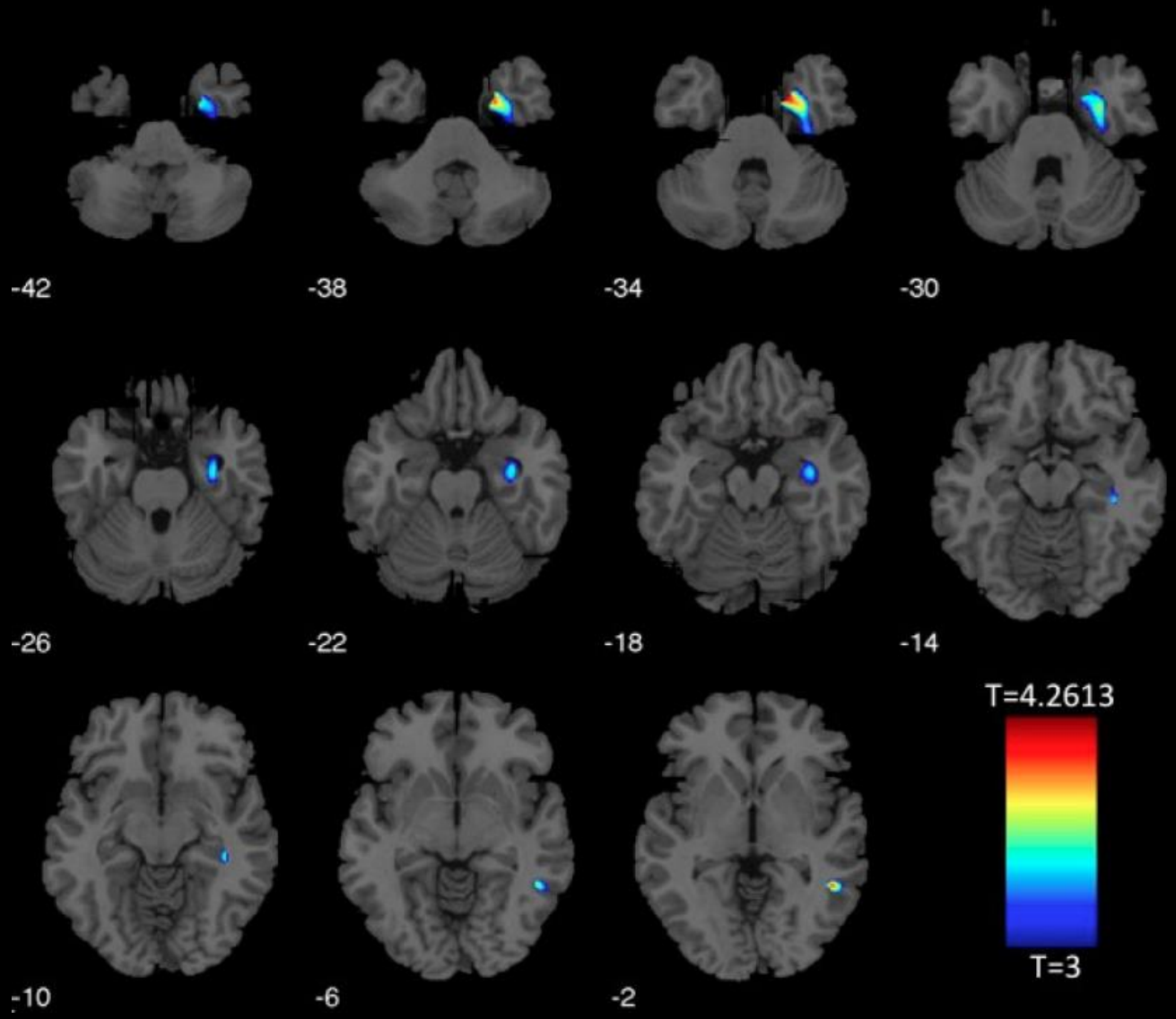
Assessment of susceptibility to scams

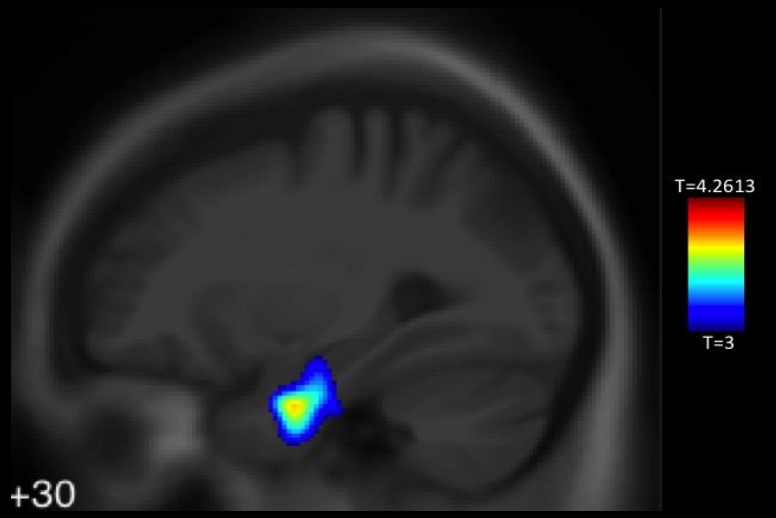
The susceptibility to scams scale is a five-item self-report measure in which participants rated their agreement to a statement according to a 7-point Likert scale (strongly agree to strongly disagree). The five statements included in the measure have been previously reported (James et al. 2014) and address topics such as telemarketing behaviors, older adults being targeted by con-artists, and suspiciousness of claims that seem too good to be true. The statements are:

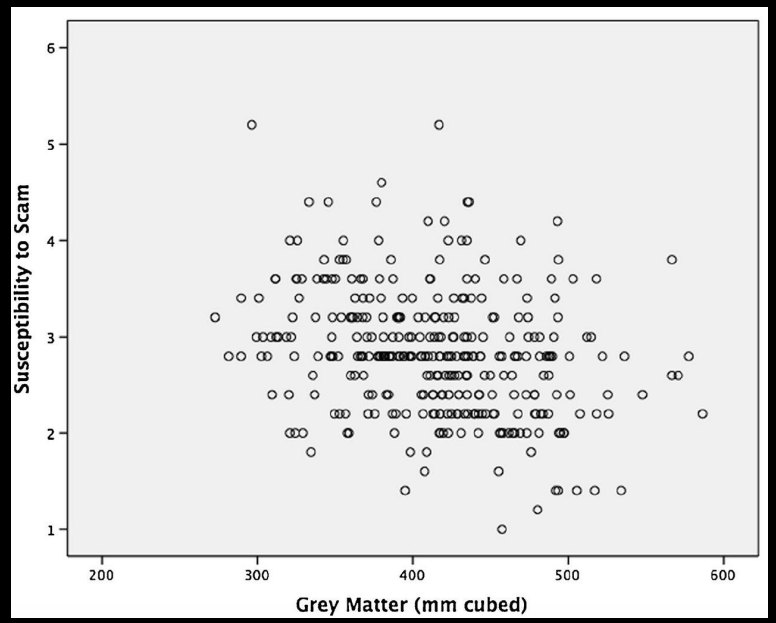
1. I answer the phone whenever it rings, even if I do not know who is calling.
2. I have difficulty ending a phone call, even if the caller is a telemarketer, someone I do not know, or someone I did not wish to call me.
3. If something sounds too good to be true, it usually is.
4. Persons over the age of 65 are often targeted by con-artists.
5. If a telemarketer calls me, I usually listen to what they have to say.

Each question corresponds to a Likert scale and has a total possible range of 1 to 7 (1 = strongly agree, 2 = agree, 3 = slightly agree, 4 = neither agree or disagree, 5 = slightly disagree, 6 = disagree, 7 = strongly disagree). The total score for susceptibility to scams was calculated by averaging the five items (with items 1, 2, and 5 reverse coded). The statements were based generally on findings from the AARP and the Financial Industry Regulatory Authority Risk Meter, a measure of poor and risky financial decision making that is widely used in finance studies (AARP 1999; Financial Industry Regulatory Authority 2013). The intraclass correla-

Susceptibility to Scams - Grey Matter Density

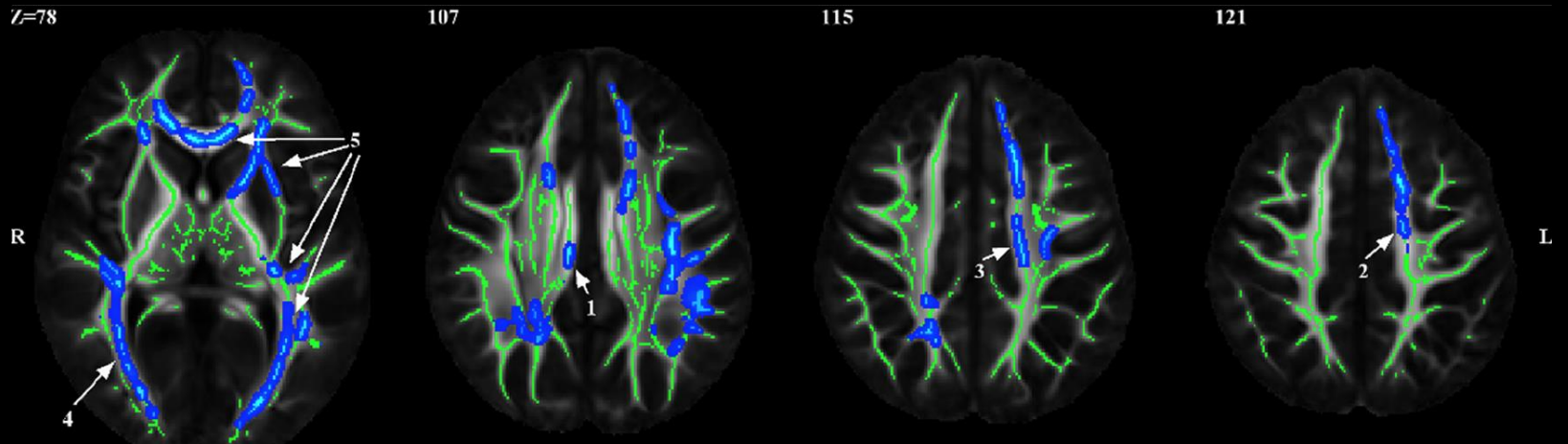




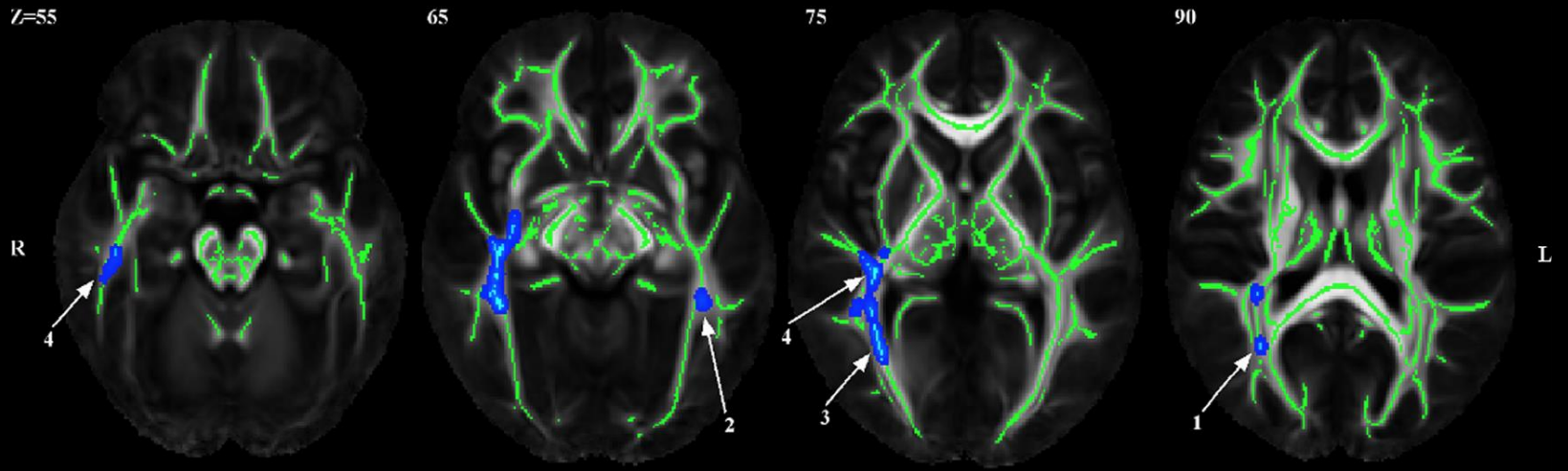


Han et al., 2016

Susceptibility to Scams –White Matter Integrity



FA (age, education, sex)



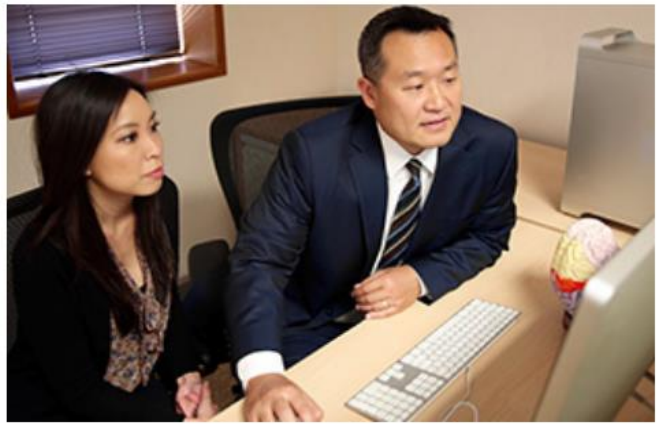
FA (age, education, sex, global cognition)

Melissa Lamar et al., 2018

The Finance, Cognition, and Health in Elders Study: Toward Preventing Financial Exploitation of Older Adults

By Gali H. Weissberger and S. Duke Han

February 28, 2018



Why is financial exploitation so common in the elderly population? Why do some older adults fare better than others when making financial decisions? What factors protect or place one at greater risk of being financially exploited? These are just some of the questions that a multidisciplinary team of investigators hope to answer through the Finance, Cognition, and Health in Elders Study (FINCHES) being carried out through USC's Department of Family Medicine.

With strong support from the Elder Justice Foundation

See www.hanresearchlab.com for more details

- The Value of Adding a Service Advocate to the Forensic Center
- Coordinated response to help tribal elder victims of abuse needed: How do we address limited community services and supports?

Finance, Cognition, and Health in Elders Study (FINCHES)

- The overall goal of FINCHES is to examine the association between financial exploitation in old age and physical, emotional, cognitive, and brain health outcomes.
- Non-cognitively impaired older adults who have experienced financial exploitation (FE) are recruited from the community and demographically matched to control participants.
- Methods include physical and mental health surveys, neuropsychological and neuroimaging assessments, and qualitative methodology.
- Pilot data collection began in 2017 with support from the Elder Justice Foundation, current enrollment: 33 with FE and 26 controls.
- Groups do not differ on demographic variables of age (FE: M=68.55, SD=11.99; non-FE: M=67.73, SD=11.81; t=0.261, p=0.79), education (FE: M=15.76, SD=2.52; non-FE: M=15.46, SD=2.76; t=0.429, p=0.66), sex (FE: 23 female/10 male; non-FE: 11 female/10 male, X2=3.416, p=0.06), and race (FE: White=23; Black=2; Asian=5; Other=1; non-FE: White=15; Black=3; Asian=3; Other=1; X2=2.908, p=0.71).

ELDER JUSTICE FOUNDATION

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www.elderjusticefoundation.org

AGING & MENTAL HEALTH
https://doi.org/10.1080/13607863.2019.1571020

Routledge
Taylor & Francis Group

Check for updates

Physical and mental health correlates of perceived financial exploitation in older adults: Preliminary findings from the Finance, Cognition, and Health in Elders Study (FINCHES)

Gali H. Weissberger[a], Laura Mosqueda[a], Annie L. Nguyen[a], Anya Samek[b], Patricia A. Boyle[c,d], Caroline P. Nguyen[a] and S. Duke Han[a,c,e,f,g]

[a]Department of Family Medicine, USC Keck School of Medicine, Alhambra, CA, USA; [b]Center for Economic and Social Research, University of Southern California, Los Angeles, CA, USA; [c]Rush Alzheimer's Disease Center, Rush University Medical Center, Chicago, IL, USA; [d]Department of Behavioral Sciences, Rush University Medical Center, Chicago, IL, USA; [e]Department of Psychology, USC Dornsife College of Letters, Arts, and Sciences, Los Angeles, CA, USA; [f]USC School of Gerontology, Los Angeles, CA, USA; [g]Department of Neurology, USC Keck School of Medicine, Los Angeles, CA, USA

ABSTRACT

Objectives: Financial exploitation (FE) in old age is poorly understood, particularly among those without significant cognitive impairment. The Finance, Cognition, and Health in Elders Study (FINCHES) aims to identify factors associated with FE among cognitively-healthy older adults. Preliminary findings regarding physical and mental health correlates in the pilot phase of FINCHES are reported.

Method: Sixteen older adults who self-reported FE were demographically-matched on age, education, sex, and race/ethnicity to eighteen older adults who did not report past FE.

Results: Those who believed they were exploited endorsed significantly greater symptoms of depression ($p = 0.014$) and marginally greater symptoms of anxiety ($p = 0.062$). Participants trended towards lower perceived successful aging ($p = 0.094$). Perceived FE participants also endorsed greater medical conditions ($p = 0.047$), but follow-up individual item analyses suggest that this was driven by problems with sleep ($p = 0.030$).

Conclusions: These preliminary findings from the pilot phase of FINCHES highlight negative mental health factors associated with perceived FE among cognitively-intact older adults.

ARTICLE HISTORY
Received 26 October 2018
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KEYWORDS
Financial exploitation; aging; mental health; physical health; sleep

Physical Frailty and Financial Exploitation

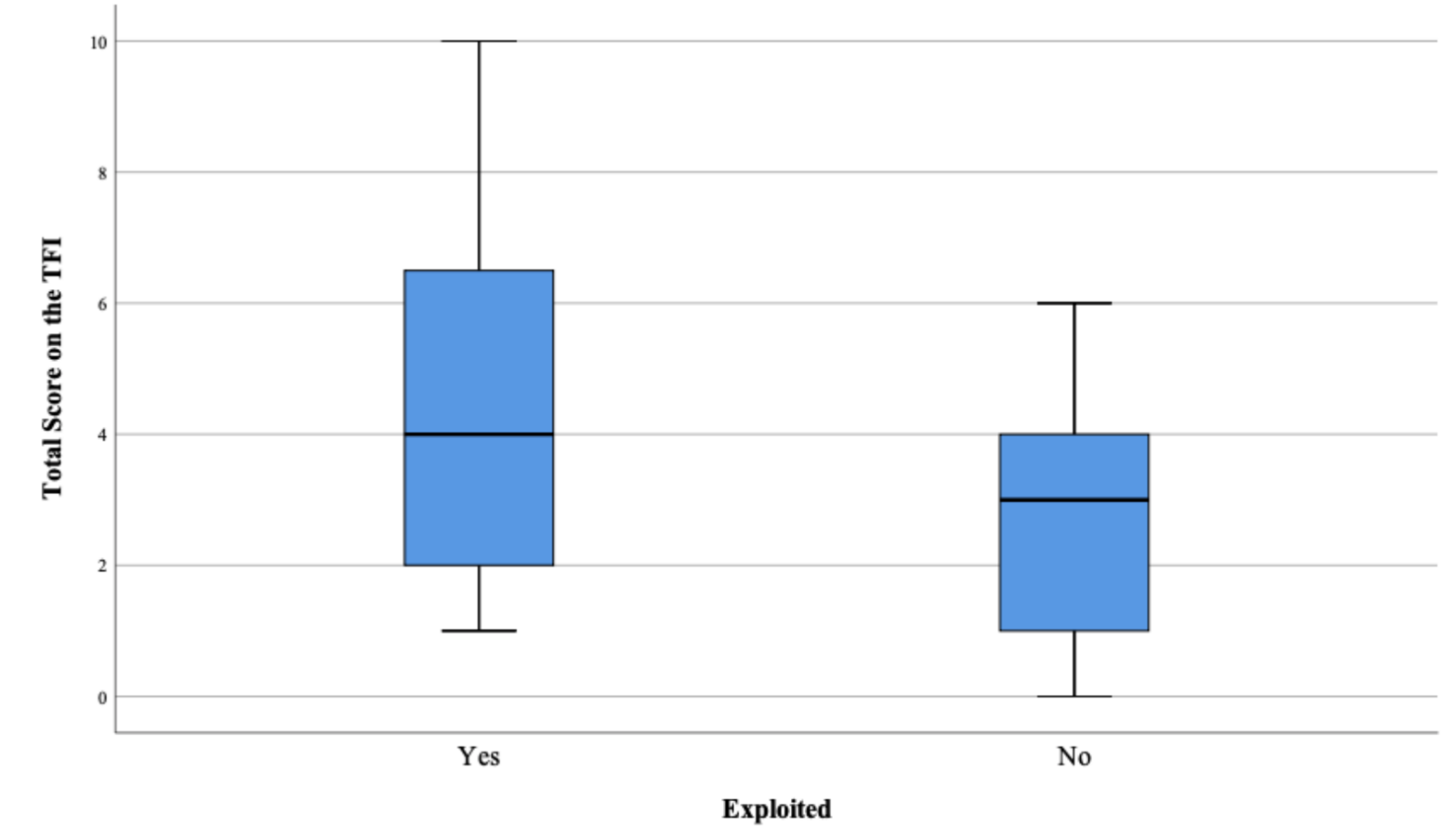


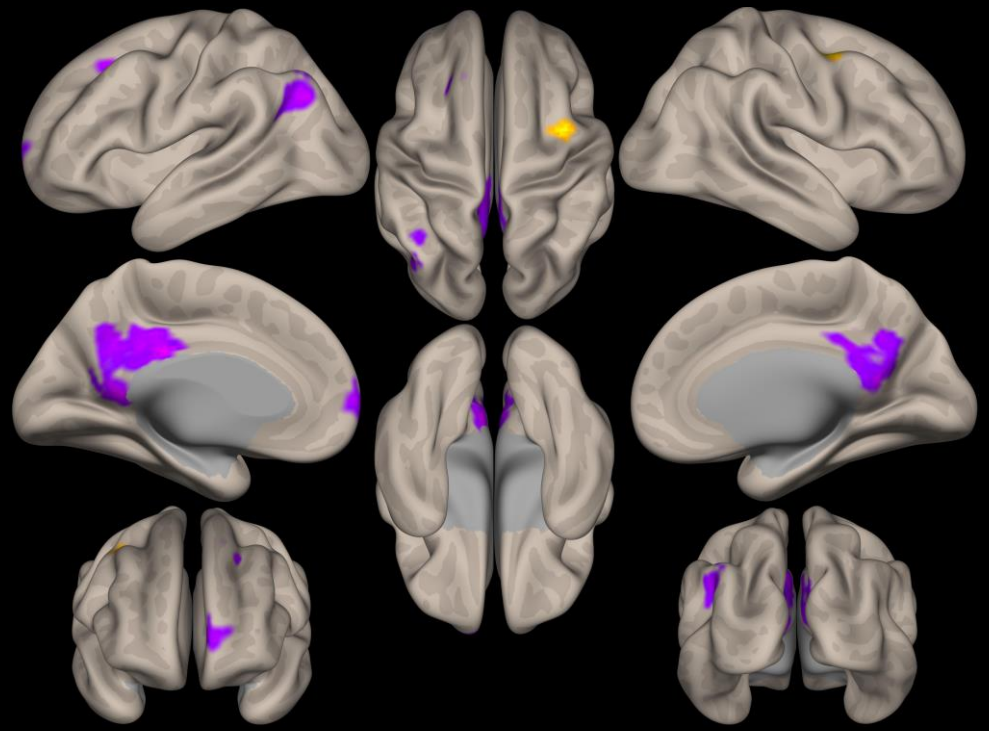
Figure 1. Boxplot display of total scores on the 15-item Tilburg Frailty Inventory (TFI) for perceived financially exploited ($n = 24$) and non-exploited ($n = 13$) older adults.

Jenna Axelrod et al., to be submitted

FINCHES Neuroimaging

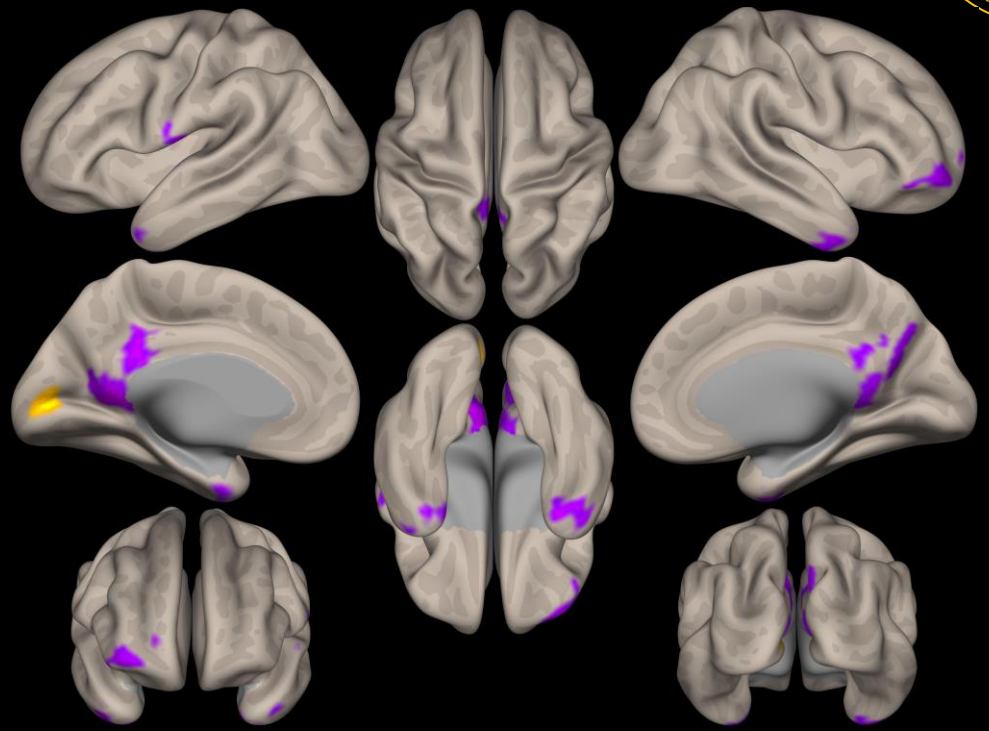
- Older adults who self-reported a history of FE (N=15; M age=70.3, SD=9.1) and non-FE adults (N=16; M age=72.9, SD=9.9) underwent resting-state functional MRI.
- The left and right hippocampus were regions of interest prescribed based on the Harvard-Oxford atlas.
- Functional realignment and unwarping, slice-timing correction, structural segmentation and normalization, functional normalization, outlier detection, smoothing, and denoising were applied to scans.
- FC differences between groups were considered significant at an FDR-corrected two-sided cluster level of $p<0.05$, and voxel level threshold of $p<0.008$.
- Age, education, sex, and MoCA scores were included as covariates.

FINCHES Neuroimaging



Left Hippocampus

B precuneus, L frontal pole
R middle frontal



Right Hippocampus

B precuneus, R frontal, B temporal
L intracalcarine

Functional Connectivity of the Insula in Financially Exploited Older Adults: Preliminary Findings from the Finance, Cognition, and Health in Elders Study (FINCHES)

Keck School of Medicine of USC

RUSH UNIVERSITY MEDICAL CENTER

Gali H. Weissberger[1], Laura Mosqueda[1], Annie Nguyen[1], Anya Samek[2], Patricia Boyle[3], Caroline P. Nguyen[1], Emanuil Parunakian[1], & S. Duke Han[1,3,4,5,6]

1. Department of Family Medicine, USC; 2. Center for Economic and Social Research, USC; 3. Department of Behavioral Sciences, Rush Alzheimer's Disease Center 4. School of Gerontology, USC; 5. Department of Neurology, USC 6. Department of Psychology, USC

1 BACKGROUND

- Older adults are estimated to lose 3 billion to 36 billion annually to financial exploitation (FE). (Metlife, 2011; True Link Financial, 2015)
- Seniors are disproportionately impacted by scams, as assets lost in old age are often difficult to replace. (Nerenberg, 1999)
- Neural correlates of FE are poorly understood.
- The insula is involved in perceptions of trust (Castle et al., 2012); thus functional connectivity of the insula may be impacted by FE

2 STUDY OBJECTIVE

- The Finance, Cognition, and Health in Elders Study (FINCHES) aims to characterize the neuropsychological, psychosocial, economic preferences, and brain correlates of older adults who are victims of financial exploitation.
- The present study examined whole-brain functional connectivity of the insula in older adults with or without history of FE enrolled in the pilot phase of FINCHES.

3 METHODS

Recruitment

- National Center on Elder Abuse (NCEA), Center on Elder Mistreatment (CEM), health clinics, community organizations, and senior centers
- Inclusion criteria: ≥50 years old, cognitively normal
- Exclusion criteria: history of brain injury, stroke, major neurological or psychiatric illnesses, current substance abuse

Sample

- FE group: 15 older adults self-reported a history of FE
- Non-FE group: 16 older adults denied a history of FE

Resting State fMRI

- Acquisition: 3T Siemens Magnetom; two EPI sequences (TR=607ms, TE=32.0ms, flip angle = 50°; 64 isocenter transversal slices parallel to the AC-PC line; reconstructed voxel size 2.5mm x 2.5mm x 2.5mm.
- Processing
  - SPM12 CONN toolbox
  - Realignment and unwarping, slice-timing correction, structural segmentation and normalization, functional normalization, outlier detection, smoothing, and denoising
  - ROIs: left and right insula; prescribed based on the Harvard-Oxford atlas

Data Analysis

- Differences in insular functional connectivity between FE and non-FE groups
- FDR-corrected two-sided cluster level of $p < 0.05$
- Voxel level threshold of $p < 0.005$
- Covariates: age, education, sex, total score on MoCA

4 RESULTS

Table 1. Demographics: No differences between groups

	FE (n=15)		Non-FE (n=16)		
	M	SD	M	SD	p-value
Age	72.9	9.1	70.3	9.9	0.449
Education	16.4	2.5	15.7	2.6	0.449
Sex (%F)	67%	-	50%	-	0.473
Race (% non-white)	27%	-	31%	-	0.779
MoCA score	27.7	1.3	27.6	1.5	0.347

Figure 1. Left Insula

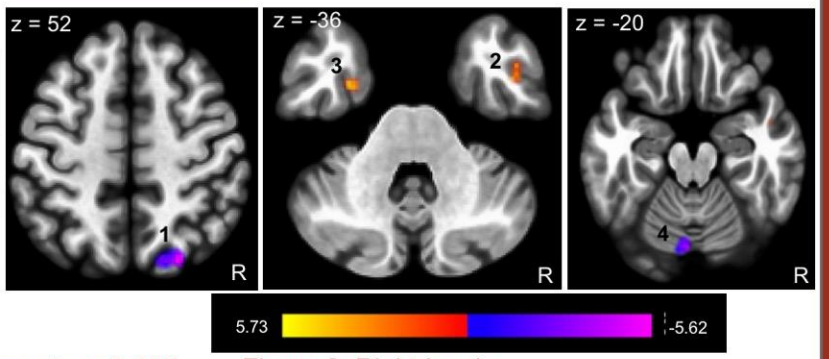
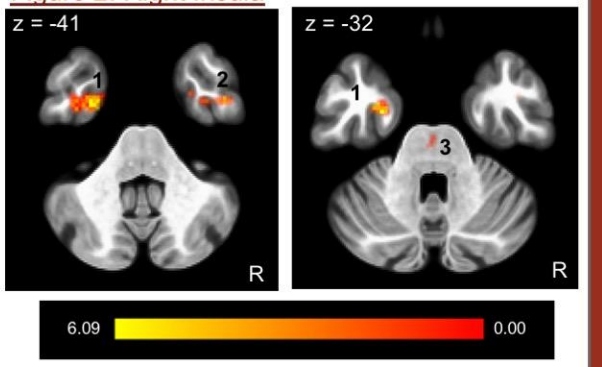


Table 2. Significant clusters, $p < 0.05$, voxel $p < 0.005$

Region of maximum intensity voxel	MNI Coordinates			Cluster size	t-Value[1]
Left Insula					
1. Right superior parietal	24	-74	52	256	-4.93
2. Right inferior temporal	46	-2	-40	245	6.03
3. Left fusiform	-30	-2	-32	155	5.32
4. Left cerebellum	-6	-76	-20	155	-4.64
Right Insula					
1. Left fusiform/ parahippocampal	-28	-4	-34	410	6.06
2. Right inferior temporal	46	-2	-40	226	5.33
3. Left cerebellum	-4	-30	-26	156	4.94

[1]*Positive value reflects FE>non-FE; models adjusted for age, education, sex, MoCA score*

Figure 2. Right Insula



5 DISCUSSION

- In this preliminary rsfMRI analysis of the FINCHES pilot study, differences between FE and non-FE participants emerged in whole-brain functional connectivity (FC) with left and right insular cortices.
- FE older adults had significantly greater functional connectivity between the insula and regions in the bilateral temporal lobes than non-FE older adults.
- Non-FE older adults had greater connectivity between the insula and a region spanning right superior parietal cortex.
- Group differences in FC between the insula and the temporal lobe may implicate brain functional and network changes that occur as a consequence of financial exploitation, potentially due to changes in one's perception of trust following financial exploitation. (Castle et al., 2012)
- Decreased functional connectivity between the insula and superior parietal cortex in the FE group may reflect functional network changes that place one at increased risk of FE, possibly due to difficulty integrating sensory input in risky situations (Paulus et al., 2003; Wolpert et al., 1998).
- More research is needed to understand the directionality of relationships.

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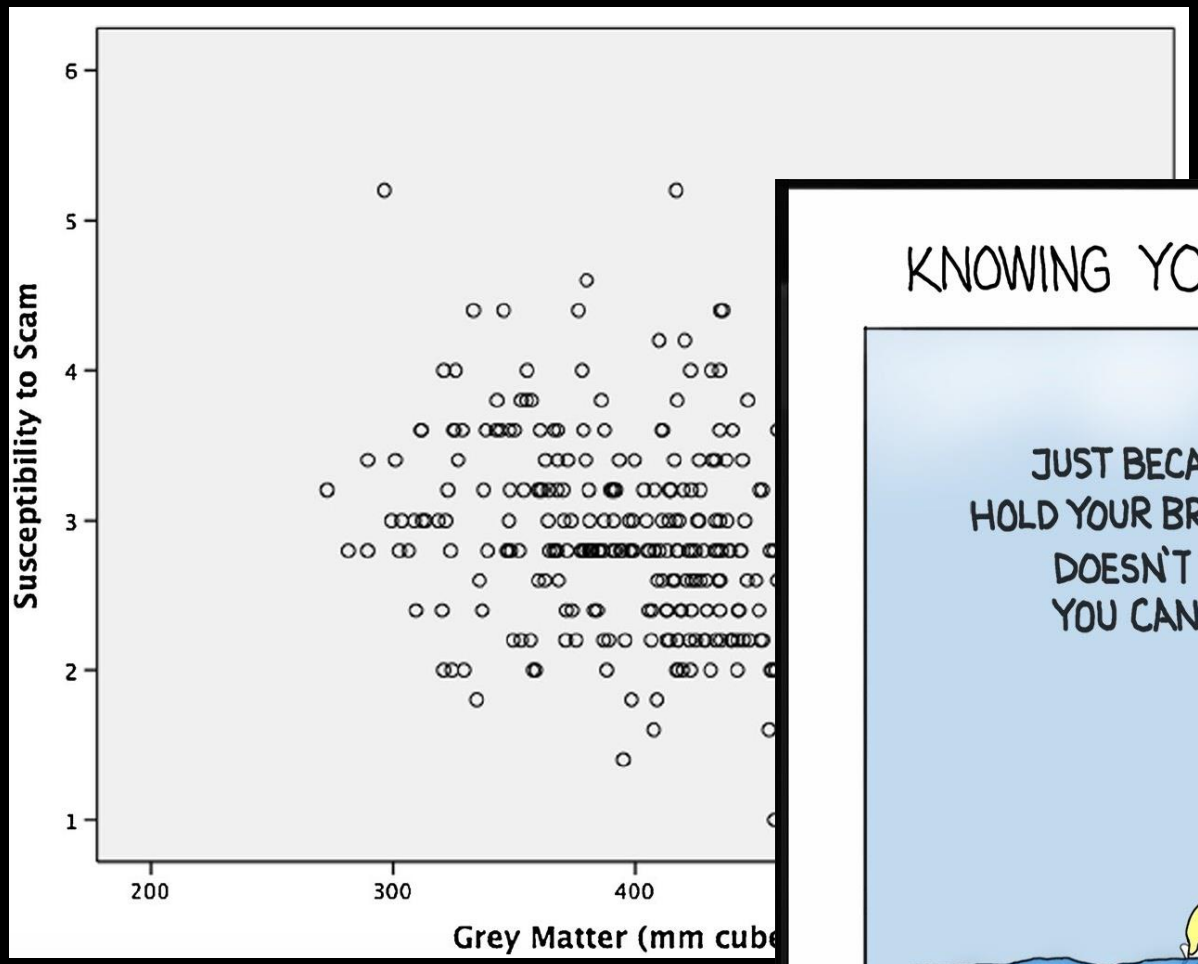
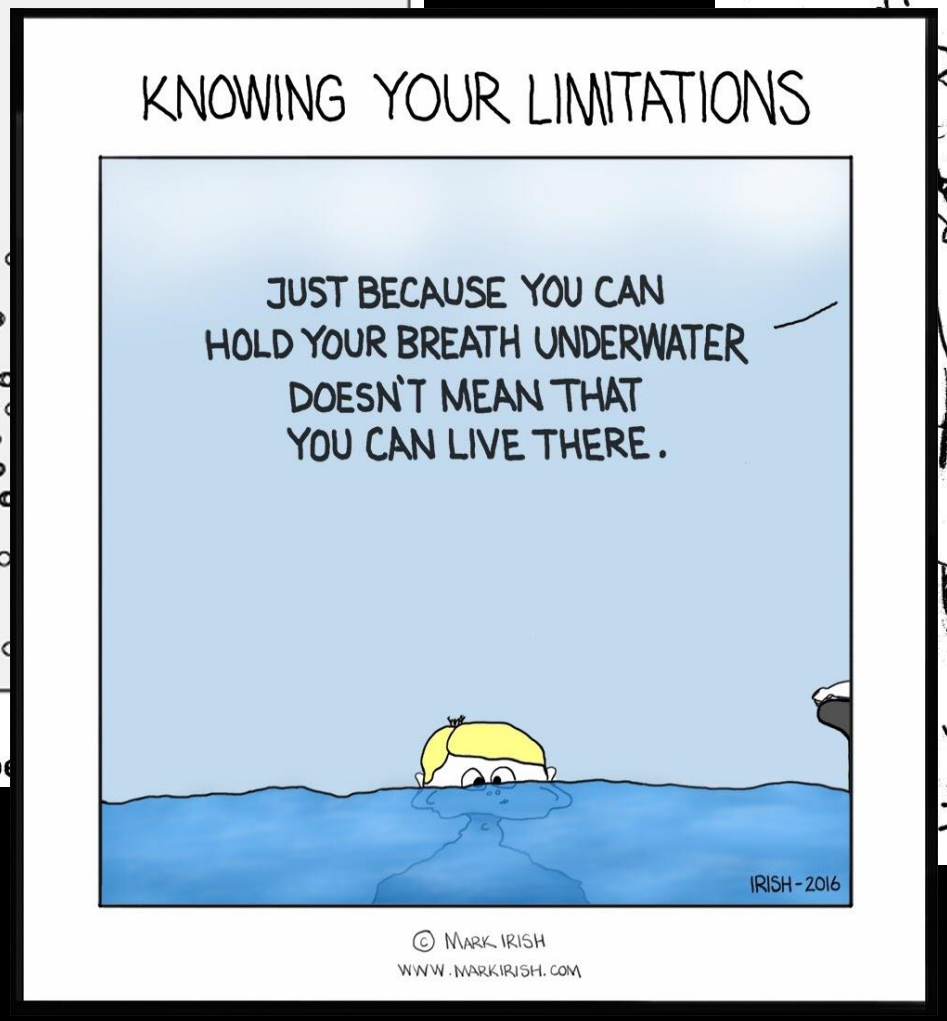
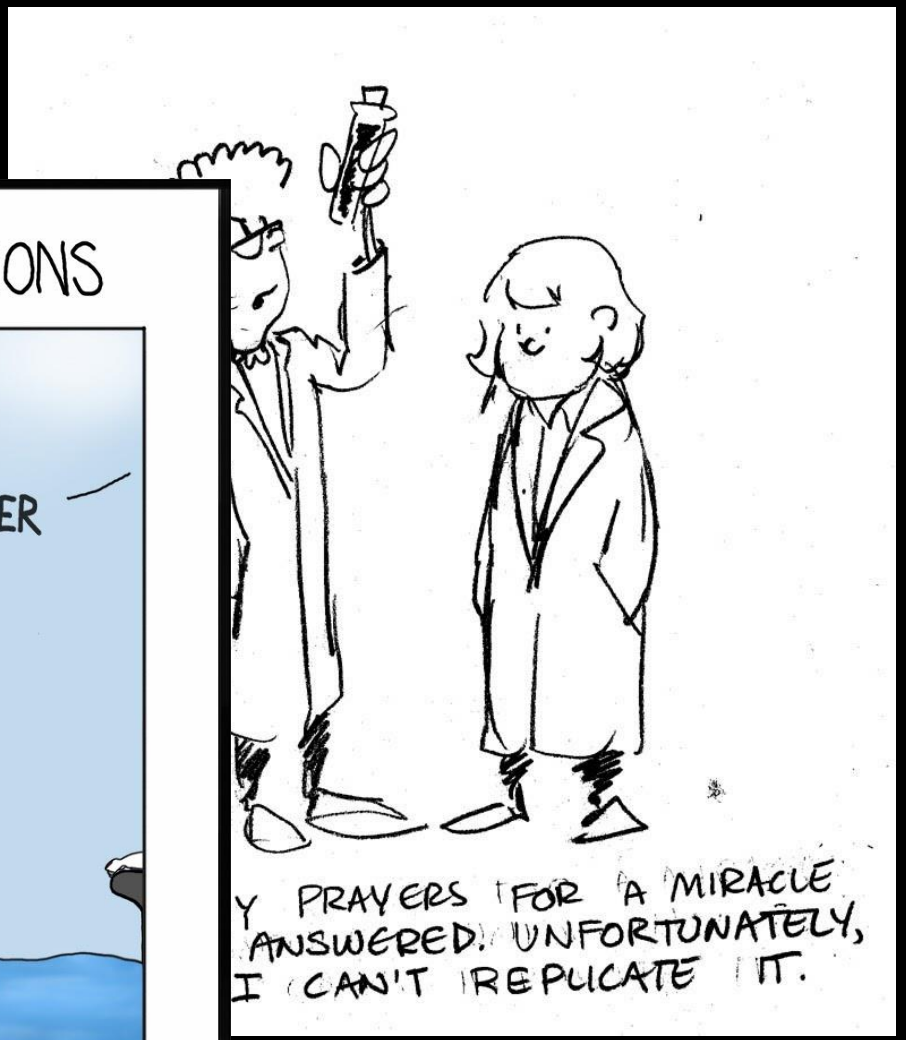
Thoughts on Moving Forward (Guidelines)







Summary

- A complex functional and structural network of brain regions susceptible to age-related neuropathology may be involved in financial vulnerability in old age.
- Neuroimaging is a tool that can be used to examine brain characteristics of vulnerability *in vivo* ahead of any significant cognitive or behavioral change.
- Future neuroimaging work is needed to replicate findings, assess generalizability, and increase sensitivity and specificity of metrics.
- There are multiple factors (neurobiological, cognitive, emotional, social, medical, etc.) that are involved in financial vulnerability in old age.

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