Age Differences in Information Foraging:
Search and Switch in Word Search Puzzles

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INTRODUCTION

❖ Self-regulation of cognition in natural environments almost always involves alternating phases of:

- **Exploration**, or **search** that is in the service of deciding how effort will be allocated, and

- **Exploitation**, or **task engagement** in which effort is allocated to meet task-specific goals.

❖ **Information Foraging** models use the analogue of how animals forage for food in the wild to explain how people regulate these processes in both external environments (e.g., Fu & Pirolli, 2007; Payne et al., 2007; Pirolli & Card, 1999) and in memory (Hills et al., 2010, 2012).

❖ One general principle is that optimal foragers adjust their patterns of search to expected information gain from particular (food) patches and search costs in switching between patches. For example, it is adaptive to continue to exploit patches as long as they are profitable, especially when the cost of switching between patches is high (Charnov, 1976).

❖ We examined age differences in an information foraging task in patches varying in difficulty (i.e., yield relative to time allocated; profitability). Given age-related differences in speed and WM, we expected older adults to show slower information uptake, especially in the more difficult condition. More interesting was whether older adults would show differential likelihood of switching as profitability decreased (cf. Mata et al., 2009)

METHODS

Participants

Mean(SD)	Age	Education *	Verbal **	Speed **	WM**	Fluency
Young (N=28)	19.79 (1.23)(19~23)	14.46 (1.47)	6.87 (2.53)	11.21 (2.30)	4.15 (1.08)	15.10 (3.23)
Old (N=30)	70.57 (6.33)(62~85)	16.25 (3.55)	10.69 (3.36)	9.43 (2.19)	3.46 (0.67)	16.66 (3.92)

- Significant age difference (* p<.05; ** p<.01)
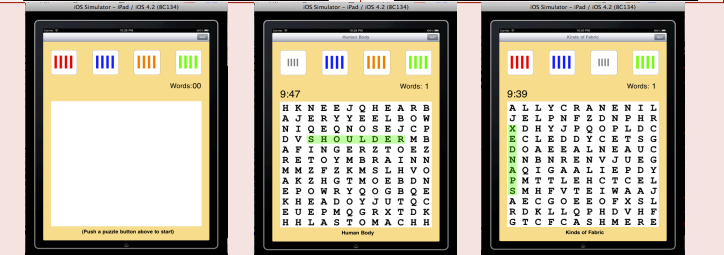- No age difference in the use of iPad

Materials and Procedure --The word search puzzle paradigm

- To maximize the number of items found in a set of 4 word search puzzles on an iPad.
- One puzzle was visible at a time
- Participants switched between puzzles at liberty, with a 10-minute limit
- 4 puzzles, each containing 16 words from different semantic categories

All Easy Condition		Mixed Condition		All Hard Condition
4 easy puzzles		2 easy puzzles	2 hard puzzles	4 hard puzzles
High-prototypical category exemplars		Low-prototypical category exemplars		
Forward only		All orientations, both forward and backward		
No difference in word frequency and word length across conditions				

| Human Body (easy; high profitability)	Birds (difficult; less profitable)

RESULTS

Word Search Performance: Younger adults found more words in all conditions

#words (out of 64)	All Easy	All Hard	Mixed Easy	Mixed Hard
Young	38.93 (6.35)	23.39 (7.40)	20.14 (3.00)	11.71 (3.51)
Old	29.24 (6.95)	15.72 (6.15)	15.93 (3.99)	7.68 (3.39)

Differences in Uptake Rates: Older adults had slower uptake rates regardless of condition
- **Mixed Easy** >**Easy**
- **Mixed Hard** > **Hard**
- First attempt
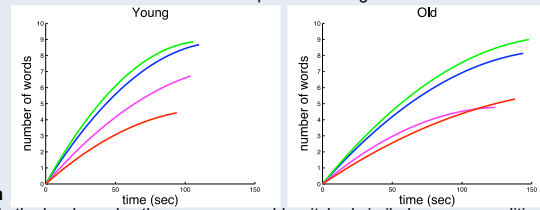
Differences in Switch
- Young switched more in the hard puzzles than easy ones; old switched similarly across conditions
- Younger with higher uptake rates (reaching asymptote quickly) switched more often. Older with better verbal ability and quicker speed switched less often (persisting in a patch longer).

Correlations among #switch, total #words, mean uptake rates (MUR; word per second), verbal ability, speed, working memory and fluency (*: p<.05, +: p<.1)

Young|old	#switch		#words		MUR		verbal		speed		WM	
#words	0.14	-0.28										
MUR	0.47*	-0.13	0.68*	0.70*								
Verbal	-0.29	-0.34+	0.37*	0.36+	0.14	0.24						
Speed	0.09	-0.43*	0.18	0.07	0.18	0.03	0.20	0.35+				
WM	-0.24	-0.25	0.00	0.54*	-0.14	0.44*	0.19	0.33+	0.21	0.19		
fluency	-0.08	-0.01	0.31	0.21	0.25	0.18	0.15	0.36+	0.15	0.03	0.33+	0.36*

Differences in Revisiting the Non-Depleted Puzzles
- Older adults found most of the words in their first attempt to the puzzles
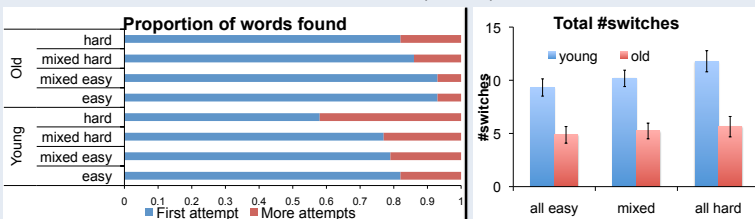
Differences in Perseverance
- Measured by give up time (the time to find the last word to the time to leave a puzzle)

Mean give up time	All Easy	All Hard	Mixed Easy	Mixed Hard
Young	19.04 (9.88)	24.90 (10.89)	24.82 (12.25)	25.88 (22.89)
Old	29.83 (13.95)	40.31 (18.00)	30.16 (18.87)	32.94 (20.26)
	•Older > young			
	•Older adults were particularly likely to persevere in the difficult condition			

Predicting Word Search Performance

	Young				Old			
Easy Puzzle	Model 1		Model 2		Model 1		Model 2	
Hard Puzzle	Standardized Beta Coefficients (* p<.05; **<.01;+ p<.1)							
#switch	-0.22	-0.19	-0.13	-0.02	-0.28+	-0.37*	-0.24+	-0.26
Uptake rate	0.59**	0.82**	0.51**	0.68**	0.64**	0.48**	0.45**	0.42*
Verbal			0.33+	0.33*			0.04	0.22
Speed			-0.02	-0.03			-0.13	-0.06
WM			0.02	-0.03			0.45**	0.08

CONCLUSIONS

❖ Switch was more likely in the difficult condition than the easy condition as predicted.
❖ Younger adults showed faster uptake than older adults, but uptake was less predictive of overall performance in the old.
❖ Older adults persevered longer, especially in the more difficult condition.

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