INFORMATION FORAGING ACROSS THE LIFE SPAN: SEARCH AND SWITCH IN UNKNOWN PATCHES

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Introduction

• Search is an important cognitive process that is fundamental to how humans regulate effort to achieve goals. Information foraging theory suggests that search for information, such as in the WWW, operates in much the same way that animals forage for food in the wild (e.g., Fu & Pirolli, 2007; S. Payne et al., 2007; Pirolli & Card, 1999). A critical question is what principles govern the decision to stop exploiting the current resource in order to explore for others (Stephens & Krebs, 1986).

1. Charnov's (1976) marginal value theorem proposes that in order to maximize overall gain, foragers with perfect knowledge will depart a patch when the marginal RG (i.e., the amount of gain as a function of time) falls below the overall RG in the entire habitat.
2. However, foragers do not always have perfect knowledge of the ecology and not do they adopt optimal heuristics to make patch-departure decisions. Alternative heuristics include the fixed time rule, the fixed number of prey rule, the "give-up" time rule, and the assessment rule (Stephens & Krebs, 1986).

• Age-related slowing suggests declines in information uptake rate. Given that people adjust their time allocation to changes in rates of information uptake (Payne et al., 2007; Wilke et al., 2009), age-related changes in search would be expected. However, little is known about age differences in heuristics that operate in decisions to switch from one resource to another.

• Research Questions

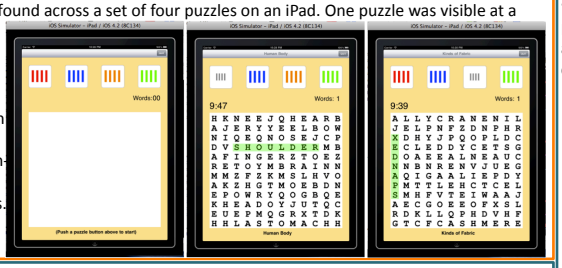
1) Do younger and older adults adopt a policy consistent with the marginal value theorem in switching between resources? 2) What cues do younger and older adults use to switch?

Method

• Word search puzzle paradigm (e.g., Chin, Fu & Stine-Morrow, 2011; Payne, Duggen & Neth, 2007), in which participants were asked to maximize the number of items found across a set of four puzzles on an iPad. One puzzle was visible at a time and participants switched between puzzles at liberty, within a given time limit.

•We manipulated profitability, operationalized in terms of word orientation and prototypicality of category membership, which impacted how quickly words were found.

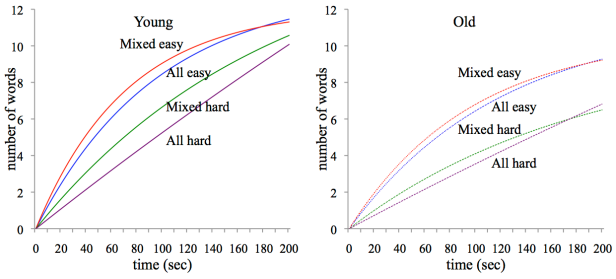
• A 2 x 3 mixed factor design with the between-subject variable, age (young vs. old) and the within-subject variable, task condition (Easy vs. Mixed vs. Hard).



Results

Measure	Young (N=28)	Older (N=29)
Age	19.79	70.57
Edu (Yrs)	14.46	16.40
% of people used iPad 3+ weekly	10.7 %	10.3 %
WM	4.15	3.46
Fluency	15.10	16.48
Executive Control	0.17	-0.16
Verbal	6.88	10.78
#wds in Easy	38.93	29.24
#wds in Hard	23.39	15.72
#wds in Mixed easy	20.14	15.9
#wds in Mixed hard	11.71	7.41

Younger adults found more words than older adults across all the conditions. Age differences in performance did not vary across condition



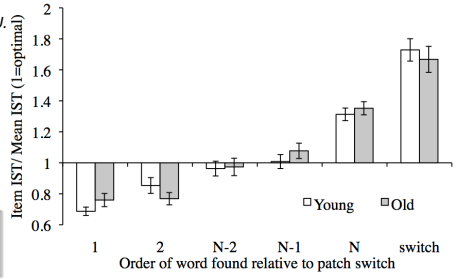
Nonlinear mixed-effects modeling was conducted to estimate rate of information gain (RG). RG was defined as the cumulative number of words found as a function of time with data modeled based on 2-second intervals. we modeled the *cumulative number of words*, Y, with two parameters, *rate of change*, β_{1i}, and *asymptote*, β_{0i}, on *i* time bin. Given individual differences in rate of change, we decomposed this parameter into a fixed effect, γ, and a random effect, *U*.

$Y = \beta_{0i} - (\beta_{0i} \exp(-\beta_{1i} \text{Time}))$ (1)

$\beta_{1i} = \gamma_1 + U_{1i}$ (2)

***Marginal Value Theorem and Empirical Switch Patterns*:**

(1) Relative to the predictions of the marginal value theorem, both groups left the puzzle late.



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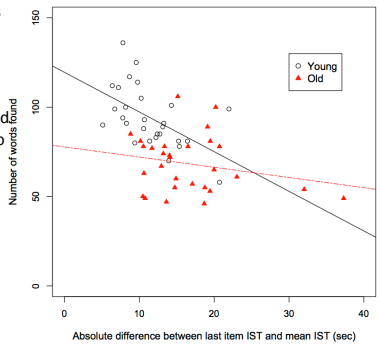
(2) The closer the younger adults were to following the optimal policy suggested by the marginal value theorem, the better their performance. However, task performance among the old could not be predicted by adherence to the theoretical optimum as defined by the marginal value theorem.



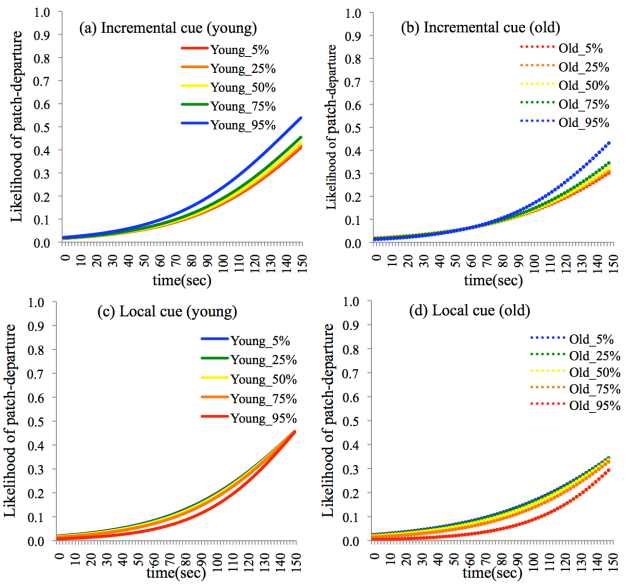
Age-Dependent Predictors of Switch Decisions

• The incremental cue was defined as: (time of event$_N$-time of event$_{N-1}$)/(average time between event$_1$ up to event$_{N-1}$), where *N* is the current event.

•The local cue was defined as: (marginal RG at event$_N$)/(marginal RG at event$_{N-1}$), where *N* is the current event.

• Younger adults were likely to depart a puzzle depending on the long-term change in RG at the earlier stage of search, while older adults were likely to depart a puzzle depending on the local change in the RG.

• Although this marginally significant effect must be interpreted with caution, it is possible that executive control moderates older adults' switch strategy, such that older adults with higher executive function more likely to use the long-term change in RG cue to determine when to switch.



Discussion

• People were sensitive to the diminishing rates of information gain in terms of making patch-departure decisions.

• Older adults may be less accurate in monitoring their RG over time. Because older adults with better executive control were more likely to adjust their switch decisions to the long-term change in the RG over time, we conclude that EC contributed to patch-departure decisions by enabling more accurate monitoring, quicker responsiveness to changes in RG, or some combination of the two.

• Thus, lower levels of exploration among older adults may, in part, be due to differences in the perception of change in the rate of information gain, which in turn led them to persist in exploiting one information source before exploring a new one.

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