The Impact of Literacy on Language Comprehension in Older Adults

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Rationale

• Literacy is an important activity for maintaining cognitive and brain reserve across the lifespan (Manly et al., 2005; Stern, 2009)

• Studies have shown that *print exposure* (PE) the amount of time readers spend habitually engaging in reading and literacy activities, can explain the positive age-related relationships with crystallized abilities such as vocabulary and declarative knowledge among older adults (Stanovich et al., 1995).

• Higher PE is associated with facilitation in word-level processes among both child and younger adult readers (e.g., Chateau & Jared, 2000). However, less is known about the role of PE in the continued building of skilled reading over the life span.

• In the current study, we examine the effects of PE on online sentence processing and sentence memory among older adults.

Methods

Participants

• 139 community dwelling older adults.
  • Age: 64-92 (M = 72)
  • MMSE > 23
  • Education: M = 15.4
  • Normal/ corrected normal vision

Measures and Procedure

• *Exposure to Print.* The Author Recognition Test (ART; Stanovich & West, 1989). Participants were given a checklist with authors and foils, and asked to select the authors. The overall score is calculated by subtracting the number of foils identified from the number of authors correctly identified.

• *Vocabulary Ability.* The ETS-Advanced Vocabulary and Extended Range Vocabulary Test (Ekstrom et al., 1976).

• *Verbal Working Memory (vWM).* The loaded reading span task (Stine & Hindman, 1994). Participants read a series of sentences for immediate true/false judgments, and then reported the last word of each sentence in sets of increasing size. The score was the maximum set size with accurate recall.

• *Reading Task.* Sets of 24 two-sentence passages (18 words each) were presented to each participant to read word-by-word in an individual laboratory session for immediate recall on 1/3 of the trials.

Results

Effects of Print Exposure on Sentence Processing

• Word-by-word reading times submitted to analysis using linear mixed effects (LME) models with cross-random effects for subjects and items.

• LME simultaneously models predictors of subject and item variance, and their interactions, without biased estimates (Quene & van den Bergh, 2007; Baayen, Davidson, & Bates, 2008).

• 432 word X 139 subjects = 60,048 total observations.

• Raw RT's log transformed to correct for skew.

• Entered predictors of reading time hierarchically in 3 models (see below). Estimates and standard errors for each model are presented in Table 1.

Model 1. Resource Allocation Model

$$\ln(Y_{ijk}) = \gamma_{000} + \gamma_1(\text{Syll}) + \gamma_2(\text{lnWF}) + \gamma_3(\text{IntSB}) + \gamma_4(\text{SB}) + \gamma_5(\text{NC}) + U_{0j0} + V_{00k} + e_{ijk}$$

Model 2. Effects of Print Exposure

$$\ln(Y_{ij}) = \gamma_{000} + \gamma_1(\text{Syll}) + \gamma_2(\text{lnWF}) + \gamma_3(\text{IntSB}) + \gamma_4(\text{SB}) + \gamma_5(\text{NC}) + \gamma_6(\text{ART}) + \gamma_7(\text{ARTxSyll}) + \gamma_8(\text{ARTxlnWF}) + \gamma_9(\text{ARTxIntSB}) + \gamma_{10}(\text{ARTxSB}) + \gamma_{11}(\text{ARTxNC}) + U_{0j0} + V_{00k} + e_{ijk}$$

Model 3. Unique Effects of Print Exposure

$$\ln(Y_{ij}) = \gamma_{000} + \gamma_1(\text{Syll}) + \gamma_2(\text{lnWF}) + \gamma_3(\text{IntSB}) + \gamma_4(\text{SB}) + \gamma_5(\text{NC}) + \gamma_6(\text{ART}) + \gamma_7(\text{vWM}) + \gamma_8(\text{Vocab}) + \gamma_9(\text{ARTxSyll}) + \gamma_{10}(\text{ARTxlnWF}) + \gamma_{11}(\text{ARTxIntSB}) + \gamma_{12}(\text{ARTxSB}) + \gamma_{13}(\text{ARTxNC}) + U_{0j0} + V_{00k} + e_{ijk}$$

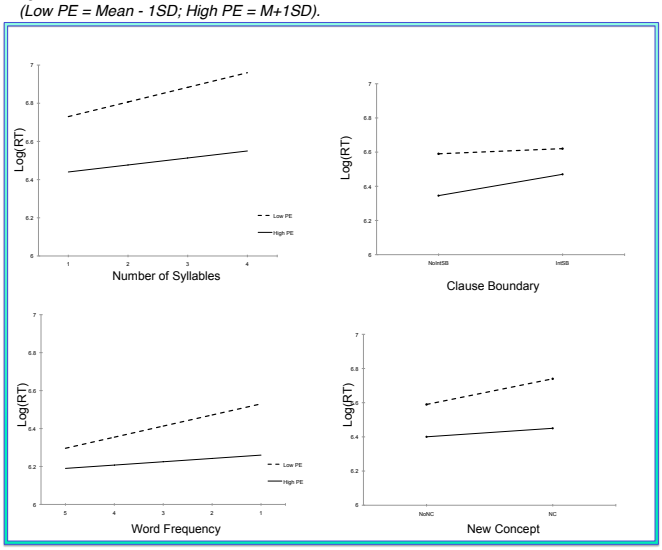
Represents unique effects of PE after it was "robbed of some of its rightful variance" (p. 265; Cunningham & Stanovich, 1991)

Table 1. Estimates and Standard Errors From Linear Mixed Effects Models

	Model 1		Model 2		Model 3	
	B	SE	B	SE	B	SE
Intercept	6.49	.0389 ***	6.76	.0662 ***	6.83	.1257 ***
Item Predictors						
Syll	.0489	.0095 ***	.0683	.0111 ***	.0683	.0111 ***
logWF	-.0510	.0006 ***	-.0577	.0070 ***	-.0587	.0070 ***
IntSB	.0396	.0149 **	.0638	.0187 ***	.0638	.0187 ***
SB	.4785	.0279 ***	.4579	.0393 ***	.4579	.0329 ***
NC	.0578	.0167 ***	.0835	.0199 ***	.0853	.0199 ***
Subject Predictors						
ART	—	—	-.0255	.0054 ***	-.0178	.0070 **
Vocab	—	—	—	—	-.0557	.0250 †
vWM	—	—	—	—	-.0399	.0238 †
Cross Effect Interactions						
ARTxSyll	—	—	-.0019	.0005 ***	-.0019	.0005 ***
ARTxlogWF	—	—	.0006	.0003 *	.0006	.0003 *
ARTxIntSB	—	—	.0023	.0010 *	.0023	.0011 *
ARTxSB	—	—	.0028	.0016 ns	.0021	.0016 ns
ARTxNC	—	—	-.0024	.0010 **	-.0023	.0010 **
-2 Log Likelihood	64428.5_A		63063.1_B		63059.4_B	

Note. ns = non-significant, $p > .10$; † $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$. Subscripts denote significant differences in model fit (a lower value is better).

Figure 1. Partial Effects Plots of Interactions in Model 3 at Conditional Levels of PE (Low PE = Mean - 1SD; High PE = M+1SD).

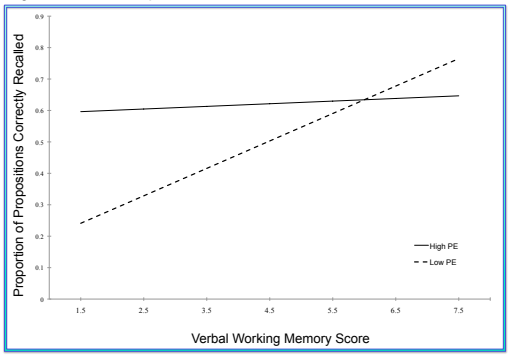


Effects of Print Exposure on Memory for Text

• Multiple regression was used to examine the independent and joint effects of PE and vWM on sentence recall.

OLS multiple regression		
	β	*p*
Step 1		
PE	.32	< .001
vWM	.27	< .001
Step 2		
vWM x PE	-.89	= .032

Figure 2. Relationship between vWM and Recall as a function of PE



Conclusions

• Older readers with higher levels of PE were facilitated in word level processing. This freed up resources to be available for higher-level textbase processes (Long, Johns, & Morris, 2007) such as processing of new concepts and increases in processing time at minor clause boundaries (Wrap-up; Just & Carpenter, 1980; Rayner et al., 2000).

• Clear effects of PE on sentence recall among older readers. Higher rates of PE contributed to better memory for text, even in the face of capacity declines. Thus, higher rates of literacy buffered the effects of vWM on sentence memory.

•Evidence for PE as indicator of cognitive reserve for text memory.

• The increased efficiency of component reading processes that comes with greater exposure to print contributes to maintaining and improving skilled reading, even among older readers.

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