



The Effects of Age and Literacy Skill on Processing Lexical Ambiguities

Allison A. Steen^{1,2}, Shukhan Ng¹, Brennan R. Payne^{1,3}, Kara D. Federmeier^{1,3}, and Elizabeth A. L. Stine-Morrow^{1,2}

¹Beckman Institute, ²Department of Educational Psychology, and ³Department of Psychology

University of Illinois at Urbana-Champaign, Urbana IL

Rationale

Readers activate the multiple meanings of ambiguous words regardless of contextual constraint or individual differences in comprehension ability, and subsequently suppress inappropriate meanings. However, suppression can vary with reader skill (Gernsbacher, 1990) and age (Faust et al., 1997). Little is known about the effects of suppression failure on online processing, nor how age differences vary with literacy skill. We addressed these questions by measuring eye movements as young, middle-aged, and older adults varying in literacy skill read grade-level appropriate sentences.

Method

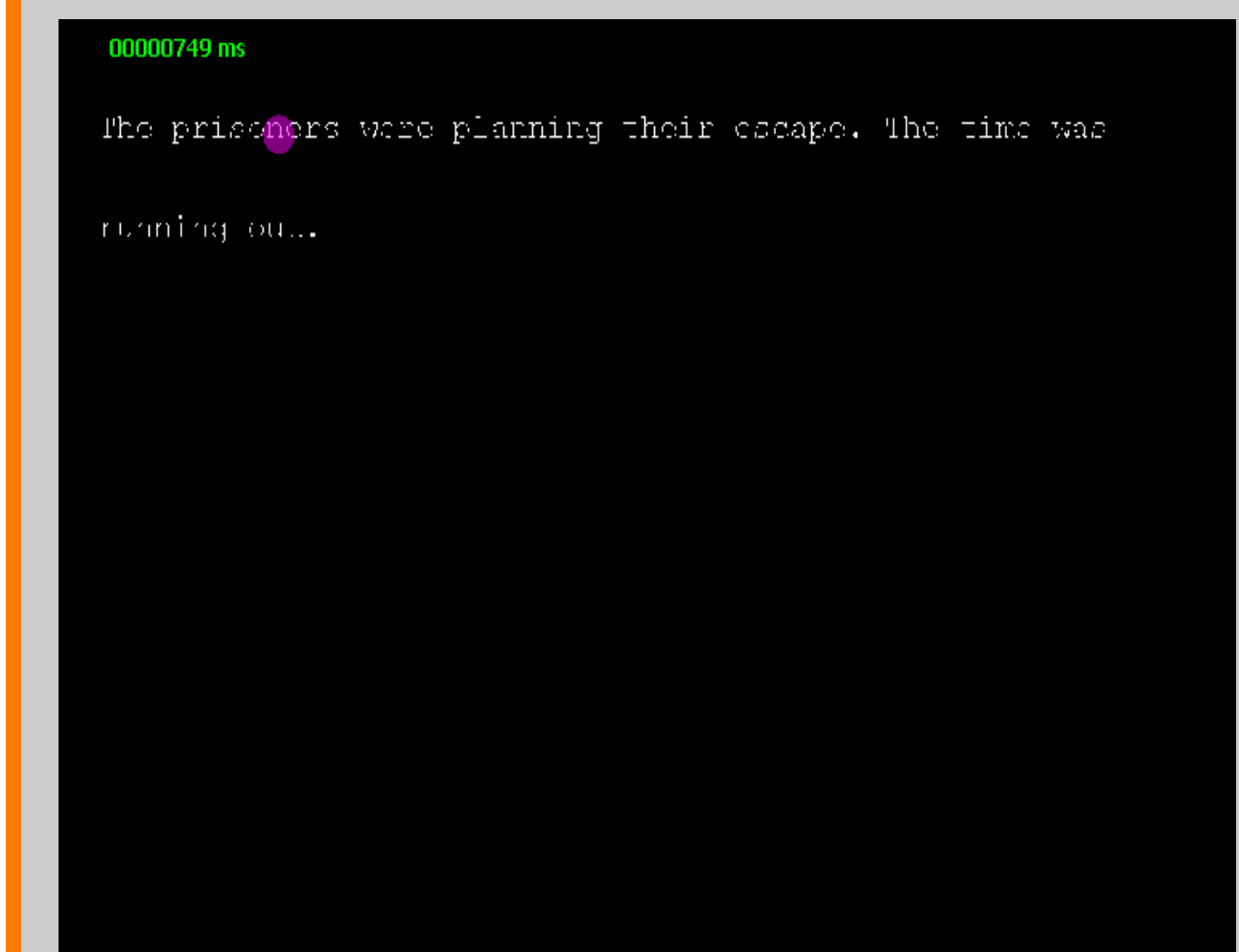
Participants

	High Literacy			Low Literacy			Effects (p-value)		
	Y (n=20)	MA (n=11)	O (n=13)	Y (n=6)	MA (n=16)	O (n=15)	Age	Lit	A x L
Age	25.8	42.1	54.6	27.2	40.9	57.0	<0.01	0.20	0.40
Reading Level*	12.5	11.5	12.0	6.7	7.2	7.1	0.82	<0.01	0.14
Education	12.8	13.6	14.3	11.0	11.3	11.5	<0.05	<0.01	0.67
Gf **	0.6	0.4	0.2	0.3	-0.4	-0.8	0.06	<0.01	0.78
Gc **	0.5	0.4	0.6	-0.4	-0.4	-0.3	0.47	<0.01	0.96
Comprehension	78%	80%	83%	74%	74%	72%	0.31	<0.01	0.28
*Reading Level = composite grade level: SORT (vocabulary), and WJ Reading Fluency (speeded sentence comprehension)									
**Average Z-score of WASI (block design/matrices and vocabulary/similarities respectively)									

Materials and Procedure

Participants read 60 sentence pairs (mean FK grade level = 3.5) for comprehension. The first sentence of the pair was biased toward the subordinate meaning of a sentence-final ambiguous word (e.g., *palm*) or an unambiguous word with the same meaning (e.g., *tree*). The second sentence contained a target word reflecting the dominant meaning of the ambiguous word (e.g., *hand*). The target occurred either early or late in the sentence to examine the time-course of suppression. Participants' eye-movements were monitored during reading.

Condition		Text
Ambiguous	Late	At the beach, she played under the <i>palm</i> . Even though she was in the shade, her <i>hand</i> still got sunburnt.
	Early	At the beach, she played under the <i>palm</i> . Her <i>hand</i> still got sunburnt even though she was in the shade.
Unambiguous	Late	At the beach, she played under the <i>tree</i> . Even though she was in the shade, her <i>hand</i> still got sunburnt.
	Early	At the beach, she played under the <i>tree</i> . Her <i>hand</i> still got sunburnt even though she was in the shade.
Comprehension Probe: Did she stay in the shade at the beach? (yes)		



Results

Reading Time Measures

Reading time measures include first fixation duration (FFD), gaze duration (GD), regression path duration (RPD), probability of regressing out (pRO).

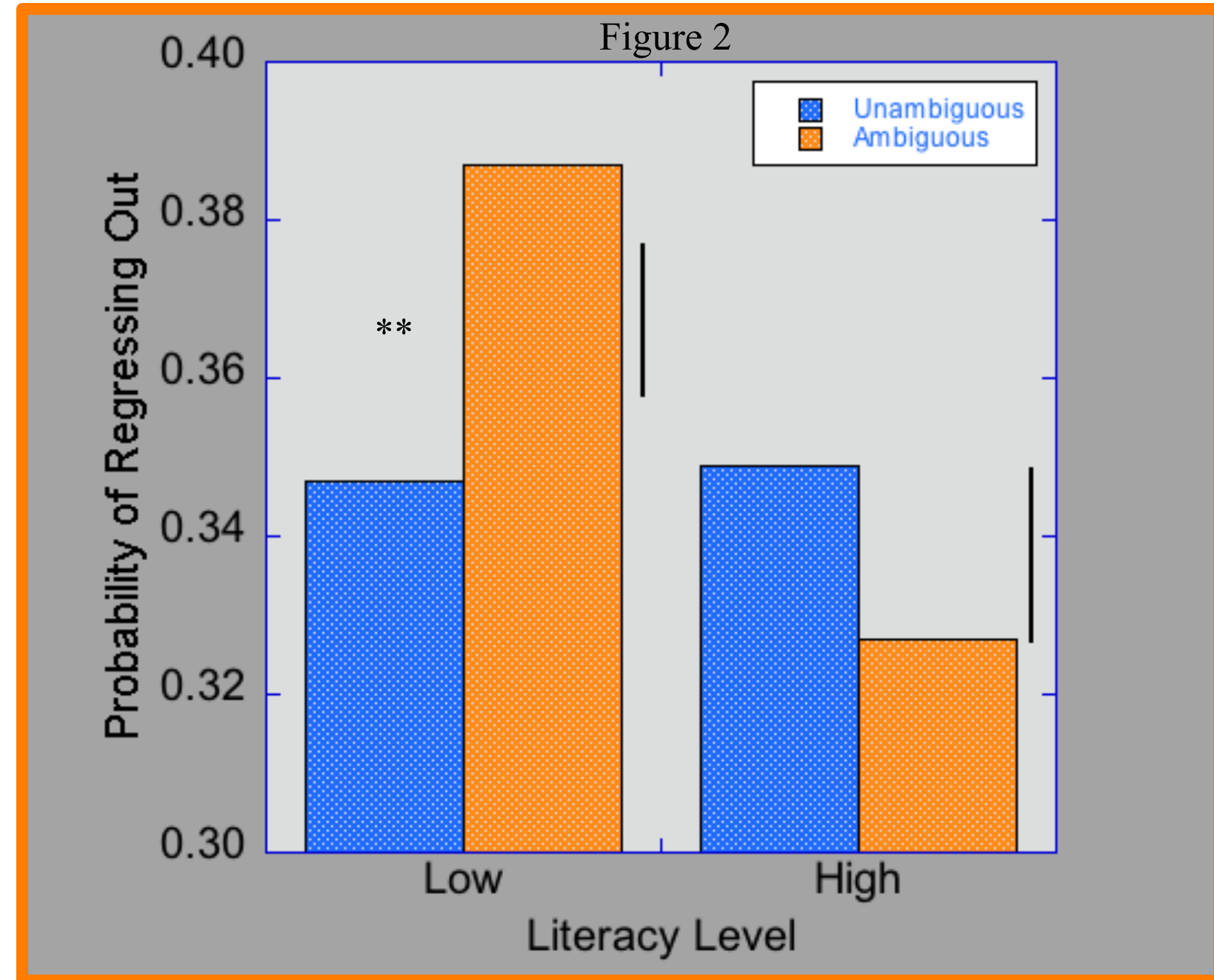
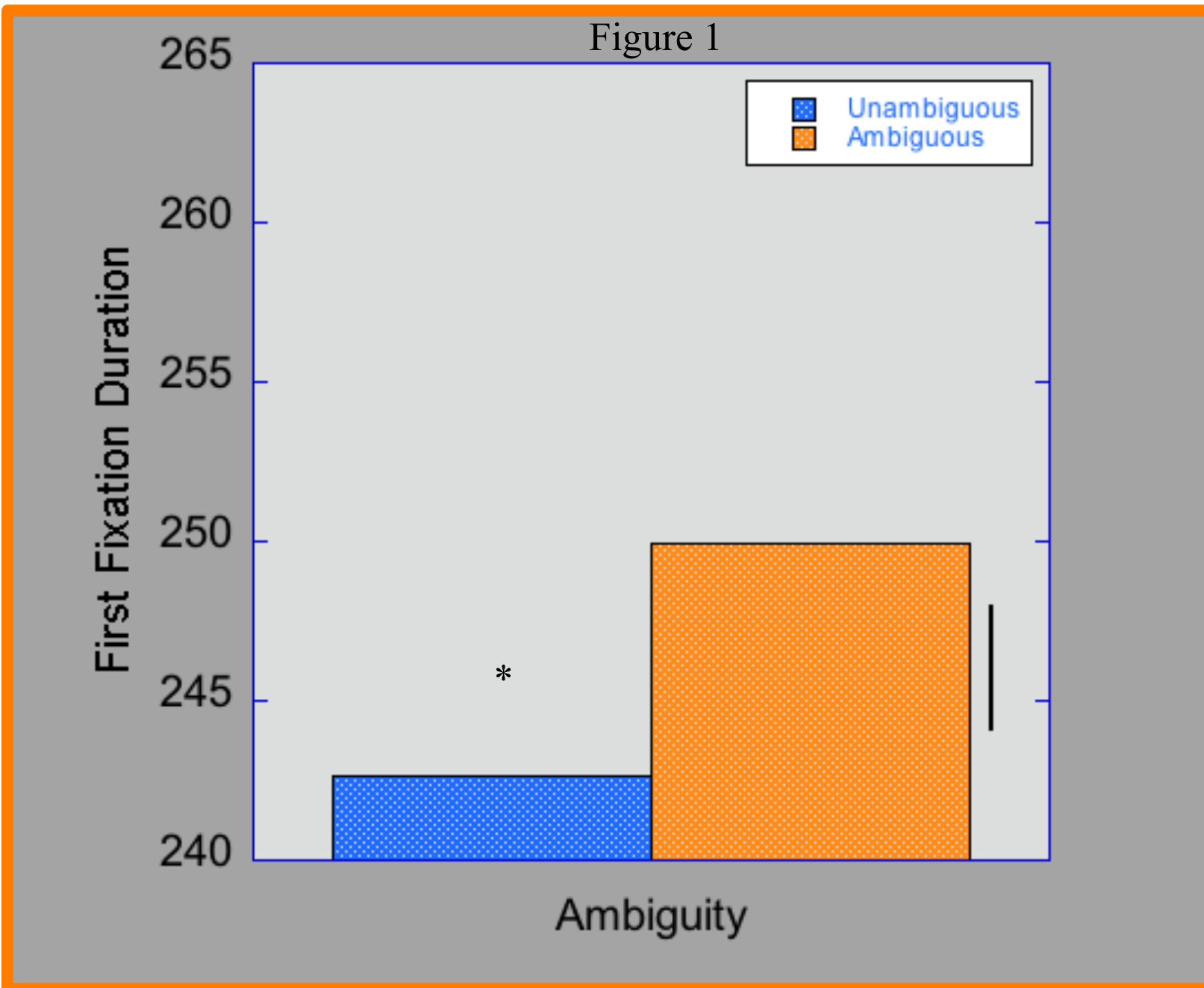
		High Literacy			Low Literacy			Effects (p-value)		
		Y (n=20)	MA (n=11)	O (n=13)	Y (n=6)	MA (n=16)	O (n=15)	Age	Lit	A x L
Ambiguous word	FFD	217	243	225	260	248	284	0.36	<0.01	<0.05
	GD	281	322	322	401	344	415	0.18	<0.01	0.06
	RPD	608	606	674	912	771	805	0.41	<0.01	0.26
	pRO	0.38	0.33	0.30	0.45	0.36	0.29	<0.05	0.42	0.67
Target word	FFD	229	239	234	285	257	292	0.44	<0.01	0.17
	GD	289	312	297	424	334	413	0.25	<0.01	<0.05
	RPD	453	482	545	775	623	700	0.24	<0.01	0.10
	pRO	0.23	0.21	0.23	0.35	0.28	0.27	0.33	<0.01	0.45

- RT measures for Low Literacy (LL) adults were longer than those for High Literacy (HL) adults for FFD, GD, RPD; $F(1,76) > 14.898$, $p < 0.001$.
- For all RT measures, middle-aged adults showed a numerical trend towards reduced effects of literacy; this was sporadically significant.

Results (continued)

Effects on the Ambiguous Word

- FFDs at the ambiguous word were marginally longer than at the unambiguous word, showing a subordinate-bias effect (SBE; Duffy et al., 1988), $F(1,76) = 3.37$, $p = 0.070$. The SBE did not significantly vary with age or literacy skill, suggesting that readers generally activated both meanings of the ambiguous word (**Figure 1**).

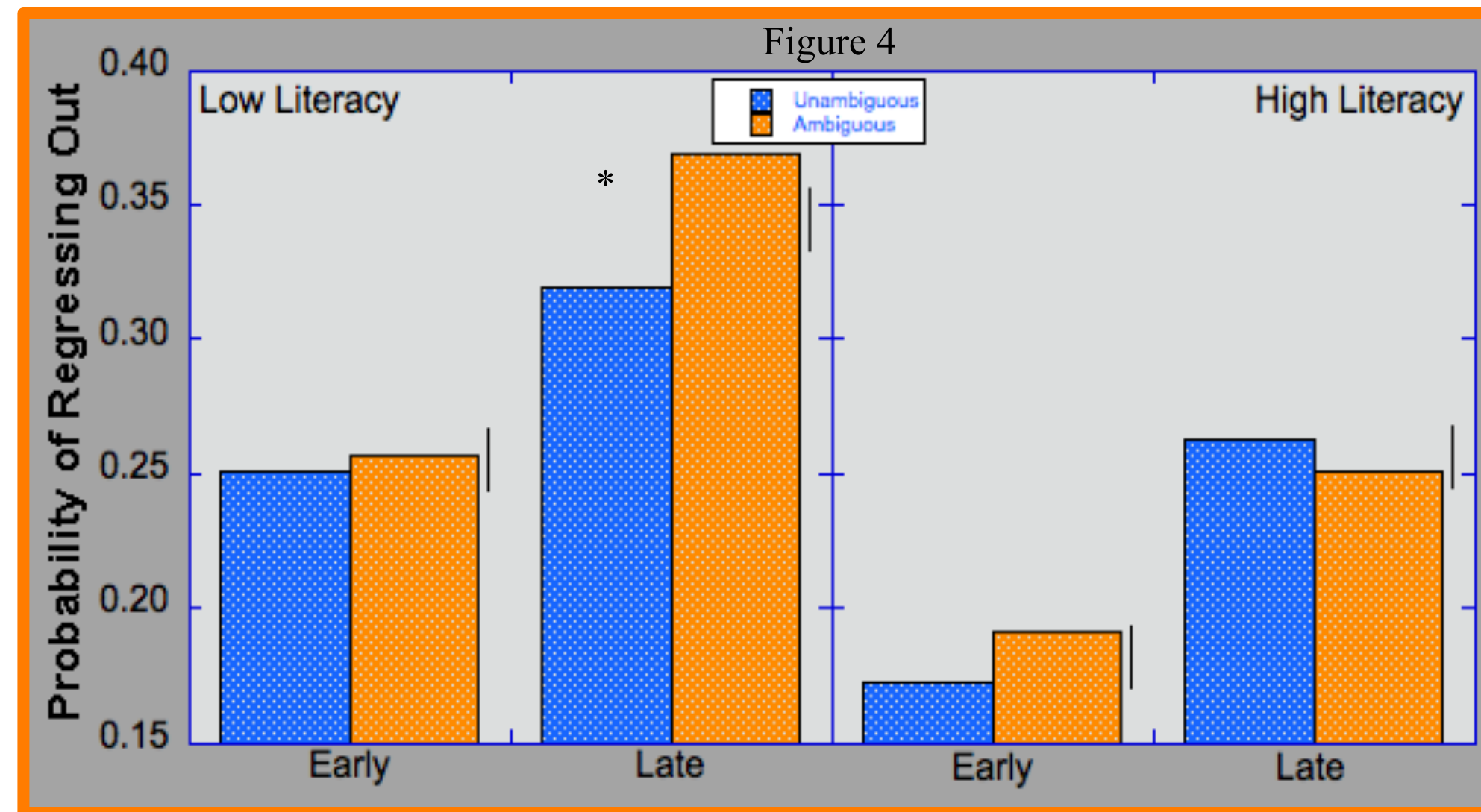
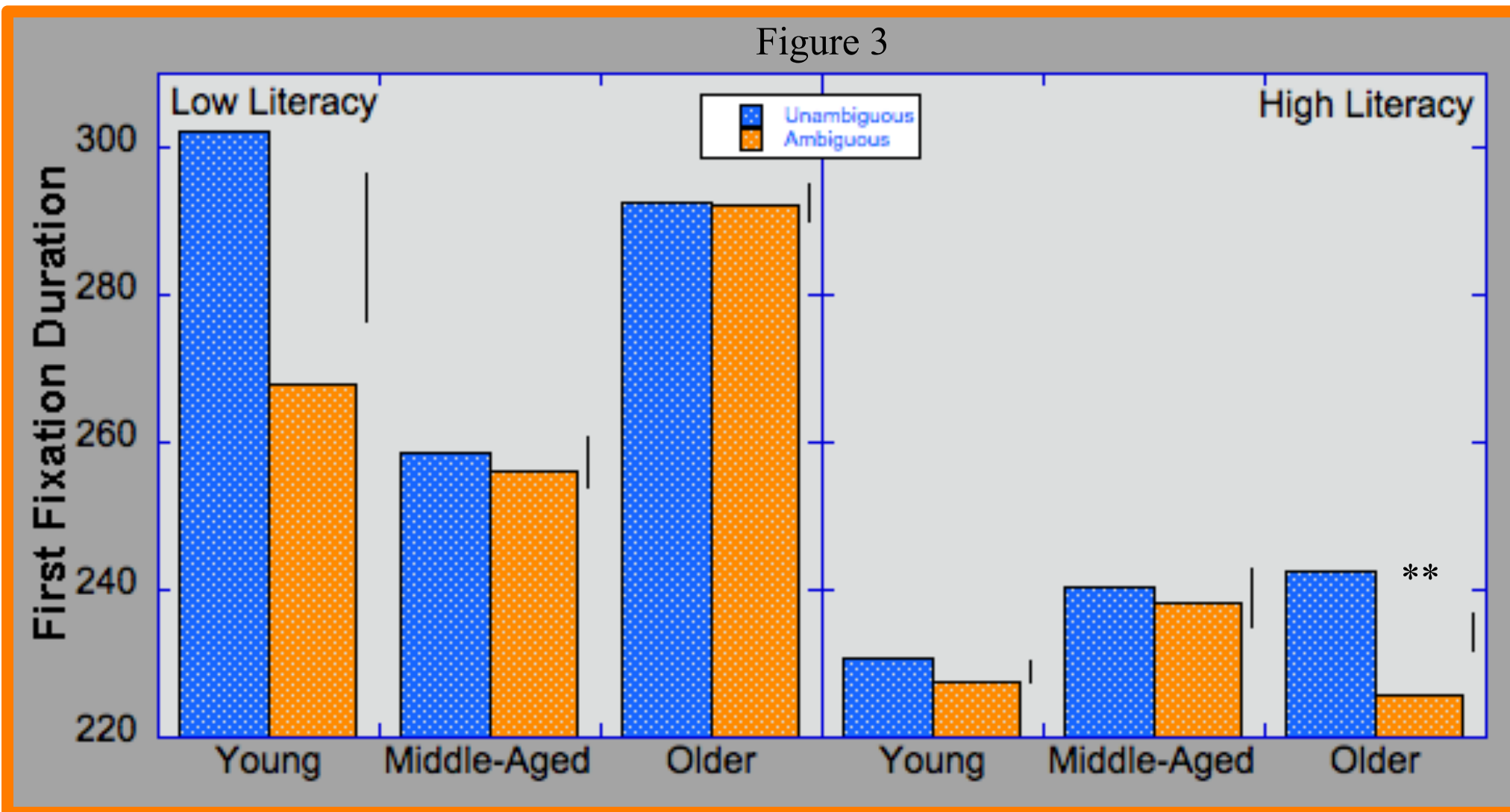


- HL adults were relatively unfazed by the ambiguity, but LL adults were more likely to regress out from the ambiguous word than from the unambiguous word, $F(1,76) = 4.30$, $p = 0.041$ (**Figure 2**).

Effects on the Target Word

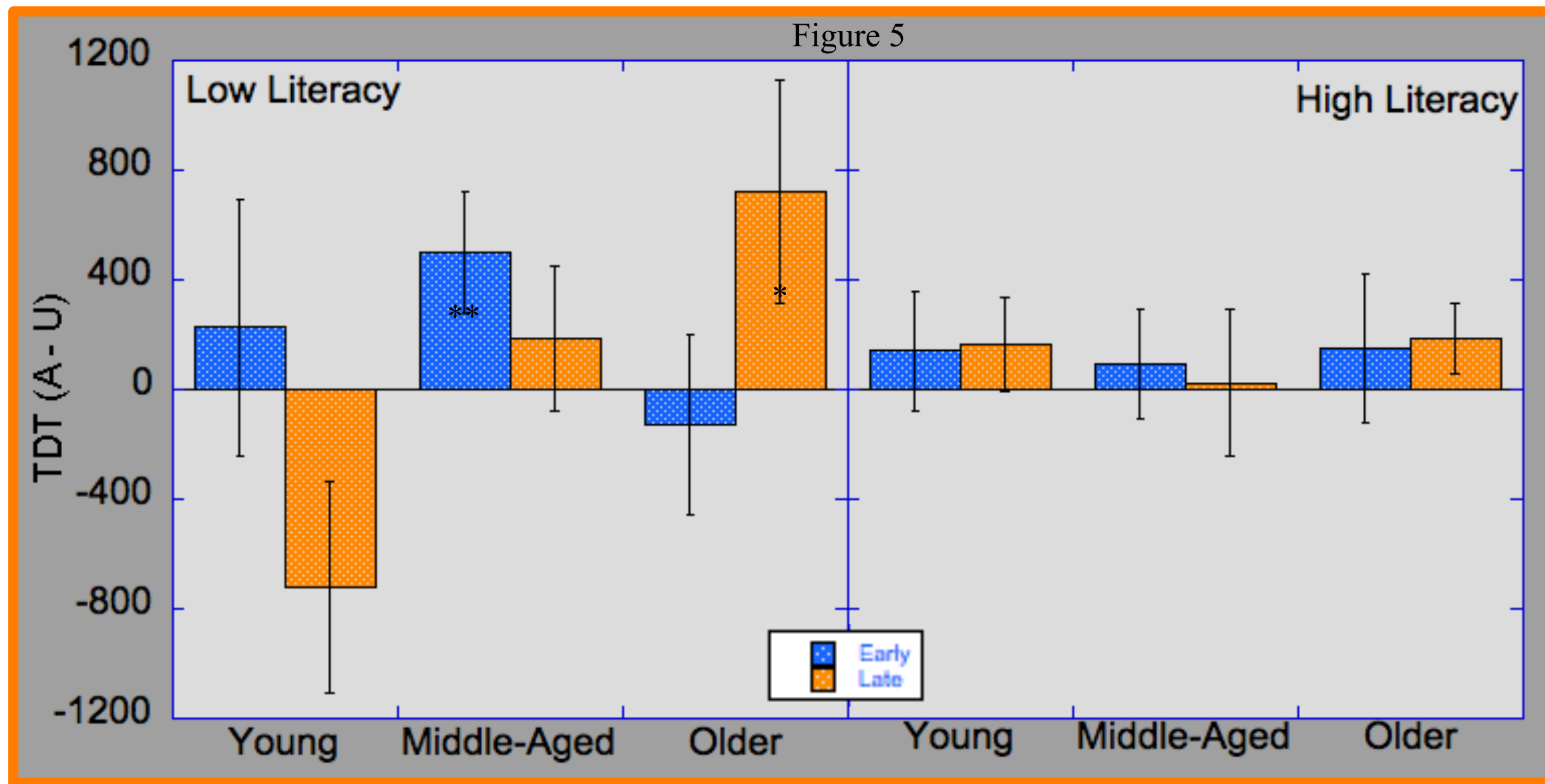
- FFDs at the target word (e.g., *hand*) were shorter in the ambiguous condition than the unambiguous condition ($F(1,76) = 10.50$, $p = 0.002$), suggesting that the inappropriate meaning of the ambiguous word remained active into the next sentence. This effect varied with group, $F(2,76) = 5.04$, $p = 0.009$, and only reached significance for the older HL group (**Figure 3**).

- HL readers were not disrupted by the ambiguity, but LL readers were marginally more likely to regress out from late target words (e.g., *hand*) when preceded by the ambiguous word, $F(1,76) = 2.93$, $p = 0.091$ (**Figure 4**).



Effects on Total Processing Time

- The ambiguity effect (Ambiguous - Unambiguous) on total trial dwell time (TDT) further suggested that LL readers were more disrupted by the ambiguity relative to LL readers, with sporadic effects depending on condition, $F(2,76) = 3.89$, $p = 0.025$ (**Figure 5**).



Conclusions

- Readers activate multiple meanings of ambiguous words even if they are contextually inappropriate, and this activation persists into the next sentence. The persistence of inappropriate activation varied somewhat with age and literacy skill.
- Ordinary lexical ambiguity was ultimately disruptive for only low literacy adults especially with increasing age.

References

- Duffy, S. A., Morris, R. K., Rayner, K. (1988). Lexical ambiguity and fixation times in reading. *Journal of Memory and Language*, 27, 429-446.
- Faust, M. E., Balota, D. A., Ducheck, J. M., Gernsbacher, M.A., Smith, S. (1997). Inhibitory control during sentence comprehension in individuals with dementia of the alzheimer type. *Brain and Language*, 57, 225-253.
- Gernsbacher, M.A., Varner, K.R., Faust, M.E. (1990). Investigating differences in general comprehension skill. *Journal of Experimental Psychology*, 16(3), 430-445.