Parafoveal Processing Influences Word Frequency & Predictability Effects on Eye Movements during Reading

Glasgow Language Processing

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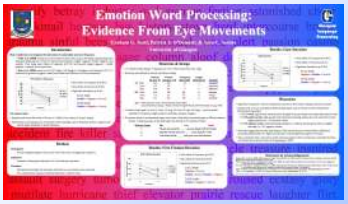
Emotion Word Processing: Evidence from Eye Movements

Scott, O'Donnell, & Sereno

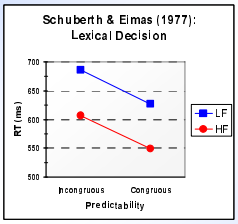


Frequency & Predictability

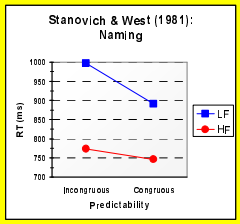
- **Word frequency**
  - High-frequency (**HF**) words are read more quickly than low-frequency (**LF**) words.
  - A ***word frequency effect*** (**HF<LF**) is used as a marker (index) of successful word recognition (lexical access).
- **Contextual Predictability**
  - Given a prior context, words that are highly predictable (**HP**) from context are read more quickly than those that are less predictable (**LP**).
  - The temporal locus of predictability effects, ***lexical*** (interactive) or ***post-lexical*** (modular), is a matter of continued debate.

Freq X Pred: Early RT Studies

Condition	Context	Target HF	Target LF
Congruous	*The skier was buried in the ...*	***snow***	***avalanche***
Incongruous	*The bodyguard drove the ...*		



Additive *or*



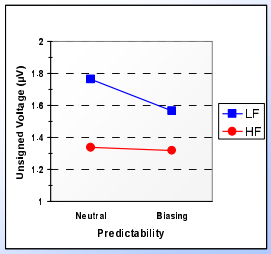
Interactive

Freq X Pred: ERP Study

Condition	Context	Target HF	Target LF
Biasing	*Flying to its nest was a...*	***bird***	***hawk***
Neutral	*To our surprise we saw a...*		

Sereno, Brewer, O'Donnell (2003)

N1 component: 132-192 ms



Freq X Pred: Eye Movements

Altarriba, Kroll, Sholl, & Rayner (1996)
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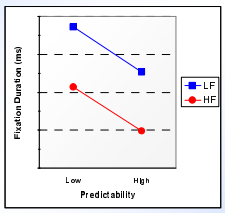
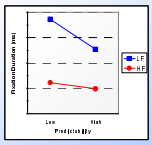
Rayner, Ashby, Pollatsek, & Reichle (2004)
Miellet, Sparrow, & Sereno (in press)

Inhoff (1984)





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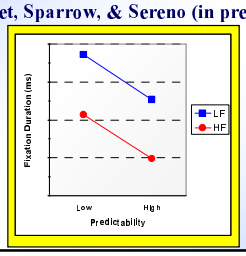

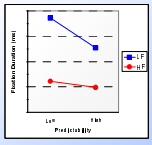

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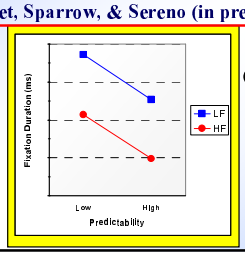
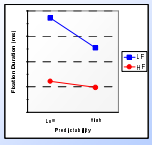
conducted en français





Rayner et al. (2004)

High Predictability

LF Bugs Bunny eats lots of ***carrots*** to stay healthy.

HF June Cleaver always serves meat and ***potatoes*** for dinner.

Low Predictability

LF June Cleaver always serves meat and ***carrots*** for dinner.

HF Bugs Bunny eats lots of ***potatoes*** to stay healthy.

Rayner et al. (2004)

Limitations	**Remedies**
Items per condition: ***8***	***22***
Targets embedded in: ***single sentence***	***2nd of 2 sentences***
Length of context (# pre-target words): ***7.7 words***	***15.5***

High Predictability

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Low Predictability

LF June Cleaver always serves meat and ***carrots*** for dinner.

HF Bugs Bunny eats lots of ***potatoes*** to stay healthy.

High Predictability

LF Although a rugby player, Clive struggled through the crowd at the bar carrying glasses of ***lager*** and bags of crisps.

HF Gillian was on the last mile of the women's marathon. She grabbed a bottle of ***water*** from a spectator and drank it.

Low Predictability

LF Gillian was on the last mile of the women's marathon. She grabbed a bottle of ***lager*** from a spectator and drank it.

HF Although a rugby player, Clive struggled through the crowd at the bar carrying glasses of ***water*** and bags of crisps.

High Predictability

LF Ingrid's boiler had suddenly broken down. Fortunately, her neighbour's father was a ***plumber*** and would be able to help.

HF Callum was having trouble with his homework. He asked his uncle who was a ***teacher*** to help him with the assignment.

Low Predictability

LF Callum was having trouble with his homework. He asked his uncle who was a ***plumber*** to help him with the assignment.

HF Ingrid's boiler had suddenly broken down. Fortunately, her neighbour's father was a ***teacher*** and would be able to help.

Method

- **Materials & Design**:
  Frequency (HF,LF) x Predictability (HP,LP)
  HF & LF targets matched pair-wise on word length (mean = 5.84 letters; range: 5-8 letters)

	HF		LF	
	HP	LP	HP	LP
Frequency (BNC, per million)	145	145	4	4
Predictability (1-7)	6.19	4.07	6.11	3.69
Cloze probability	.57	.02	.50	.01
# of items	22	22	22	22

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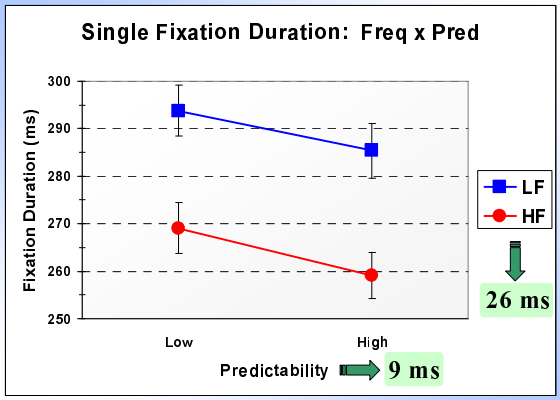
Method

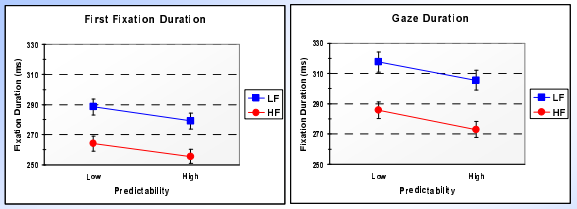
- **Participants**: 64 (mean age = 22; #F = 47)
- **Apparatus**:
  - Dual-Purkinje Eyetracker (Gen 5.5)
  - 4 characters ≈ 1° of visual angle
- **Procedure**:
  - 88 experimental passages
  - Yes/No comprehension questions on half the trials

Results: Fixation Time Measures

- **Early**
  - First fixation duration (FFD)
  - Single fixation duration (SFD)
  - Gaze duration (GD)
- **Later**
  - Next forward-going fixation after target ('spillover')
  - Total Fixation Time (TT)

reject	4%
skip	21%
1 fix	63%
2+ fix	12%





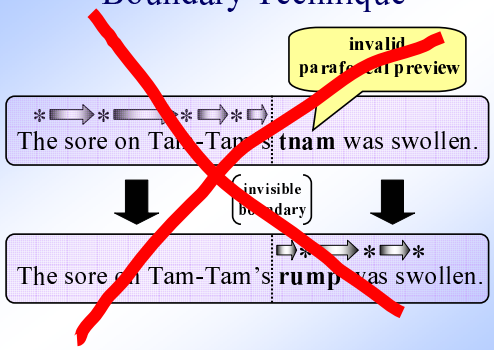
Just then, a smug grin comes over his face…

Ha! Told you so!

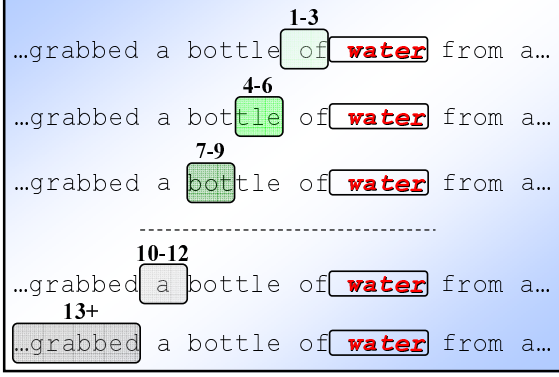
Parafoveal Pre-Processing

- In reading, words are initially processed ***parafoveally*** before they are directly foveated.
- Prior research indicates that both the ***frequency*** and ***predictability*** of the parafoveal word can influence its subsequent fixation duration.
- Specifically,
  - HF parafoveal words are subsequently fixated for less time than LF ones (Inhoff & Rayner, 1986).
  - HP parafoveal words are subsequently fixated for less time than LP ones (Balota, Pollatsek, & Rayner, 1985).

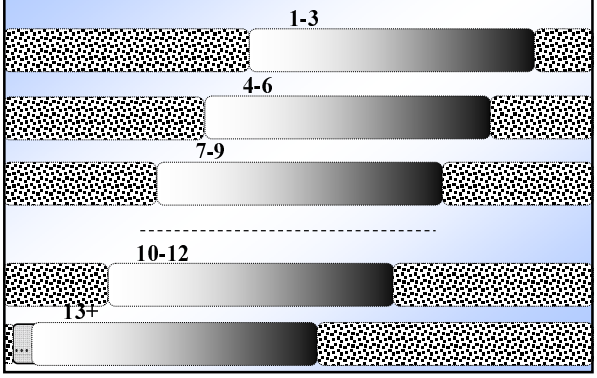
Boundary Technique



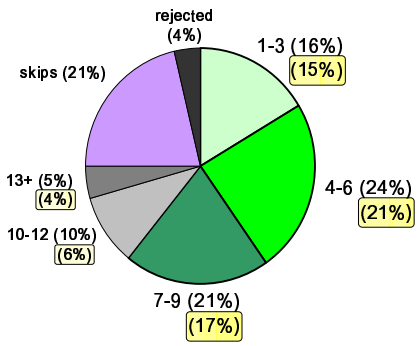
Launch Distance



(Poorly) Simulated Perceptual Span

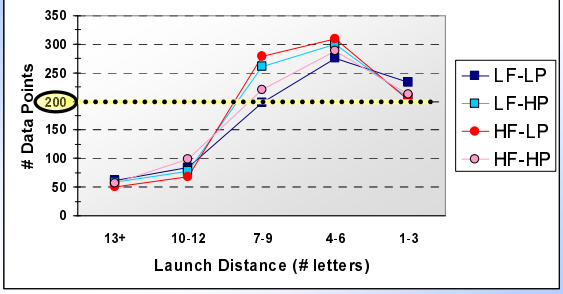


%Data Contingent on Launch Distance

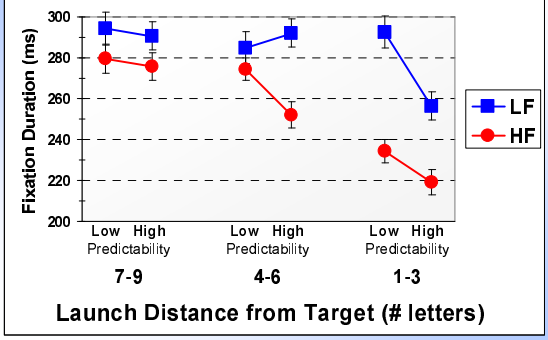


#subjects		#items per cond		#conditions		# data points
64	x	22	x	4	=	5632

Data Points by Condition: SFD



SFD: Freq x Pred X Launch



Summary of Results

- RT studies, in general, have found that word frequency and contextual predictability ***interact***.
- Eye movement studies, measuring target word fixation time in normal reading, have found that frequency and predictability are ***additive***.
- When the amount of parafoveal preview is manipulated (post-hoc via launch distance), however, different patterns of data emerge.

Summary of Results

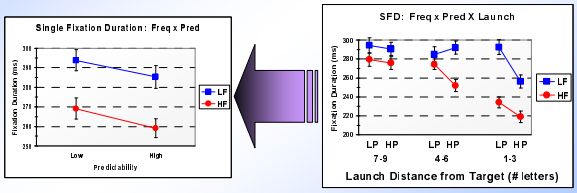
- Specifically,

Launch distance	Freq	Pred	FxP
Far (7-9)	✓		
Mid (4-6)	✓	HF	✓
Near (1-3)	✓	HF,LF	HF<LF

- Fixation duration *vs*. RT?
  - **Far** condition ≈ RT physically, but ***not*** behaviorally
  - **Near** condition ≈ RT behaviorally, but ***not*** physically

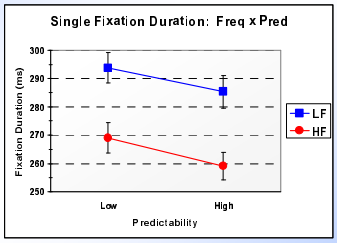
Conclusions

- Apparent ***additive*** effect of Freq & Pred in reading is comprised of opposing ***interactive*** effects.



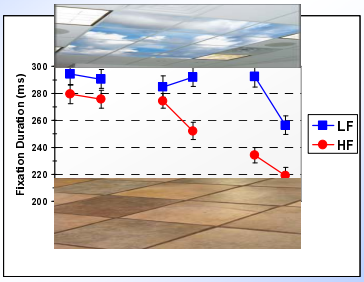
Conclusions

- Explanation 1: Frequency First



Conclusions

- Explanation 2: Floors & Ceilings



Conclusions

- Launch Site
  - Used as a tool to capture the temporal dynamics of parafoveal processing.
  - Demonstrated sensitivity to the temporal & spatial contingencies intrinsic to reading.
  - Provides a more fluid or transitional account of concurrent oculomotor and linguistic processing.

Thank y'all