Estimating Word's Predictability on Lexical Processing using Latent Semantic Analysis – Verification from Eye Movement Data

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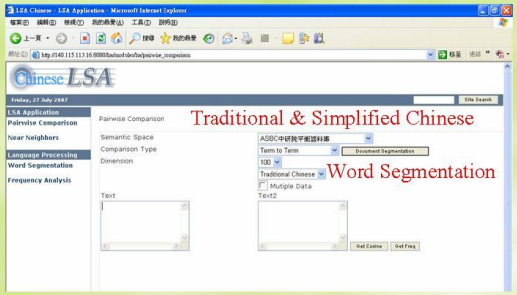
Word Predictability & Lexical Processing

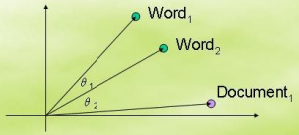
- E-Z Reader Model (Reichle, et al., 2003)
  - Early Stage (L1)
    - Orthographic Form
    - Familiar Check
    - $t(L_1)=[\beta_1 - \beta_2 \ln(\text{frequency})](1-\theta\ \textbf{predictability})$
  - Late Stage (L2)
    - Phonological / Semantic Form
    - Completion of Lexical Access
    - $t(L_2)=\Delta[\beta_1 - \beta_2 \ln(\text{frequency})](1-\textbf{predictability})$
  - Predictability Effect is stronger on L2 than on L1
- SWIFT Model (Engbert, et al., 2002)
  - $L_n = (1-p_n) I_n,\ I_n = \alpha - \beta \log(f_n)$
- High-predictable words are read faster than low-predictable words.
  - First Fixation Duration
  - Gaze Duration
  - Total Time
- High-predictable words are skipped more and re-fixated less than low-predictable words.
  - Skip Rate
  - Regression
- Chinese reader exploit target word predictability during reading. (Rayner, et al. 2005)

Latent Semantic Analysis (LSA)



Pairwise Comparison Application

- From ASBC (5M Chinese Words Corpus)
- Term-to-Document Co-occurrence Matrix
- 49021 Terms (Words)
- 40463 Documents (Paragraphs)
- Local & Global Weighting
- Singular Value Decomposition (SVD)
- High-Dimension Semantic Space
- Mean:0.067 Std: 0.115



Estimates of Predictability by LSA, Cloze Task and Transitional Probability

LSA vs. Cloze Task

- Re-analysis of Materials for P/U targets in Rayner, et al., 2004.
- Semantic Space of General English Reading (http://lsa.colorado.edu/)

Context_Pre	Context_Post	Target Word	Predictability	Freq	LSA
Most cowboys know how to ride a	if necessary.	horse	P	H	0.62
Most cowboys know how to ride a	if necessary.	camel	U	L	0.1
In the desert, many Arabs ride a	to get around.	horse	U	H	0.29
In the desert, many Arabs ride a	to get around.	camel	P	L	0.64

LSA CAN distinguish High- / Low- Predictability

LSA & Transitional Probability

- Previous Content Word vs. Target (LSA)
- Contextual Constraint (by LSA and TP)

他 在 沙漠 裡 騎 _____ 。
He desert ride

candidate	explanation	TP	LSA (沙漠)
著	[zhao1] catch/receive/suffer	0.231	0.35
馬	[ma3] horse/horse chess piece/Surname	0.139	0.77
腳踏車	[jiao3 ta4 che1] bicycle	0.134	0.07
⋮	⋮	⋮	⋮
駱駝	[luo4 tuo5] camel	0.004	**0.83**

Eye Movement Data vs. Estimated Predictability

Correlations Among Predictors

Variable	InFreq	WordLength	Strokes	LSA	TP
InFreq	—	-.639	-.570	.180	.306
WordLength		—	.044	-.128	-.318
Strokes			—	-.116	-.278
LSA				—	.301
TP					—

Frequency
Complexity
Predictability

Unstandardized Regression Coefficients

Variable	FFD Mean	FFD Std. D	GD Mean	GD Std. D	TotalTime Mean	TotalTime Std. D
WFreq	-5.2**	3.3	-6.6 **	3.9	-10.9**	9.7
WordLength	24.5**	8.7	35.1**	13.6	113.8**	31.5
Strokes	1.1**	0.7	1.5**	0.9	3.7**	1.7
LSA	*-5.2*	*14.4*	*-14.1*	*29.2*	-76.2**	55.5
TP	-56.1**	46.0	-43.5**	47.0	*36.6*	*174.5*

- LSA might be adopted to calculate contextual constraint and represent word predictability on lexical processing.

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