The psychological reality of formal regularities in Chinese characters

James Myers
National Chung Cheng University
Lngmyers@ccu.edu.tw

EACL-7 Venice 2011/9/13-15

Acknowledgments

- Thanks to National Science Council grant NSC 97-2410-H-194-067-MY3
- Thanks to lab assistants Hong Guo-Ming, Hsu Zi-Ping, Du Pei-Fen, Su Yu-Ting, Hsu Chiung-Wen
- And thanks to our participants for agreeing to do these weird experiments

Psychological reality

- Language is psychological, so all linguistic evidence implies "psychological reality" (Chomsky, 1980)
- Yet traditional linguistic evidence fails to demonstrate mental grammar (Ohala, 1986)
  - Phonological patterns may be historical relics, with speakers memorizing words as they are
- Experiments with nonce forms can test whether patterns go beyond rote memory

Formal regularities in grammar

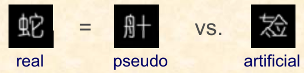
- Phonology is the level of language that is patterned (articulated) but meaningless
- It need not even be "interpreted" in sound
  - Prosodic elements (e.g., metrical feet) do not have straightforward acoustic correlates
  - Sign language has phonology without sound
- Can formal regularities in orthography also be considered a form of "phonology"?
  - And are they "psychologically real"?

Sign phonology vs. orthography

- Sign languages are natural languages
  - Linguistically (e.g., Sandler & Lillo-Martin, 2006)
  - Psycholinguistically (e.g., Emmorey, 2002)
- Orthography is not quite as "natural"
  - Parasitic on speech (e.g., DeFrancis, 1989)
  - Learned with effort (e.g., Koda & Zehler, 2008)
- Yet reading can bypass spoken phonology (e.g., Jobard et al., 2003)

Patterns in Chinese characters

- Iconicity: 山 vs. 土
  - Readers do see it (Luk & Bialystok, 2005)
- Semantic and phonological cues: 媽
  - Readers use both (e.g., Williams & Bever, 2010)
- Purely formal patterns
  - Overall shape: 師 vs. 常 vs. 席 (Yeh & Li, 2002)
  - Combinability of elements (Hsu et al., 2011)
  - Visual Word Form Area (Liu et al., 2008)



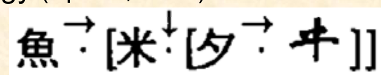
Character "grammar"?

- Duality of patterning

能　　月 公 北

- Morphology (Sproat, 2000)

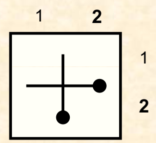
鱗



- Phonology
  - SPE-style analyses (Wang, 1983)
  - OT-style analyses (Goldberg & Goldberg, 2011)

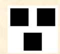
Character "prosody"?

- Global shape constraints (Myers, 1996)
  - Binarity
  - Prominence at right and bottom
- Similar to spoken/sign metrical feet
  - From biases in motor control, vision, cognition?



B W

Reduplication templates

- Binary horizontal reduplication
  林 比 兢 朋 弱 嚇 瑩 雙 選 竄 替 質
- Binary vertical reduplication
  昌 吕 圭 戔 多 炎 哥 棗 芻 患 僵 淼
- Triangular reduplication (binary both ways)
  品 惢 鑫 蟲 晶 畾 森 聶 众 磊 轟 犇
- The constraints are rarely or never violated
  - Binarity: 三 川 黑 靈 巡
  - Top-prominence triangles: *  cf. 桀

Semantic radical position

- Radicals prefer “weak” left or top positions
  位 她 棒 詞 安 笑 病
- Radicals in “weak” positions are reduced
  人:位 心:忙 水:泊 手:拾 竹:筆 艸:花
- Radicals not reduced in “strong” positions
  忘 vs. 忙 泉 vs. 泊 拿 vs. 拾 裏 vs. 裡
- Many exceptions:
  鵝 盒 氣 進 刀:刻 火:熟

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But are these patterns “real”?

- Do experienced readers know the reduplication generalizations?
  - Apparently nobody has ever tested this
- Do they know the radical generalizations?
  - They know radical position (e.g., Taft et al., 1999)
  - But do they generalize the left/top patterns?
- Do these two sets of generalizations share a single underlying explanation?
  (i.e., binary, bottom/right-prominent prosody)

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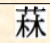
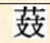
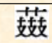
Testing reduplication: Design

- Grammaticality: Obey generalizations?
- Lexicality: Reduplication found in real characters?
- Shape: Horizontal, Vertical, Triangular
- 20 nonce characters each, Latin square design

Shape	+Lex+Gr	+Lex-Gr	-Lex+Gr	-Lex-Gr
Horizontal				
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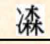
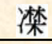
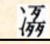
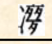
Triangular				

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Testing reduplication: Task

- Judge if nonce characters are Chinese-like
  - Binary scale (see, e.g., Weskott & Fanselow, 2011)
- 120 fillers
  - Combinations of real elements: 
  - One extra or missing stroke:  
  - Element flipped: 
- Judgment and reaction time both recorded
- Participants
  - 20 native Mandarin speakers in Taiwan

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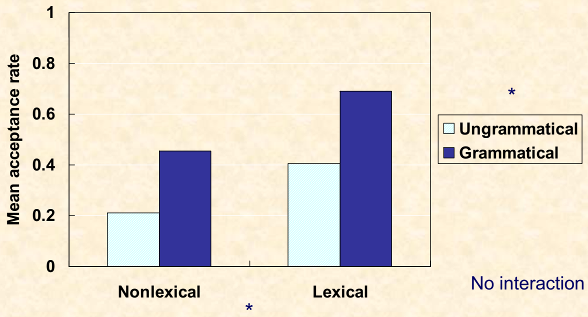
Reduplication judgments



No interaction

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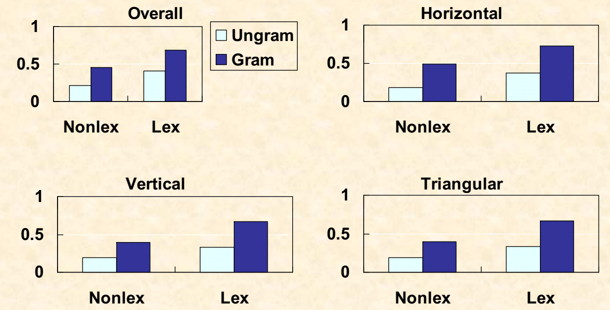
Reduplication judgments by shape



(weakest grammaticality effect)

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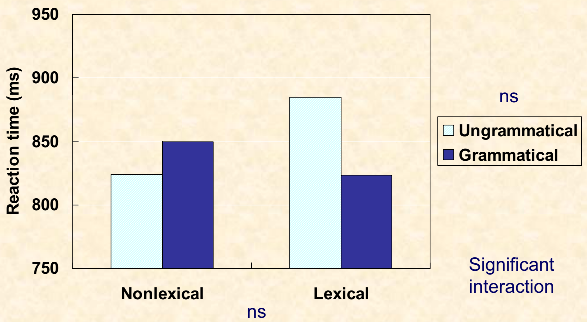
Reduplication reaction times



Significant interaction

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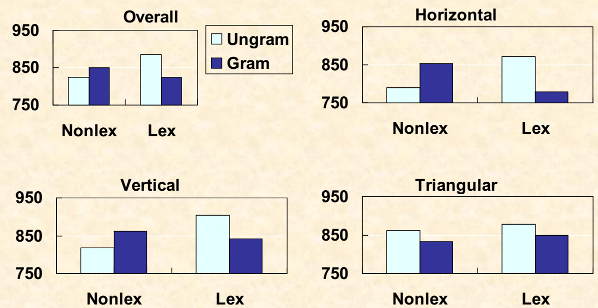
Reduplication RTs by shape



(not signficant)

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Reduplication: Summary

- Readers do generalize the reduplication pattern beyond their lexical experience
- In judgments, size of grammaticality effect is the same regardless of lexical status
- Reaction times show different processes for lexical vs. nonlexical items
  - Lexical: Lexical access (faster for real)
  - Nonlexical: Violation detection (faster for bad)
- Triangular pattern is the least active

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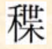
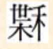
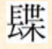
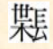
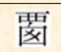
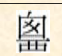
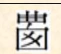
Testing radical position: Design

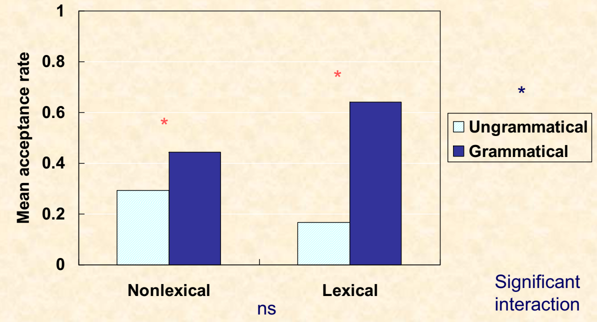
- Grammaticality: Obey generalizations?
- Lexicality: Real radical?
- Shape: Horizontal, Vertical
- 15 nonce characters each, Latin square design

Shape	+Lex+Gr	+Lex-Gr	-Lex+Gr	-Lex-Gr
Horizontal				
Vertical				

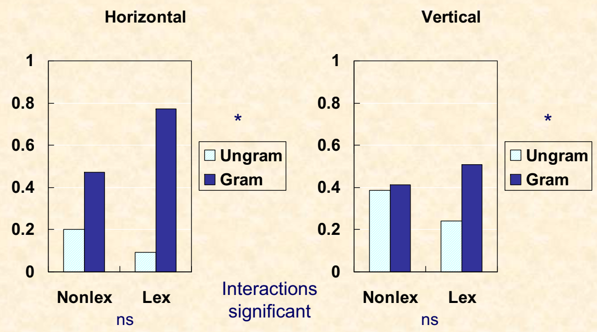
Testing radical position: Task

- Judge if nonce characters are Chinese-like
  - Binary scale: like vs. unlike Chinese character
- 60 fillers
  - Selected from reduplication experiment
- Judgment and reaction time both recorded
- Participants
  - 20 native Mandarin speakers in Taiwan
  - Different from reduplication experiment

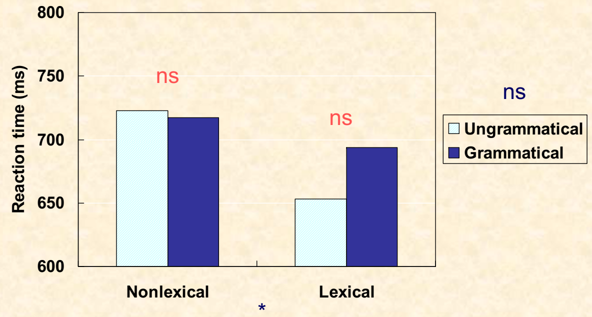
Radical position judgments



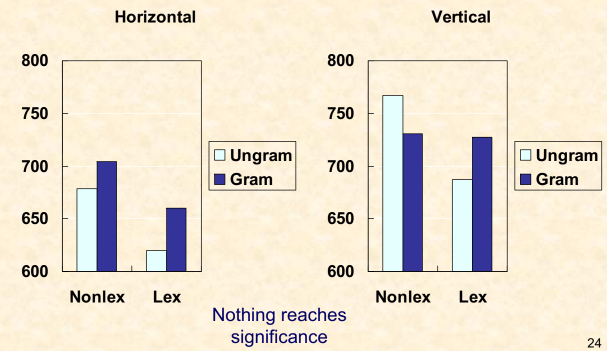
Radical judgments by shape



Radical reaction times



Radical RTs by shape

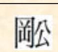
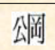
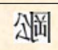


Radical position: Summary

- Readers generalize beyond lexical radicals, but only for horizontal orientation
  - This may be because left radicals are much more common than top radicals
- Reaction times only show effect of lexical status: lexical radicals are judged faster
  - Greater effect of lexical status compared with reduplication may relate to closed-class nature of radicals

Are the patterns related?

- Do judgments of reduplication and radicals recruit the same (prosodic) structures?
- If so, perhaps one will facilitate the other
- Our first try at this gave a null result…

	Prime pair		Target pair	
Prosodic				
Phonetic				

Conclusions

- Purely formal orthographic regularities can be psychologically real
  - Even beyond memorized exemplars
- Linguistic analysis suggests that some of these regularities are similar to prosody
- The search continues for evidence that "orthographic prosody" is itself psychologically real

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