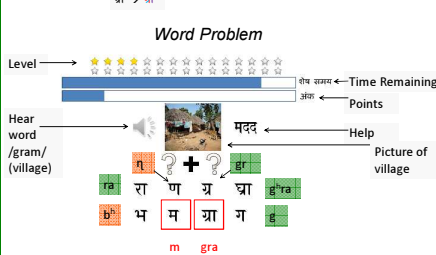# improving akshara knowledge via a mobile game

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introduction

- Hindi "letters" (akshara) represent open syllables
- Akshara are difficult to learn because there are more than 400 akshara[1] and they are visually complex
- Akshara types
  - Simple: Consonant + inherent schwa kə = क
    Vowel e = ए
  - CV: Consonant-vowel ke = के
  - Complex: Has consonant clusters ske = स्के
- Complex akshara are particularly difficult for children to learn
  - Only 55% correct identification in 4th grade[2]
    s + p + r + i + g = sprig
    स + प + र + इ + ग = स्प्रिग

mobile game

- Developed a mobile game that teaches complex akshara
- Played for twelve 30 minute sessions
- 30 levels with 10 akshara each
- 2 problem types
  - Akshara: Identify akshara components
  - Word: Practice words containing those akshara

Akshara Problem

Level ➝ ☆☆☆☆☆☆
शेष समय ➝ Time Remaining
अंक ➝ Points

ग्रा = ? + ? + ?

| आ | ओ | अं | ग | ज | त |
| धू | प | य | र | ल | व |

रंग ➝ आवाज़ 🔊
Color
ग्रा ➝ ग्रा
Sound

Word Problem

Level ➝ ☆☆☆☆☆☆☆☆☆☆
शेष समय ➝ Time Remaining
अंक ➝ Points

Hear word /gram/ (village)
मदद ➝ Help
Picture of village

η + ? = gr

| ra | रा | ण | ग्र | घा | g^hra |
| b^h | भ | म | ग्रा | ग |

m   gra

- 2 game versions
  - Narrow spacing alternated between akshara and word problems
  - Wide spacing had 10 akshara problems followed by 10 word problems

pre/post-tests

- Non-verbal IQ (Pre-test only)
  - WASI matrix reasoning
- Basic arithmetic
  - Tests specificity of intervention
- Akshara Recognition
  - Read 3 types of akshara: simple, CV, and complex
- Word Reading
  - Words without complex akshara, words with complex akshara learned in game, transfer words with complex akshara
- Spelling
  - Words without complex akshara, words with complex akshara learned in game, transfer words with complex akshara
- Akshara construction
  - Tests knowledge of abstract ligaturing rules
  - Made-up a pretend symbol and told them it represents the /l/ sound
  - Asked them to combine it with Hindi akshara they know

ए = l   चे = ple

- Vocabulary
  - Verbally define 3 word types:
    1. Words taught in game
    2. Words morphologically related to those taught in game
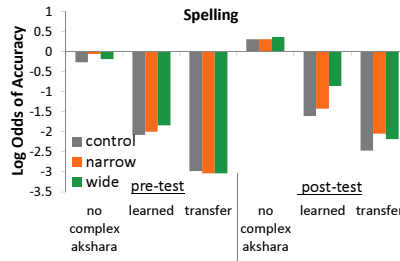   3. Words not in game

participants

- 108 4th grade girls living in Bangalore, India
- Hindi was their 3rd language
- 3 experimental groups (matched at pre-test)
  - Unseen control
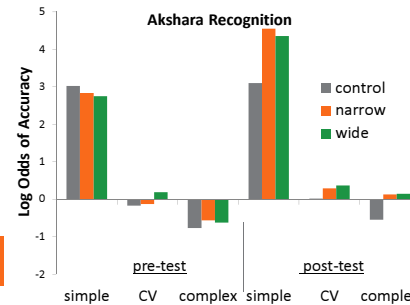 - Narrow spacing experimental
  - Wide spacing experimental

results: game play

- Narrow-spacing experimental group played faster than wide-spacing experimental group
  - Finished more levels/session
  - Tended to finish each level more quickly
  - 17 students in narrow spacing version finished game whereas only 11 in wide spacing version did
- Large individual differences
  - 3 students finished all 30 levels in 6 sessions
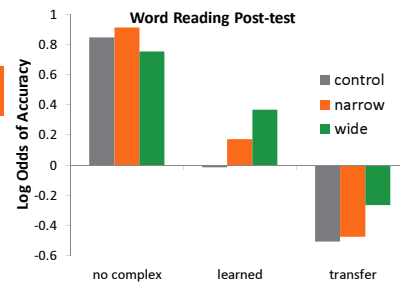 - 1 student finished 14 levels after 12 sessions

results: pre/post-tests

Spelling

(Bar chart: Log Odds of Accuracy, y-axis from -3.5 to 1; legend: control, narrow, wide; pre-test and post-test groups; categories: no complex akshara, learned, transfer)

- Intervention groups improved more than control group on words with complex akshara
- The wide spacing group improved more than the narrow spacing group on learned items

Akshara Recognition

(Bar chart: Log Odds of Accuracy, y-axis from -2 to 5; legend: control, narrow, wide; pre-test and post-test; categories: simple, CV, complex)

- Control group did not improve
- Intervention groups improved on all 3 akshara types; most improvement on simple akshara

Word Reading Post-test

(Bar chart: Log Odds of Accuracy, y-axis from -0.6 to 1; legend: control, narrow, wide; categories: no complex akshara, learned, transfer)

- The advantage of the wide spacing group over the narrow spacing group most apparent on words with complex akshara

results (cont.)

No intervention effects on…
- Arithmetic (as expected)
- Vocabulary (not goal of intervention)
- Akshara construction (too few items)

Overall, the pattern of results suggests that…
- Narrow spacing version played faster than wide spacing version
- Intervention helped participants spell words with complex akshara
- Wide spacing group better at spelling words learned in game
- Intervention helped participants recognize akshara
- Wide spacing version helped participants read words with complex akshara
  - Benefit of wide over narrow spacing version could be due to desirable difficulties

future directions

- Still analyzing word reading pre-test
- Game play logs
- Error analysis

other game targets

The intervention targeted complex akshara because research has suggested that these akshara are particularly challenging. The post-tests revealed some other aspects of Hindi that are also difficult, and could be targeted by future iterations of the game.

- Differentiating similar sounds
  - Alveolar vs. retroflex
    - In spelling post-test, 88% of students replaced a retroflex "n" with an alveolar "n"
  - Aspiration
    - In akshara recognition post-test, 67% of students pronounced /b^hi/ as /bi/
    - In spelling post-test, 66% of students replaced /tʃʰ/ with /tʃ/
- Rare vowels
  - In akshara recognition post-test, only 14% of students pronounced /tʃɛ/ correctly

references

[1]Nag, S. (2011). The akshara languages: What do they tell us about children's literacy learning ? *Language cognition interface: State of the art* (pp. 291–310).

[2]Nag, S. (2007). Early reading in Kannada: The pace of acquisition of orthographic knowledge and phonemic awareness. *Journal of Research in Reading, 30*(1), 7–22. doi:10.1111/j.1467-9817.2006.00329.x

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