

Learning to identify letters: Generalization in high-level perceptual learning

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INTRODUCTION

Learning to identify letters is crucial to reading. A series of three experiments explores the specificity of letter learning, assessing transfer of learning across letters (Exp. I), from part to whole (Exp. II), and across the visual field (Exp. III).

GENERAL METHODS

Observers identified briefly-presented (200 ms) Chinese and Armenian letters in visual noise. We measured threshold contrast for 64% correct letter identification for human and ideal observers, and calculated efficiency as the ratio of these squared contrast thresholds. Efficiency is the fraction of energy required by the human observer that suffices for the ideal observer to perform the same task.



English letters of decreasing contrast in noise (Pelli & Farrell, 1999). How far can you read? The average among our observers is 7 letters.

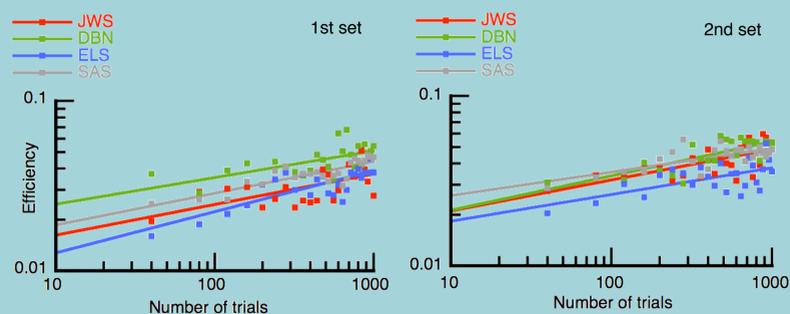
EXP I: LETTER-TO-LETTER TRANSFER

Observers were trained on one set of Chinese characters before being tested on a second set of Chinese characters.

Table 1: Sets of Chinese characters

Set	Characters
A	會 說 是 問 兩
B	多 請 少 好 見

RESULTS I



Observers were no better at learning to identify an unfamiliar set of characters after having already learned five characters from the same alphabet.

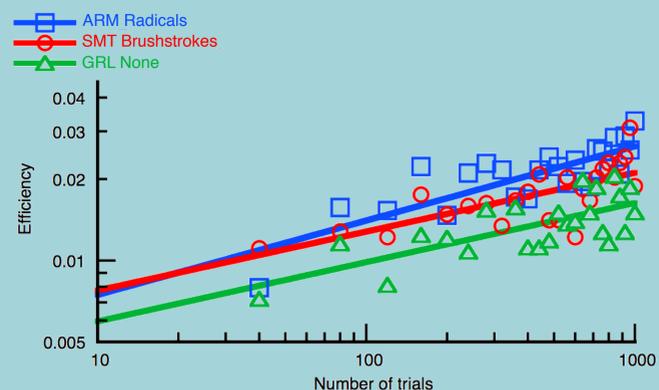
EXP II: PART-TO-WHOLE TRANSFER

Observers trained on the component brushstrokes and radicals of a set of Chinese characters before learning the characters themselves. A radical is a combination of brushstrokes of specific orientation.

Table 2: Characters and their component brushstrokes and radicals

Character	Pinyin name	English meaning	Component radicals	Component brushstrokes
木少	MIAO	beard of grain; smallest part; a measure for seconds	木 少	丨 一
牧	MU	to herd or tend	牛 攴	丿 ㇇
环	HUAN	to encircle; ring or bracelet	王 不	丿 ㇇
欣	XIN	to be happy	斤 欠	㇇ ㇇

RESULTS II



Radical and brushstroke training improved efficiency for identifying a set of characters comprised of those radicals and brushstrokes.

EXP III: TRANSFER ACROSS VISUAL FIELD

Observers trained on characters displayed at 0, 5, or 15 degrees from fixation before being tested on those same characters at all three locations. Each set shown below was used at a different eccentricity for each observer.

Table 3: Sets of the Armenian alphabet

Set	Letters
A	Ի Բ Յ Կ
B	Ր Ն Բ Պ
C	Ս Ժ Թ Ա

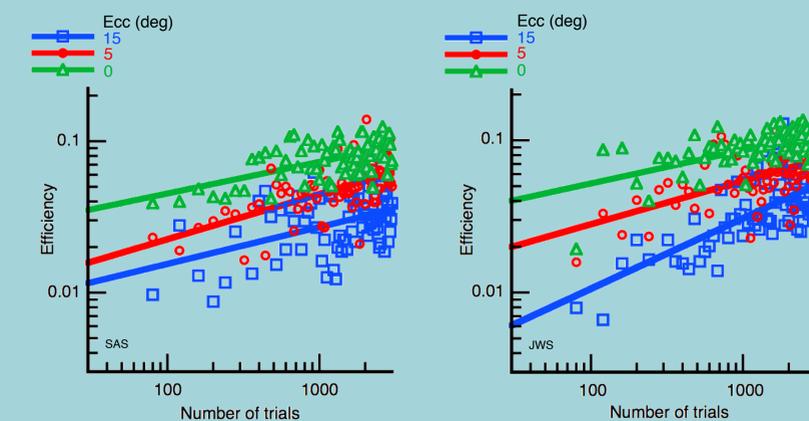
DEMO

Fixate the +. Starting from the most central, try to identify each letter out of the corner of your eye:

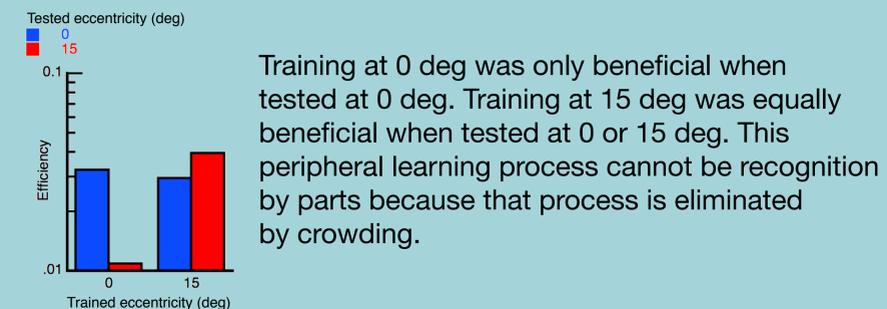
+ G H Q P

Letters displayed peripherally appear jumbled, due to a phenomenon known as *crowding*, which prevents recognition by parts (Martelli et al., 2005).

RESULTS III



Observers' efficiency showed a strong eccentricity-dependence, with learning at 0 deg reaching an efficiency three times that of learning at 15 deg.



Training at 0 deg was only beneficial when tested at 0 deg. Training at 15 deg was equally beneficial when tested at 0 or 15 deg. This peripheral learning process cannot be recognition by parts because that process is eliminated by crowding.

CONCLUSION

Letter learning is found to be quick, letter-specific, and eccentricity dependent. Observers triple their efficiency for identifying a previously unfamiliar alphabet after only 50 seconds per letter (over 250 trials) of near-threshold exposure. When learning to identify a letter, observers need not relearn combinations of features with which they are already familiar. Foveal learning is location-specific, while peripheral learning generalizes well to other locations. These results strongly suggest a dual mechanism approach to learning letters: a central by-parts process by which observers associate parts of letters with which they are already familiar, and a ubiquitous holistic process that relies on letter shape.

REFERENCES

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 Martelli, M., Majaj, N. J., & Pelli, D. G. (2005) Are faces processed like words? A diagnostic test for recognition by parts. *Journal of Vision*, 5(1), 58-70.
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