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ORIGINAL ARTICLE

The effect of letter string length and report condition on letter recognition accuracy

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Letter sequence recognition;
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Abstract
Purpose: Letter sequence recognition accuracy has been postulated to be limited primarily by low-level visual factors. The influence of high level factors such as visual memory (load and decay) has been largely overlooked. This study provides insight into the role of these factors by investigating the interaction between letter sequence recognition accuracy, letter string length and report condition.
Methods: Letter sequence recognition accuracy for trigrams and pentagrams were measured in 10 adult subjects for two report conditions. In the complete report condition subjects reported all 3 or all 5 letters comprising trigrams and pentagrams, respectively. In the partial report condition, subjects reported only a single letter in the trigram or pentagram. Letters were presented for 100 ms and rendered in high contrast, using black lowercase Courier font that subtended 0.4° at the fixation distance of 0.57 m.
Results: Letter sequence recognition accuracy was consistently higher for trigrams compared to pentagrams especially for letter positions away from fixation. While partial report increased recognition accuracy in both string length conditions, the effect was larger for pentagrams, and most evident for the final letter positions within trigrams and pentagrams. The effect of partial report on recognition accuracy for the final letter positions increased as eccentricity increased away from fixation, and was independent of the inner/outer position of a letter.
Conclusions: Higher-level visual memory functions (memory load and decay) play a role in letter sequence recognition accuracy. There is also suggestion of additional delays imposed on memory encoding by crowded letter elements.

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PALABRAS CLAVE
Reconocimiento de la secuencia de letras;
Pentagramas;
Trigramas;
Crowding (amontonamiento);
Carga de la memoria

Efecto de la longitud de la cadena de letras y de la condición reportada sobre la precisión del reconocimiento de letras

Resumen
Objetivo: Se ha postulado que la precisión del reconocimiento de la secuencia de letras se ve limitada por los factores visuales de bajo nivel. La influencia de los factores de alto nivel, tales como la memoria visual (carga y deterioro) se ha ignorado en muchas ocasiones. Este estudio aporta mayor información sobre la función de dichos factores, al investigar la interacción entre la precisión del reconocimiento de la secuencia de letras, la longitud de la cadena de letras, y la condición reportada.
Métodos: Se midió la precisión del reconocimiento de la secuencia de letras para trigramas y pentagramas en 10 sujetos adultos, para dos condiciones de reporte. En la condición de reporte completa, los sujetos reportaron las 3 ó 5 letras incluidas en los trigramas y pentagramas, respectivamente. En la condición de reporte parcial, los sujetos reportaron únicamente una letra del trigrama o pentagrama. Las letras se presentaron durante 100 milisegundos en alto contraste, con fuente y letra minúscula Courier, subtendiendo 0,4 grados a una distancia de fijación de 0,57 m.
Resultados: La precisión del reconocimiento de la secuencia de letras fue consistentemente superior en los trigramas, en comparación a los pentagramas, y en especial para las posiciones de las letras alejadas de la fijación. A pesar de que el reporte parcial incrementó la precisión del reconocimiento en ambas situaciones de longitud de la cadena, el efecto fue superior en los pentagramas, y más evidente para las posiciones de la letra final de los trigramas y pentagramas. El efecto del reporte parcial en la precisión del reconocimiento para las posiciones de la letra final se incrementó a medida que se incrementó la excentricidad alejándose de la fijación, siendo independiente de la posición interna/externa de una letra.
Conclusiones: Las funciones de la memoria visual de mayor nivel (carga y deterioro de memoria) juegan una función en la precisión del reconocimiento de la secuencia de letras. Esto sugiere también unas demoras adicionales impuestas sobre la codificación de la memoria, por parte de los elementos del amontonamiento de letras.

Introduction

The process of visual based reading is a learned behavior which involves complex interactions between several processing systems which include (but is not limited to) letter processing, phonological processing, lexical processing, eye movements and contextual influences.[1]

Low level limitations imposed on reading processes by letter sequence recognition accuracy have been inferred from associations between the visual span and reading speed for both central and peripheral viewing.[2,3] The visual span is defined as the number of letters that can be correctly recognized at and on either side of fixation without the execution of an eye movement.[2–4] Essentially, the hypothesis posed by supporters of the theory assert that shrinkage in the size of the visual span is associated with proportional decreases in reading speed, possibly due to the need for more frequent fixations and saccadic eye movements,[2,3] specifically for paragraph reading. Indeed, both visual span and reading speed have shown similar dependency with retinal eccentricity, letter contrast, letter size, and interletter spacing.[2–5] Furthermore, developmental changes in the visual span also seemed to parallel developmental changes in reading speed.[6] Therefore, based upon these observations and others, it has been proposed that the visual span interacts as a causal factor by posing as a sensory bottleneck for visual information available to higher level processes.[2,3]

Typically, the sizes of visual spans in these studies have been computed from ''visual span profiles'' which plot letter recognition accuracy for letters presented at and on either side of fixation.[2,3] Furthermore, the visual spans in these studies have been confined to the use of trigrams which are random 3-letter strings. It is this observation that forms the basis of the current study. Letter recognition accuracy is known to decrease as string length is increased,[7] and reading rate of randomly presented words also decreases as word length increases for a given contrast.[4] Additionally, the average word length in English text is about 5.1 characters,[8] and the average word length of the 1000 most frequently used words in the Corpus of Contemporary American English is approximately 5.5. Furthermore, it is also known that memory load affects recall accuracy as a function of time following the presentation of the stimulus[9] and as a function of its serial position of presentation.[10,11] Additionally, depending on the cognitive task and the stimulus complexity, the human visual system exhibits a finite capacity to store short-term visual information, which in the case of letters

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