Abstract. When alphabetic stimuli are presented very briefly, people perceive real words better than nonwords. It is generally accepted that this word superiority effect reflects the efficiency of visual word perception. However, much of what is known about this effect comes from research conducted in languages using the Latin alphabet (eg English, French, Italian), and little is known about whether alphabetic languages with visual properties fundamentally different from Latinate languages also produce word superiority effects. We report an experiment in which stimuli (words, illegal nonwords, and pseudowords) were presented in Arabic, which is a cursive script, read from right to left. The findings revealed advantages for words over pseudowords and illegal nonwords, and for pseudowords over illegal nonwords, indicating that the superiority effects reported for Latinate languages are also observed in Arabic. Implications of these findings for understanding the processes involved in word recognition are discussed.

Since the 19th century (eg Cattell 1886; Pillsbury 1897), investigations of the perceptibility of alphabetic stimuli have inspired considerable interest in how the physical characteristics of words are processed. One particularly influential finding, reported by Cattell and subsequently replicated in numerous studies, is that, when stimuli are presented very briefly, people perceive real words better than nonwords (eg Baron and Thurston 1973; Jordan et al 2000; Reicher 1969; Wheeler 1970). This phenomenon, called ‘the word superiority effect’, suggests that, when viewing time is limited, the physical characteristics of words produce a more perceptible display than other types of alphabetic stimulus (for a review, see Grainger 2008).

It is generally accepted that this superiority effect reflects the efficiency of visual word perception. However, much of what is known about the effect comes from research conducted in languages using the Latin alphabet (eg English, French, Italian). Consequently, although this research is clearly important, much of the information about the processes that underlie word superiority in alphabetic languages is derived from languages in which text is read from left to right, and in which individual letters are typically clear and readily segregated. As a result, little is known about whether alphabetic languages with visual properties fundamentally different from Latinate languages also produce word superiority effects.

Arabic has the second-most widely-used alphabet in human societies, after the Latin alphabet, and yet Arabic is notably absent from word-superiority research. However, unlike languages using the Latin alphabet, Arabic is formed in cursive script in which spaces seldom exist between letters in words, even when formally printed, and this may present problems for efficient word perception (eg Elanwar et al 2007). In addition, Arabic is read from right to left and produces different patterns of viewing positions within words compared with Latinate languages (eg Farid and Grainger 1996). Both these characteristics set Arabic apart from the alphabetic languages generally used to study word superiority. However, little is known about processes underlying Arabic word perception, and it remains to be seen whether Arabic is capable of producing a word superiority effect, especially since key elements associated with word perception in Latinate languages are lacking.

The existence of word superiority effects in nonalphabetic languages (eg Chinese) is unclear (eg Cheng 1981).
We report an experiment to determine whether the word superiority effect exists in Arabic. Following previous word superiority research, the experiment used the two-alternative Reicher–Wheeler task (Reicher 1969; Wheeler 1970) to suppress influences of guesswork which may artifactually advantage words (e.g., Johnston 1978). Previous research has sometimes also shown a small advantage for ‘legal’ nonwords (called pseudowords; e.g., ‘dulk’) over ‘illegal’ nonwords (e.g., ‘dlku’), referred to as the pseudoword superiority effect, due to the ability of pseudowords to partially activate processes normally involved in word perception (e.g., Carr 1986; McClelland and Rumelhart 1981). For completeness, both types of nonword were used in the experiment.

Participants were twenty monolingual Arabic speakers with normal or corrected-to-normal acuity. Stimuli were 150 pairs of five-letter Arabic letter-strings, 50 shown in each of three matched conditions: words, pseudowords, illegal nonwords (see figure 1a). Members of each pair differed in just one letter position (matched across words, pseudowords, and illegal nonwords), and the differences occurred equally often across all positions.

Stimuli were presented individually, in random order, on a high-definition monitor; a Cambridge Research Systems VSG 2/5 card controlled stimulus presentations and timings. Each stimulus was displayed briefly (for 17 ms) at the screen centre and responses were made via a Cambridge Research Systems CT3 keypad. After each display, the stimulus and its pair mate were presented, and participants had to select which had been shown by pressing the appropriate key.

<table>
<thead>
<tr>
<th>Stimulus condition</th>
<th>words</th>
<th>pseudowords</th>
<th>illegal nonwords</th>
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<tbody>
<tr>
<td>تعليق</td>
<td>بعلانق</td>
<td>لبتعيق</td>
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Figure 1. (a) Examples of word, pseudoword, and illegal nonword stimuli. In this example, the final (leftmost) position was tested. (b) Mean accuracy for stimuli in each condition. Bars correspond to 95% confidence intervals (e.g., Loftus and Masson 1994).

The means for each condition are shown in figure 1b. An analysis of variance revealed a significant effect of stimulus condition ($F_{2,38} = 12.01, p < 0.001, \eta^2 = 0.39$). Words were reported most accurately of all (86%, $p < 0.01$), and pseudowords (81%) were reported more accurately than illegal nonwords (78%, $p < 0.01$).

These findings revealed clear advantages for words over pseudowords and illegal nonwords, and for pseudowords over illegal nonwords, indicating that the superiority effects reported previously for languages formed from the Latin alphabet are also observed.
in Arabic. Research in reading Arabic is developing rapidly, in both the psychological and computational domains (e.g. Elanwar et al. 2007; Ibrahim and Eviatar 2009), and these new findings provide an important basis for revealing the processes underlying Arabic word perception. In particular, the findings show that, although superiority effects are likely to reflect the efficiency with which visually presented words are processed, this efficiency occurs even when languages do not facilitate the ready segregation of individual letters and are read from right to left. Thus, even under the very brief viewing conditions used to reveal word superiority effects, these characteristics of Arabic stimuli do not thwart the impressive relative efficiency of visual word perception, and suggest that perceptual superiority of words in Arabic (and perhaps other languages too) rely on features that are greater than individual letters, derived from supra-letter or configural analyses of letter groups and whole words (e.g. Allen et al. 2009; Jordan 1990; Patching and Jordan 2005). Finally, and more broadly, the demonstration of word and pseudoword superiority effects in Arabic indicates that these perceptual phenomena represent a global aspect of human alphabetic language perception that exists even in linguistic cultures in which the visual composition of words differs substantially from that of ubiquitous Latinate languages.

References
Baron J, Thurston I, 1973 “An analysis of the word superiority effect” Cognitive Psychology 4 207 – 228
Cattell J M, 1886 “The time taken up by cerebral operations” Mind 11 220 – 242
Pillsbury W B, 1897 “A study in apperception” American Journal of Psychology 8 315 – 393
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