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A new demonstration of the illusory letters phenomenon: Graphemic restoration in Arabic word perception

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Abstract

The Illusory Letters Phenomenon (ILP) is a unique demonstration that words can be perceived as complete even when letters are physically absent. However, the ILP has only ever been reported for a Latinate language (English) and it is unknown whether the illusion occurs for alphabetic languages with fundamentally different visual properties. Here we report a demonstration of the ILP for Arabic in which stimuli containing only the exterior letters of three-letter Arabic words and a nonsense pattern in the interior position were presented to fluent Arabic readers. Despite being incomplete, participants perceived these stimuli as complete Arabic words with all letters visible in their appropriate positions, and were unable to distinguish between illusory and normal displays. This finding provides an important extension of the original ILP and suggests that alphabetic languages may be widely susceptible to the phenomenon and reading generally may occur as a process augmented by illusory percepts.

A major challenge for visual word recognition research is to determine which components of words are necessary for lexical access to occur (e.g., Grainger, 2008; Jordan, 1990). One approach to this challenge involves identifying situations in which words are perceived as complete even when letters are absent. Indeed, an early example of this phenomenon was reported by Pillsbury (1897) who described studies in which incomplete words were formed from real words (e.g., *chimney*) by letter replacement (*chimnzy*) or letter omission (*chimny*). When these incomplete words were presented briefly, participants sometimes reported seeing words in their entirety, with all letters present, despite the obvious nature of each incomplete stimulus when viewed for longer durations.

A little over 100 years later, Jordan, Thomas and Scott-Brown (1999) reported in *Perception* a demonstration that the illusory restoration of missing letters in words can occur more reliably, and when viewing time is unlimited. In this study, the two exterior letters of four-letter English words (e.g., h　d) were presented with a nonsense pattern composed only of diagonal lines in each interior position (see Figure 1). When these stimuli were presented for unlimited durations, observers reported a range of illusory contours that made each stimulus appear to be a normal, complete, four-letter English word (the *Illusory Letters Phenomenon* or ILP). Indeed, participants were able to trace the outline of four letters in each stimulus, including letters in interior positions that were not actually present, and were unable to distinguish between words that were illusory and words that were physically complete.

The nature of the ILP indicates that the phenomenon is more than just a demonstration that incomplete words can produce lexical activation. For example, other studies have shown that brief presentations of incomplete word primes can improve word recognition (e.g., *apricot* preceded by *arict*; e.g., Grainger, Granier, Farioli, Van Assche, & van Heuven (2006), and that incomplete "leet" words (e.g., *R3AD*) and transposed words (e.g., *raeding*) allow some form of reading to take place despite the obvious disruption of normal orthographic content in these stimuli (e.g., Perea, Duñabeitia, & Carreiras, 2008; Rayner, White, Johnson, & Liversedge, 2006; see also Fang & Wu, 1989). But

while these effects provide important evidence that lexical activation can happen when incomplete

words are presented, the paradigms used do not provide clear evidence that the illusory perception of

complete words has actually occurred. For example, it is unclear in the brief priming paradigm that

incomplete word primes are perceived as complete words, and when reading leet words and transposed

words, the disrupted orthographic content of these stimuli is frequently apparent to participants. In

contrast, in the ILP, the observer's subjective experience is of actually perceiving complete words, with

all letters fully-formed and in their appropriate locations, even though the normal physical bases for

these complete perceptions are not present in the display. Thus, the effect is truly an illusion, where

perception is clearly separated from sensation.

However, the ILP has only ever been reported for English, and it may be that printed English

(and other Latinate languages) lends itself unusually well to producing the phenomenon. In particular,

letters in English have a constant size and shape within a typeface and, when printed, are spatially

separable and distinct (like the words on this page). Under these conditions, therefore, word

recognition processes for Latinate languages may be unusually adept at using cues from the letters that

are present in a stimulus to produce the ILP.

Figure 1. Examples of stimuli producing the ILP in English (after Jordan et al., 1999). Readers can experience the illusion

by placing the page at a viewing distance of 3m (depending on eyesight) and moving slowly towards the stimuli. At some

point, complete words become visible, including distinct letters in interior positions.

To address the generalisability of the ILP, therefore, we investigated the phenomenon using a

language with very different characteristics from English and other Latinate languages; Arabic. Arabic

has the second most used alphabet in human societies, after the Latin alphabet. However, in addition to

being read from right to left, printed Arabic, unlike Latinate languages, is formed in cursive script in

which the visual appearance of letters varies considerably within the same typeface, and spaces

between letters seldom exist. These characteristics contrast strongly with those of Latinate languages

and so Arabic provides a powerful assessment of the generalisibility of the ILP across different

alphabetic systems. Indeed, if the ILP occurs for Arabic, this would suggest that alphabetic languages

generally are susceptible to the phenomenon and reading these languages may be augmented by

illusory percepts.

Twelve illusory stimuli were formed from twelve, three-letter Arabic words in which the middle

letter was replaced by a nonsense pattern composed only of dots (see Figure 2). Following the

procedure of the original study (Jordan et al., 1999), illusory stimuli were randomly intermingled with

other, complete three-letter Arabic words (i.e., words that contained all their letters). All stimuli were

presented one above the other in a vertical column in high contrast black on white and were viewed

under bright lighting conditions. Each stimulus measured approximately 25 mm horizontally.

Figure 2. Examples of illusory stimuli used in the present study.

Participants were 20 fluent, native Arabic readers from Dubai, aged between 18 and 21 years.

To accommodate individual differences in visual acuity, the visibility of stimuli was adjusted by using

a separate set of 10 complete three-letter Arabic words and altering viewing distance until accuracy of

word report for these items was approximately 90%. The experimental items were then presented and

participants read out loud what they saw for each stimulus. In addition, participants were required at

regular intervals to identify which stimuli were the most legible.

Mean accuracy of report for complete (i.e., normal) word stimuli was 97%, indicating that the

visual information encoded from these stimuli was sufficient for high levels of accurate word

recognition. Moreover, 100% of responses made to illusory stimuli showed the ILP, and responses

were produced with no apparent (or reported) effort by participants, indicating that the visual

information encoded from each illusory stimulus was sufficient to produce the phenomenological

experience of "normal" word content. Indeed, when requested during each session, participants were

unable to distinguish between normal and illusory stimuli, and traced the outline of all three letters in

illusory stimuli with their fingers even though no letter was physically present in any interior position.

This point is supported by the finding that when asked to name the most legible stimuli, 49% were

complete words and 51% were illusory-letters stimuli ($p > 0.05$ by a binomial test).

These findings indicate that the ILP is not restricted to English, and that the phenomenon is a

characteristic common across very different alphabetic systems. As Jordan et al. (1999) argue, one

source of the ILP may be that representations for words are accessed using coarse-scale information

without fine-scale analyses of individual letters (for discussions, see Allen, Smith, Lien, Kaut, &

Canfield, 2009; Jordan, McGowan, & Paterson, 2012; Jordan et al., 1999). Thus, even when letter

content is physically incomplete, overall shape information (in Arabic and other alphabetic systems)

may generate sufficient lexical activation to produce the illusion of complete words containing all their

component letters. An additional source may be the identification of individual letters that requires

only a cursory analysis of their physical characteristics, and this process may be assisted by interactive

influences that feedback from the word level to reinforce the perception of a complete array of letters

(e.g., Rumelhart, & McClelland, 1982; Smith, Jordan, & Sharma, 1991). Indeed, both these sources of

influence may be particularly effective when prominent letters groups (like exterior letter pairs; Jordan,

1990; Jordan, Thomas, Patching, & Scott-Brown, 2003) are present in the stimulus to constrain the

identities of letters in other positions. But irrespective of which explanation ultimately proves most

appropriate, the indication now is that the ILP occurs in a language very different from English

(Arabic), suggesting that alphabetic languages generally are likely to be susceptible to the phenomenon

and that reading these languages may often occur as a process augmented by illusory percepts.

References

Allen, P.A., Smith, A.F., Lien, M.C., Kaut, K.P., & Canfield, A. (2009). A multi-stream model of visual word recognition. *Attention, Perception, & Psychophysics, 71*, 281-296.

Fang, S-P & Wu, P. (1989). Illusory conjunctions in the perception of Chinese characters. *Journal of Experimental Psychology: Human Perception and Performance, 15*, 434-447.

Grainger, J. (2008). Cracking the orthographic code: An introduction. *Language and Cognitive Processes, 23*, 1-35.

Grainger, J., Granier, J. P., Farioli, F., Van Assche, E., & van Heuven, W. (2006). Letter position information and printed word perception: The relative-position priming constraint. *Journal of Experimental Psychology: Human Perception and Performance, 32*, 865-884.

Jordan, T.R. (1990). Presenting words without interior letters: Superiority over single letters and influence of postmask boundaries. *Journal of Experimental Psychology: Human Perception and Performance, 16*, 893-909.

Jordan, T.R., McGowan, V.A., & Paterson, K.B. (2012). Reading with a filtered fovea: The influence of visual quality at the point of fixation during reading. *Psychonomic Bulletin & Review, 19*, 1078-1084.

Jordan, T.R., Thomas, S.M., & Scott-Brown, K.C. (1999). The illusory letters phenomenon: An illustration of graphemic restoration in visual word recognition. *Perception, 28*, 1413-1416.

Jordan, T.R., Thomas, S.M., Patching, G.R., & Scott-Brown, K.C. (2003). Assessing the importance of letter pairs in initial, exterior, and interior positions in reading. *Journal of Experimental Psychology: Learning, Memory and Cognition, 29*, 883-893.

Perea, M., Duñabeitia, J.A., & Carreiras, M. (2008). R34D1NG W0RD5 W1TH NUMB3R5. *Journal of Experimental Psychology: Human Perception and Performance*, *34*, 237-241.

Pillsbury, W.B. (1897). A study in apperception. *American Journal of Psychology, 8*, 315-393.

Rayner, K., White, S.J., Johnson, R.L., & Liversedge, S,P. (2006). Raeding wrods with jubmled

lettres: There is a cost. *Psychological Science, 17*, 192-193.

Rumelhart, D.E,. & McClelland, J.L. (1982). An interactive activation model of context effects in

letter perception, part 2: The contextual enhancement effect and some tests and extensions of the

model. *Psychological Review, 89*, 60-94.

Smith, P.T., Jordan, T.R., & Sharma, D. (1991). A connectionist model of word recognition that

accounts for interactions between mask size and word length. *Psychological Research, 53,* 80-

87.

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