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Letter-case information and the identification of brand names

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A central tenet of most current models of visual-word recognition is that lexical units are activated on the basis of case-invariant abstract letter representations. Here, we examined this assumption by using a unique type of words: brand names. The rationale of the experiments is that brand names are archetypically printed either in lowercase (e.g., adidas) or uppercase (e.g., IKEA). This allows us to present the brand names in their standard or non-standard case configuration (e.g., adidas, IKEA vs. ADIDAS, ikea, respectively). We conducted two experiments with a brand-decision task ('is it a brand name?'): a single-presentation experiment and a masked priming experiment. Results in the single-presentation experiment revealed faster identification times of brand names in their standard case configuration than in their non-standard case configuration (i.e., adidas faster than ADIDAS; IKEA faster than ikea). In the masked priming experiment, we found faster identification times of brand names when they were preceded by an identity prime that matched its standard case configuration than when it did not (i.e., faster response times to adidas-adidas than to ADIDAS-adidas). Taken together, the present findings strongly suggest that letter-case information forms part of a brand name's graphemic information, thus posing some limits to current models of visual-word recognition.

The vast majority of current models of visual-word recognition and reading assume an analytic process in which, upon presentation of a printed word, the corresponding lexical unit is activated on the basis of abstract letter identity representations that are invariant 'over changes in position, size, CASE and *font*' (Dehaene, Cohen, Sigman, & Vinckier, 2005, p. 335; Grainger, Rey, & Dufau, 2008; see also Coltheart, 1981; Paap, Newsome, & Noel, 1984; for early empirical evidence). In the hierarchical neural accounts of letter/word recognition of Dehaene *et al.* (2005) and Grainger *et al.* (2008), there are groups of neurons that early in letter/word processing selectively respond to case-specific letter allographs (e.g., they respond to 'e' but not to 'E'). More important, higher in the hierarchy – that is, later in processing – there are arrays of neurons that respond to case-independent (abstract) letter representations (e.g., they respond to the same degree to 'e' or 'E'; see Polk *et al.*, 2009; for a biologically inspired neural network model that learns case-invariant abstract letter identities). Indeed, the most influential computational models of visual-word recognition assume, for parsimony's sake, that the letter level is

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composed exclusively of uppercase letters (e.g., the interactive-activation model and its successors; see Davis, 2010).

All the above-cited accounts are fully consistent with the fact that in masked priming (i.e., a paradigm that taps early word processing; see Grainger, 2008; for review), the advantage of the identity priming condition over the unrelated priming condition is similar in magnitude for visually similar lowercase-uppercase words and for visually dissimilar lowercase–uppercase words (e.g., kiss-KISS and edge-EDGE; see Bowers, Vigliocco, & Haan, 1998). Furthermore, masked priming experiments have revealed that responses to matched-case identical prime-target pairs (e.g., EDGE-EDGE) are virtually similar as the responses to mismatched-case identical prime-target pairs (e.g., edge-EDGE; see Jacobs, Grainger, & Ferrand, 1995; Perea, Jiménez, & Gómez, 2014). Another recent demonstration of the role of abstract letter representations during visual-word recognition is that, in a lexical decision experiment (i.e., a word/non-word discrimination task), response times (and error rates) to pseudowords like viotin and viocin (created by substituting the letter l in the word 'violin') are virtually the same not only with adult readers but also with developing readers (Grade 4 children) – note that viotin is more visually similar to its base-word than viocin (Perea & Panadero, 2014).

But are *all* words identified on the basis of case-invariant abstract letter representations? Here, we examined this issue with a unique type of words: brand names. A number of brand names are archetypically printed in lowercase (e.g., adidas, Microsoft, etc.), while others are archetypically printed in uppercase (e.g., IKEA, SAMSUNG, etc.). Furthermore, to make brand names more identifiable and memorable, they are commonly printed with the same case, format, colour, and font (e.g., the IKEA logo). In some cases, brand names are morphed over time into an acronym (e.g., Kentucky Fried Chicken into KFC) or a logo (e.g., as in the case of Apple). Indeed, it has been claimed that 'in the case of brand names, visual features become an intrinsic part of their identity and have been incorporated into people's processing strategies that aid their retrieval' (Gontijo & Zhang, 2007, p. 27; see also Tavassoli, 2001). Thus, the cognitive processes underlying the identification of brand names can be used as a benchmark to test the assumption of case-invariant abstract letter identities made in leading models of letter/word recognition (e.g., Dehaene *et al.*, 2005; Grainger *et al.*, 2008). Importantly, there is one account that does assume that letter-case information forms an integral part of a word's lexical representation. Specifically, Peressotti, Cubelli, and Job (2003) claimed that 'while size, font and style (cursive or print) affect the visual shape of letters, the uppercase–lowercase distinction is abstract in nature as it is an intrinsic property of letters' (p. 108). In the framework of Peressotti *et al.*'s 'orthographic cue' account, a given lexical unit would not be retrieved only on the basis of the letter identity and letter position, but also on the basis of letter-case information. Peressotti *et al.* (2003) proposed their account when examining the role of the initial capitalized letter in proper nouns (e.g., Mary, America), but it can be readily extended to the processing of brand names.

The main aim of the present experiments was to examine the role of letter-case information of the brand names (lowercase vs. uppercase) during their visual identification. In particular, we took advantage of the fact that some brand names are archetypically presented in lowercase (e.g., adidas) or in uppercase (IKEA). This allowed us to compare the recognition of the brand names written in their standard case configuration (e.g., adidas, IKEA) or their non-standard case configuration (e.g., ADIDAS, ikea). If letter-case information plays a role during the identification of brand names, the encoding of the lexical units corresponding to brand names should be faster when they

are printed in their standard case configuration (i.e., when the archetypical case matches the presentation case; e.g., adidas in lowercase, IKEA in uppercase) than when printed in their non-standard case configuration (i.e., when the archetypical case does not match the presentation case; e.g., ADIDAS in uppercase, ikea in lowercase).

Previous evidence on the role of letter-case information in the recognition of brand names is very scarce. Gontijo and Zhang (2007) reported an experiment with a lexical decision task ('is the letter string a word?') in which they selected brand names whose standard case configuration was uppercase (e.g., SONY, GUCCI, IBM, etc.). Results revealed that participants were faster when the brand names were written in uppercase (i.e., the archetypical case) than when they were written in lowercase (e.g., GUCCI faster than gucci) – the parallel difference did not occur with common nouns (see Gontijo & Zhang, 2007). Gontijo, Rayman, Zhang, and Zaidel (2002) found a similar pattern of data with a visual-field lexical decision task. Although these findings are highly suggestive, they have two potential limitations. First, the standard case configuration of all these brand names was uppercase, and this may potentially have led to some strategies and biases. A stronger demonstration of this phenomenon would require employing 50% of the brand names whose standard case configuration is in lowercase (e.g., adidas) and the other 50% in uppercase (e.g., IKEA). Second, the presence of faster identification times of the standard-case stimuli (e.g., GUCCI faster than gucci) in a single-presentation lexical decision task does not necessarily imply that the case of the brand name aids the process of word identification *per se*. One might argue that the presence of faster decision times for words printed in their standard case configuration may be due to a familiarity discrimination assessment that 'gives a crude estimate of the stimulus's visual familiarity which may then be used as a source of evidence in making certain kinds of decisions' (Besner, 1983, p. 432). Bear in mind that participants may use all relevant sources of information to aid their decisions, and letter-case information can be one of them. To demonstrate that the letter-case information influences the encoding of brand names rather than late decisional processes, it is important to examine whether the effect of letter-case occurs at the early stages of visual-word processing (i.e., before decisional processes are at work) in a masked priming experiment (e.g., comparing adidas-adidas vs. ADIDAS-adidas and IKEA-IKEA vs. ikea-IKEA). In a recent experiment, Gomez, Perea, and Ratcliff (2013) demonstrated, using fits from the diffusion model (Ratcliff, Gomez, & McKoon, 2004), that masked repetition priming involves changes in the encoding time (a non-decisional component), whereas the decision parameters remained unaltered. Thus, an advantage of adidas-adidas over ADIDAS-adidas with the masked priming procedure would imply that the advantage occurs at an early encoding stage.

In Experiment 1, the participants' task was to decide whether a letter string was a brand name or not (i.e., 'is the stimulus a brand name or not?') in a single-presentation procedure. We manipulated the case of the printed stimulus (lowercase [e.g., adidas, nike], uppercase [e.g., ADIDAS, NIKE]) in brand names that differed in letter-case configuration (lowercase [e.g., adidas], uppercase [e.g., NIKE]). If the recognition of brand names is exclusively driven by case-invariant abstract letter representations – as neural accounts of visual-word recognition propose – we expect no differences between the brand names printed in the standard-case versus non-standard-case formats. Alternatively, if letter-case information from the brand names plays a role during word recognition – as the 'orthographic cue' account proposes – an advantage would be expected for adidas versus ADIDAS and IKEA versus ikea.

Experiment 2 was designed to examine the impact of letter-case information during the early stages of word processing using a masked priming procedure – we also used a brand-decision task. The target stimuli were brand names in their standard case configuration (or pseudo-brand names; e.g., FEGUS, canetton). These targets were briefly preceded by a masked prime that was printed in lowercase or in uppercase (e.g., adidas-adidas vs. ADIDAS-adidas; IKEA-IKEA vs. ikea-IKEA). Thus, two factors were manipulated: (1) the letter-case configuration of the target brand names (lowercase [e.g., adidas], uppercase [e.g., IKEA]) and (2) the case of the prime (lowercase [e.g., adidas, ikea], uppercase [e.g., ADIDAS, IKEA]) – an unrelated priming condition was also employed. If letter-case information of the brand names plays a role early in word processing, we would expect faster response times when the prime matches their standard case configuration than when it does not (i.e., adidas-adidas faster than ADIDAS-adidas and faster response to IKEA-IKEA than to ikea-IKEA).

EXPERIMENT 1

Method

Participants

Twenty students (all female) from the University of Valencia (Spain) took part voluntarily in the experiment. All of them had normal (or corrected-to-normal) vision and were native speakers of Spanish.

Materials

A set of 104 brand names was selected – none of them involved acronyms (e.g., KFC or IBM). To ensure that the brand names were familiar to the participants, and before selecting the final set of stimuli, six additional students (from the same population as the participants in the experiment) corroborated that the pre-selected brand names were familiar to other potential participants. Fifty-two brand names corresponded to those archetypically printed in lowercase [brand names with an initial uppercase letter were also included in this group] (e.g., adidas, skype, audi, twitter, Nestlé, Reebok, Facebook, Colgate, Microsoft, Trident, etc.; mean length: 6.7, range: 4–13) and the remaining 52 corresponded to those archetypically printed in uppercase (IKEA, LACOSTE, ROLEX, NISSAN, SAMSUNG, GUCCI, PORSCHE, NOKIA, OREO, NIVEA, etc.; mean length: 6.2, range: 4–11). There were worldwide brand names (as in the examples above) and regional (Spain) popular brand names (e.g., MERCADONA, Cuétara, TOUS, campofrío, Frigo, HIPERCOR, etc.). Two lists of counterbalanced materials were created in a Latin Square manner (e.g., if adidas was presented in List 1, ADIDAS would be presented in List 2). A set of 104 pseudo-brand names of the same length and orthographic structure as the brand names (e.g., FEGUS, canetton, PUSSAN, Folex, Purshka, LARDENT, SINSUM, viropozza, etc.) was created to serve as distractors for the purposes of the task – these distractors were printed either in lowercase or in uppercase, with the same proportions as the brand names.

Procedure

The experimental session was individual and took place in a quiet room. DMDX software (Forster & Forster, 2003) was employed to present the stimuli and register the responses.

On each trial, a fixation point (+) was presented for 500 ms at the centre of the computer screen. This was replaced by the target stimulus until the participant responded (or 2.5 s had passed). The stimuli were presented in 18-pt Times New Roman in black on a white background. Participants were instructed to press the 'sí' [yes] key if the letter string was a brand name and to press the 'no' key if the letter string was not a brand name. Both accuracy and speed were stressed in the instructions. There was a short practice phase (16 stimuli: 8 brand names and 8 pseudo-brand names) before the experimental phase (104 brand names and 104 pseudo-brand names). The order of the stimuli was randomized for each participant. The whole session lasted about 10 min.

Results and Discussion

Incorrect responses (7.7% of brand names) and response times beyond the 250–2,000 ms cut-offs (0.6% of brand names) were excluded from the latency analyses. The mean response times for correct responses and the error rates for each condition are presented in Table 1. For the brand names, mean response times (RTs) and per cent errors were submitted to separate ANOVAs with a 2 (Standard case configuration of brand name: lowercase, uppercase) × 2 (Printed-stimulus case: lowercase, uppercase) × 2 (List: list 1, list 2) design. The ANOVAs were conducted over subjects ($F1$) and items ($F2$). In this and the subsequent experiment, List was included as a dummy factor to remove the error variance due to the counterbalancing lists.

The ANOVA on the latency data revealed an advantage of the brand names archetypically printed in uppercase over the brand names archetypically printed in lowercase, although the effect was not significant in the analysis by items, $F1(1,18) = 8.88$, $MSE = 1{,}061$, $\eta_p^2 = .33$, $p = .008$; $F2(1,100) = 1.82$, $MSE = 13{,}344$, $\eta_p^2 = .02$, $p = .18$. The main effect of printed-stimulus case was not significant, both Fs < 1. More importantly, the ANOVA revealed a significant interaction between the standard case configuration of the brand name and the case of the printed stimulus, $F1(1,18) = 13.55$, $MSE = 1{,}703$, $\eta_p^2 = .43$, $p = .002$; $F2(1,100) = 14.42$, $MSE = 3{,}918$, $\eta_p^2 = .13$, $p < .001$. This interaction reflected that, for the brand names which are archetypically presented in lowercase (e.g., adidas), responses times were, on average, 43 ms faster when the stimuli were printed in lowercase than when printed in uppercase ($F1(1,18) = 9.61$, $MSE = 1{,}849$, $\eta_p^2 = .16$, $p = .006$; $F2(1,50) = 9.20$, $MSE = 3{,}857$, $\eta_p^2 = .35$, $p = .004$), whereas for the brand names which are archetypically presented in uppercase (e.g., IKEA), responses times were, on average,

Table 1. Mean response times (in ms; standard errors between brackets) and percentage of errors for the brand names in Experiment 1 (single-presentation brand-decision task)

	Standard case of brand name			
	Lowercase		Uppercase	
	RT	%E	RT	%E
Lowercase string	674 (13.0)	8.5 (1.5)	687 (15.6)	8.7 (1.6)
Uppercase string	717 (18.1)	6.7 (1.6)	661 (15.5)	6.9 (1.2)

Note. The mean RTs and error rates were 748 ms and 5.3% for the lowercase pseudo-brand names and 761 ms and 5.7%, for the uppercase pseudo-brand names, respectively.

26 ms faster when the stimuli were printed in uppercase than when printed in lowercase ($F1(1,18) = 6.69$, $MSE = 996$, $\eta_p^2 = .27$, $p = .019$; $F2(1,50) = 5.59$, $MSE = 3{,}979$, $\eta_p^2 = .10$, $p = .023$).

The ANOVA on the error rates did not reveal any significant effects (all ps $> .13$).

The main finding of the current experiment is that word-identification times to brand names were faster when the archetypical case of the brand name matched that of the printed stimulus (i.e., adidas faster than ADIDAS and IKEA faster than ikea). That is, the standard case configuration of the brand names (e.g., adidas, IKEA, etc.) helps the decision to say 'brand'. The question now is whether this advantage takes place at the initial stages of word processing or whether it occurs later in processing (e.g., at a decisional stage).

As indicated in the Introduction, an excellent strategy to tap the early stages of visual-word processing is the masked priming technique. This was the procedure used in Experiment 2, together with a brand-decision task. In Experiment 2, all brand names were presented in their standard case configuration and were preceded by an identity prime that was printed in the standard case configuration (adidas-adidas; IKEA-IKEA) or not (ADIDAS-adidas; ikea-IKEA) – for comparison purposes with prior masked priming experiment, we also included an unrelated priming condition. To avoid visual continuity, a 16-ms pattern mask (a series of #s) was inserted between the prime and the target, and the primes were printed in smaller size than the targets (see Jacobs *et al.*, 1995; Perea *et al.*, 2014, for a similar procedure). The predictions were clear. If letter-case information from the brand names plays a role early in word processing, then one would expect an advantage in the recognition times of brand names when they are preceded by an identity prime that matches the standard case configuration than when preceded by an identity prime that does not match the standard case configuration (i.e., faster responses times to adidas-adidas than to ADIDAS-adidas, and faster response times to IKEA-IKEA than to ikea-IKEA). Alternatively, if the effect of letter-case information occurs at a later decisional stage of word processing, then one would expect no differences between the two identity priming conditions – that is, one would just expect a repetition priming advantage over the unrelated priming condition.

EXPERIMENT 2

Method

Participants

Twenty new students from the same population as in Experiment 1 took part in the experiment.

Materials

The target stimuli were the same as in Experiment 1. All brand names were presented in their standard-case format (e.g., adidas, IKEA) and were preceded by a prime that was: (1) the same as the target, always in lowercase (e.g., adidas-adidas; ikea-IKEA); (2) the same as the target, always in uppercase (e.g., ADIDAS-adidas; IKEA-IKEA); and (3) a brand name unrelated to the target (e.g., Bershka-Trident; FANTA-adidas; Opel-IKEA; SONY-FIAT) – half of the unrelated primes were printed in lowercase and the other half were printed in uppercase. For the pseudo-brand names, the manipulation was similar to that for the brand names. Three lists were created to counterbalance the materials across the three priming conditions in a Latin square manner.

Procedure

We employed a brand-decision task, as in Experiment 1 (i.e., 'is it a brand name?'). The basic difference with Experiment 1 was that we employed a masked priming procedure rather than a single-presentation procedure. The setup of a given trial was as follows: A pattern mask (a series of #s) was presented in 24-pt for 500 ms at the centre of the computer screen. This was replaced by the prime stimulus in 20-pt for 33.3 ms (i.e., 2 refresh rates in the 66-Hz CRT screen), which in turn was replaced by a pattern mask in 24-pt for 16.6 ms, and then the target stimulus in 24-pt was presented until the participant responded (or 2.5 s had passed). All stimuli were presented in the same location, and the second mask was inserted to minimize visual continuity between prime and target (see Jacobs *et al.*, 1995; Perea *et al.*, 2014). As usual in masked priming experiments, we employed a non-proportional font (Courier New).

Results and Discussion

Error responses (9.9% of brand names) and response times beyond the 250–2,000 ms cut-offs (1.2% of brand names) were excluded from the latency analyses. The mean RTs for correct responses and the error rates for each condition are presented in Table 2. For the brand names, mean RTs and per cent errors were submitted to separate by-subjects and by-items ANOVAs with a 2 (Standard case configuration: lowercase, uppercase) × 2 (Case of the identity prime: lowercase vs. uppercase) × 3 (List: list 1, list 2, list 3) design (see Perea *et al.*, 2014, for a similar design that focused on the identity priming conditions).

The ANOVA on the response times revealed that the responses to brand names were faster when preceded by a lowercase identity prime than when preceded by an uppercase identity prime, $F1(1, 24) = 6.51$, $MSE = 984$, $\eta_p^2 = .21$, $p = .018$; $F2(1, 102) = 2.29$, $MSE = 2{,}276$, $\eta_p^2 = .02$, $p = .13$. The main effect of the Standard case configuration of the target stimulus was not significant, both ps $> .19$. More importantly, we found an interaction between the two factors, $F1(1, 24) = 4.65$, $MSE = 1{,}064$, $\eta_p^2 = .16$, $p = .041$; $F2(1, 102) = 5.60$, $MSE = 2{,}276$, $\eta_p^2 = .05$, $p = .020$. This interaction reflected that, for the brand names archetypically printed in lowercase (e.g., adidas), there was a sizeable 29-ms advantage of the lowercase identity priming condition (adidas-adidas) over the uppercase identity priming condition (ADIDAS-adidas), $F1(1, 24) = 10.36$, $MSE = 1{,}092$, $\eta_p^2 = .30$, $p = .004$; $F2(1, 51) = 10.62$,

Table 2. Mean response times (in ms; standard errors between brackets) and percentage of errors for the brand names in Experiment 2 (masked priming brand-decision task)

	Standard case of brand name			
	Lowercase		Uppercase	
	RT	%E	RT	%E
Identity (lowercase)	660 (14.0)	10.0 (1.3)	666 (15.1)	8.4 (1.3)
Identity (uppercase)	689 (17.6)	9.3 (1.7)	665 (12.8)	8.6 (1.7)
Unrelated	711 (15.0)	13.4 (2.7)	703 (16.3)	9.9 (1.6)

Note. For the pseudo-brand names, the mean RTs and error rates were 759 ms and 7.6% for the identity priming condition, and 769 ms and 7.6% for the unrelated priming condition, respectively.

MSE = 1,606, η_p^2 = .17, p = .002. In contrast, for the brand names archetypically printed in uppercase (e.g., IKEA), there were no signs of a difference (i.e., less than 2 ms) between the lowercase identity priming condition (ikea-IKEA) and the uppercase identity priming condition (IKEA-IKEA), both Fs < 1.

For the sake of completeness, we also examined the masked repetition priming effect (i.e., the unrelated priming condition minus the average of the two identity priming conditions). Unsurprisingly, we found a sizeable advantage of the targets when preceded by an identity prime than when preceded by an unrelated prime, $F1(1, 24) = 27.87$, *MSE* = 1,312, η_p^2 = .54, $p < .001$; $F2(1, 105) = 44.31$, *MSE* = 2,044, η_p^2 = .30, $p < .001$ – this repetition priming effect was similar in magnitude for the two types of case-configurations of brand names (i.e., adidas vs. IKEA), as deduced by the lack of interaction between the two factors, both Fs < 1.

The ANOVA on the error rates did not reveal any significant effects, all Fs < 1.

The results of the present experiment revealed that letter-case information plays a role in the early stages of the processing of brand names. In particular, for the brand names whose standard-configuration is lowercase, there was a 29-ms advantage for the target words preceded by an identity prime that matched the standard case configuration relative to those target words preceded by an identity prime that did not match the standard case configuration (e.g., adidas-adidas faster than ADIDAS-adidas). This finding poses problems for any account of visual-word recognition that assumes that there is an early activation of case-invariant abstract letter units for *all* letter strings (e.g., Dehaene *et al.*, 2005; Grainger *et al.*, 2008). Instead, the present data provide empirical support for the view that letter-case information forms part of a word's graphemic representation, as advocated by the 'orthographic cue' account (Peressotti *et al.*, 2003).

We acknowledge that the whole story is somewhat more complicated because the brand names archetypically printed in uppercase (e.g., IKEA) were equally activated by a lowercase or an uppercase identity prime (i.e., we found similar response times for IKEA-IKEA and ikea-IKEA). Similarly, in a recent masked priming experiment with acronyms (e.g., FBI; KFC, etc.), Brysbaert, Speybroeck, and Vanderelst (2009) also found that a target stimulus like FBI was equally activated by the masked prime fbi (i.e., an unfamiliar format) and the case-consistent masked prime FBI. What we should note here is that the magnitude of masked repetition/form priming with lowercase–uppercase pairs is similar to that with uppercase–lowercase pairs (e.g., see Soares, Perea, & Comesaña, 2014), so that the case of the prime-target pairs *per se* cannot be used to explain the dissociation between the brand names whose standard-configuration is in lowercase versus uppercase. We examine two potential reasons for this dissociation in the General Discussion.

GENERAL DISCUSSION

We conducted two experiments that examined the role of letter-case information (lowercase vs. uppercase) during the printed recognition of brand names whose standard case configuration was lowercase (e.g., adidas) or uppercase (e.g., IKEA). The two main findings are summarized as follows: First, in a brand-decision task, word-identification times were faster when the standard case configuration of the brand names matched that of the written stimulus (i.e., adidas faster than ADIDAS; IKEA faster than ikea). This finding poses problems for leading neural accounts of visual-letter/word recognition (Dehaene *et al.*, 2005; Grainger *et al.*, 2008), but it is

entirely consistent with the 'orthographic cue' account (Peressotti *et al.*, 2003). Second, in a masked priming brand-decision task, we found faster identification times when the brand names (in their archetypical case configuration) were preceded by an identity prime that matched the standard case configuration than when it did not (i.e., faster responses times to adidas-adidas than to ADIDAS-adidas) – this difference was absent for those brand names archetypically printed in uppercase, however. Thus, letter-case information plays a role even in the early stages of the processing of brand names. We now examine the implications of these findings for models of visual-word recognition.

The presence of faster word-identification times when the brand names were printed in their standard case configuration than in their non-standard case configuration in a brand-decision task (Experiment 1) demonstrates that participants have access to (and employ) 'orthographic cues' such as letter-case when making their decisions (e.g., IKEA faster than ikea; adidas faster than ADIDAS), thus extending the findings reported by Gontijo and Zhang (2007) and Gontijo *et al.* (2002) with brand names in lexical decision. A remaining, important question is whether this effect occurs at an early encoding stage or whether it occurs at a late, decisional stage. To that end, we conducted a masked priming experiment with the brand-decision task (Experiment 2). Leaving aside the unsurprising advantage of the identity priming condition relative to the unrelated priming condition, the key finding was that, for the brand names whose standard case configuration is in lowercase (e.g., adidas), we found faster response times when the identity prime was printed in the standard case configuration of the brand name than when the identity prime was printed in the non-standard case configuration (i.e., faster response times to adidas-#####-adidas than to ADIDAS-#####-adidas). If the encoding of the prime had involved case-invariant abstract letter/word representations – as leading neural accounts of visual-word recognition propose (e.g., see Dehaene *et al.*, 2005; Grainger *et al.*, 2008), no differences between these two conditions would have been expected. Instead, this finding fits perfectly well with the predictions of those accounts that assume that letter-case information forms an integral part of a word's graphemic representation (e.g., 'orthographic cue' account, see Peressotti *et al.*, 2003).

We acknowledge that this is not the whole story because the parallel effect did not occur for those brand names that are archetypically presented in lowercase (i.e., we found similar response times to ikea-####-IKEA and IKEA-####-IKEA). Similarly, using acronyms, Brysbaert *et al.* (2009) found that response times to fbi-FBI (i.e., non-standard case configuration) were similar to the response times to FBI-FBI (i.e., standard case configuration). There are two (non-exclusive) explanations for the dissociation between lowercase and uppercase brand names. First, brand names archetypically presented in uppercase can occasionally be encountered in lowercase (e.g., web addresses [www.ikea.com], news reports, or informal writing), and this is also the case of acronyms (e.g., the official YouTube channel of FBI indicates 'If you have tips on a crime, submit to tips.fbi.gov'). In contrast, brand names archetypically presented in lowercase are much more likely to be regularly presented in their standard case configuration (e.g., www.adidas.com, but not www.ADIDAS.com). As a result, letter-case information in the 'lowercase' brand names (e.g., adidas) may be more stable than in 'uppercase' brand names (e.g., IKEA). Indeed, in Experiment 1, the advantage of adidas over ADIDAS in the response times was greater than the advantage of IKEA over ikea (43 vs. 26 ms, respectively). Second, lowercase brand names may have a more distinct form on the basis of the ascending, neutral, and ascending letters (e.g., adidas), and this may favour a greater

role of visual cues during the word-recognition process in comparison with the uppercase brand names (e.g., IKEA).[1]

Taken together, the findings from Experiments 1 and 2 pose some problems for those accounts of visual-word recognition that assume that visual-word recognition is attained *exclusively* on the basis of the word's case-invariant abstract letter identities. Instead, the data strongly suggest that, for brand names, letter-case information influences the process of word recognition (e.g., adidas faster than ADIDAS; IKEA, faster than ikea). Bear in mind that brand names are repeatedly presented in the same case, format, colour, etc., so that they can be more easily remembered and accessible. Although we have opted for an interpretation of the present data in terms of orthographic cues, an issue that deserved further research is the role of purely visual elements in the recognition of brand names. In the present experiments, all items were presented in black in a standard font; that is, except for case, the presented stimuli did not remarkably match the visual configuration of the brand names. To shed more light on the specific contribution of visual factors, it would be necessary to present the brand names in their usual configurations, and examine whether it provides a reading benefit over and above the information from the standard case configuration employed in the present experiments (i.e., adidas, IKEA; see Bottomly & Doyle, 2006; or Tavassoli, 2001, for evidence of the importance of colours in brand names).

What we should also note here is that there are other types of words that are also commonly presented with the same case, and the findings are similar to those reported here. For acronyms (e.g., FBI, NATO, etc.), identification times are faster when they are presented in the standard case (FBI) than in the non-standard case (fbi; see Seymour & Jack, 1978; for early evidence). Likewise, proper names – in which the initial letter is capitalized – are identified more rapidly than proper (or common) names with their initial letter in lowercase (see Peressotti *et al.*, 2003). Therefore, the data from brand names, acronyms, and proper names provide converging evidence in favour of an account of visual-word recognition in which letter-case information is stored at a graphemic level, as proposed by the 'orthographic cue' account (Peressotti *et al.*, 2003). Consistent with this proposal, in a recent masked priming experiment with pairs of isolated letters that looked visually similar versus dissimilar in lowercase/uppercase (e.g., c/C vs. r/R), Carreiras, Perea, Gil-López, Abu Mallouh, and Salillas (2013) found a different spatial distribution of the repetition priming effect for c/C and r/R pairs at the P300 window (around 280–500 ms post-target in the ERP waves). Carreiras and colleagues concluded that the late processes corresponding to the activation of abstract representations retain 'some form of sensitivity [i.e., *letter-case information*] during the entire flow of information processing' (p. 1984). (The italics text is ours.)

[1] *To examine whether the frequent-case configuration plays a role in the identification of brand names using a task that does not require a binary decision, we also conducted a naming experiment. This experiment failed to reveal an advantage of the archetypical case of the brand names, and it only revealed an advantage of the stimuli printed in lowercase (i.e., adidas faster than ADIDAS; ikea faster than IKEA). This null effect must be taken with some caution because the pronunciation of words (including brand names) in a shallow orthography like Spanish (i.e., the language of the present experiments) may have followed a non-lexical grapheme-to-phoneme conversion. Keep in mind that lexical (e.g., word-frequency) and semantic (e.g., associative priming) effects in Spanish are smaller in naming tasks than in tasks that require lexical access (e.g., Perea & Carreiras, 1998; Perea & Rosa, 2002b). Finally, the 'lowercase' advantage is a common finding in the literature on visual-word recognition and reading (see Mayall & Humphreys, 1996; Paap et al., 1984; Perea & Rosa, 2002a; Tinker, 1963) and it may be due to the fact that letters in lowercase are more distinctive (and presented more frequently) than the letters in uppercase (e.g., see Paap et al., 1984) – note that this effect is not at odds with the idea of fast activation of 'abstract letter identities' during visual-word recognition and reading (see Perea & Panadero, 2014, for discussion).*

In sum, the present experiments pose some problems for those models of visual-word recognition that assume that *all* words are identified on the basis of case-invariant abstract letter/word representations. Instead, the present data strongly suggest that letter-case information forms part of a word's graphemic representation – at least for brand names. To examine the generality of this proposal for other types of words, future research should examine in detail the role of case-sensitive letter/bigram counts in letter/word identification and reading (see Jones & Mewhort, 2004).

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