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Naming acronyms: The influence of reading context in skilled reading and surface dyslexia

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Short title: Context effects in acronym reading

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Abstract

Background: Within dual route models of reading, words with regular spelling to sound correspondences can be read successfully using lexical or non-lexical reading processes. Research has indicated that which of these pathways is used is influenced by the other items that form the presentation context. We extend these findings using acronym stimuli as targets, presenting them in contexts designed to cue reading through grapheme phoneme conversion or letter naming.

Method: In experiment 1, undergraduate participants (n = 30) read aloud stimuli presented onscreen. Response times and accuracy for target acronyms ambiguous in their print to pronunciation conversion (e.g. HIV versus NASA) were compared between two contexts. In one condition the majority of items were unambiguous acronyms (e.g. BBC). In the second condition, the non-target items were regular words (e.g. CAT). Experiment 2 administered the same reading task to a single case of semantic dementia.

Results: A significant interaction between presentation context and acronym pronunciation was observed, such that responses were faster and more accurate to items that were pronounced in the same way as the majority of other stimuli in the list. Similar, though more dramatic, context effects were observed in a case of semantic dementia.

Conclusions: We argue that context effects are pervasive in reading research and that presentation context should be considered when interpreting future findings, particularly in cases of aphasia and dyslexia.

Introduction

Dual route models of reading (e.g. Coltheart, Curtis, Atkins & Haller, 1993; Coltheart, Rastle, Perry, Langdon & Ziegler, 2001) propose two methods for generating phonology for written stimuli. Non-word (and novel word) pronunciation is accommodated by a rule based system which assigns the most common phoneme for each grapheme in the stimulus and assembles them sequentially. Following these rules will allow for phonology to be generated for new words. Grapheme-phoneme correspondence principles will also produce the correct reading for the majority of English words (e.g. MINT, HINT or TINT which are termed *regular words*). Unfortunately, English contains a number of words which are exceptions to these rules (*irregular words* like PINT). Pronouncing these words requires a second route, the lexical route, which contains stored representations of all known words and allows the appropriate phonology to be retrieved. By definition the lexical route is unable to offer a pronunciation for any stimulus that has not yet been stored in the lexicon. The literature concerning the circumstances under which each route is emphasized, and the factors which affect the processing of a written stimulus by either route, is extensive (e.g. Baluch & Besner, 1991; Reynolds & Besner, 2005a; 2005b; 2008). These studies commonly look at the extent to which reading regular and familiar words is modulated by contexts populated by novel or irregular words. The current study seeks to extend such work by considering a class of items that have been somewhat overlooked – acronyms. In particular, this work seeks to determine whether acronyms behave like other words with respect to the influence of *context* and whether the pattern is similar for normal and impaired (acquired dyslexic) reading. We will first establish what we mean by "context effects in reading" by highlighting key relevant findings in the literature.

Several studies have shown that the reading system in healthy individuals is able to adjust which of the available reading routes is used in order that processing best suits the context in which items are read (Baluch & Besner, 1991; Reynolds & Besner, 2005a; 2005b; 2008; Zevin & Balota, 2000). Simply put, when the majority of the stimuli in a list require processing in a particular way (e.g. they are irregular, and can only be pronounced correctly using the lexical route) the reading system adjusts to focus on this route for the entire reading task. If a given item cannot be read using the emphasized route the switch between processes takes some additional effort, resulting in longer response times and a greater number of errors. Baluch and Besner (1991), for example, demonstrated the effect of list context using the Persian language. They found that the presence or absence of non-words in the reading list affected the processing of transparent words – those items that could, in principle, be successfully pronounced using either reading route. When the list did not contain non-words, high frequency transparent words were processed more quickly than their low frequency counterparts, indicating that participants were using the lexical route. When non-words were presented as part of the list of stimuli, responses to transparent words were not affected by frequency suggesting that they were processed using the non-lexical route. Further evidence of the flexibility of the reading system was reported in a series of studies by Reynolds and Besner (2005a; 2005b; 2008) using the alternating runs paradigm. In this paradigm, irregular words and non-words are presented in a predictable sequence – two irregular words followed by two non-words and so on. Irregular words are read more slowly when preceded by non-words than when they follow another irregular word (and vice versa). This is consistent with the fact that both types of items depend on different processing routes such that moving from one item to another has a resource switching cost. Reynolds and Besner (2008) showed that no such switch cost was incurred when reading regular words, irrespective of whether they are preceded by irregular words or non-words as successful reading of regular words can be accomplished via lexical and non-lexical processes.

It seems, then, that the way in which words are read aloud is influenced by the context in which these words appear. However, much less is yet understood about the processing of acronyms (BBC, HIV, NASA) and other abbreviations, which proliferate in academic journals, newspapers and social media, with new terms being coined on a regular basis. They are constructed by selecting the initial letters of each word in a phrase. This process often results in acronyms which comprise unusual or illegal combinations of letters so that they often resemble non-words in their orthographic form, and as they are intended as a shortcut for lengthy, often highly specialized, terms they may often be novel to the reader. The majority of acronyms (though not all) are pronounced one letter at a time – a pronunciation that is quite different from the rest of the words in the English language. A large proportion of acronyms contain only consonants (e.g. BBC or DVD). We have previously referred to this type of acronym as *unambiguous* (Izura & Playfoot, 2012) because it is immediately clear from the orthography of these items that naming each letter in turn is the only sensible way of generating a pronunciation. There are also acronyms that contain both vowels and consonants (e.g. HIV or NASA) in combinations that are plausible in the English language. As such these are *ambiguous* in that it is not immediately obvious whether they should be pronounced letter by letter or otherwise (Izura & Playfoot, 2012). This ambiguity is reflected in the fact that in some cases such vowel bearing acronyms are pronounced letter by letter (an acronym *typical* pronunciation); in others the pronunciation is "word-like" and acronym *atypical*. There is nothing about the spelling of HIV that makes it obvious that the pronunciation should be one letter at a time, nor is there anything that indicates that NASA should be pronounced as a two-syllable word. Although there is still relatively little published research concerning acronym reading, it has often been assumed that this complex and unusual relationship between print and pronunciation would require that reference is made to stored representations of acronym phonology (e.g. Laszlo & Federmeier, 2007; 2008). Under this circumstance, all acronyms would be read by the lexical route, irrespective of their spelling, pronunciation, or the context in which they appeared.

However, while there is considerable evidence to suggest that familiar acronyms do have phonological representations in the lexicon much as words do (Brysbaert et al., 2009; Slattery et al, 2006) our recent work has indicated that these representations do not necessarily need to be accessed for a correct pronunciation to be reached (Izura & Playfoot, 2012; Playfoot, Izura & Tree, 2013). Instead, we have argued that acronym naming can be achieved through the application of a single sub-lexical rule. Izura and Playfoot (2012) asked undergraduate participants to read aloud a list of ambiguous and unambiguous acronyms. The overall accuracy rate was high (98%). Accuracy for unambiguous acronyms was near ceiling for all participants (99.5%). Importantly, at the end of the naming trials Izura and Playfoot (2012) asked their participants to indicate which of the acronyms they had been familiar with before the study commenced. The authors provided a breakdown of the accuracy for each type of acronym depending on whether the participants had indicated that they knew the item. When the acronyms were unfamiliar to the participants, the accuracy for unambiguous acronyms (e.g. BBC) was 100%, and ambiguous typical acronyms (e.g. HIV) were pronounced correctly on 98% of occasions. The accuracy for previously unfamiliar ambiguous atypically pronounced acronyms (e.g. NASA) was far lower at 42%. Thus participants were highly accurate when reading acronyms named letter by letter even when they reported that they had never previously encountered a particular item – that is to say when such items were effectively nonwords (and had to be read non-lexically). Unfamiliar (or nonword like) ambiguous and atypical acronyms were read much more poorly, indicating the need for a lexical process (developed by familiarisation) for success. It is therefore clear that although lexical representations may be stored for all acronyms, those with a predictable letter by letter pronunciation may not require that these representations are accessed during reading. Further evidence for the existence of a sublexical rule for reading acronyms has been provided by the examination of acronym processing in acquired dyslexia. Playfoot et al. (2013) described JD, a patient with semantic dementia. An archetypal feature of semantic dementia is surface dyslexia (Hodges, Patterson, Oxbury & Funnell, 1992; Coltheart, Saunders & Tree, 2010) which describes a deficit in reading irregular words while regular word reading is preserved. Reading errors in such cases tend to be "regularizations" (Marshall & Newcombe, 1973) in which irregular words are pronounced as if they had regular spelling to sound correspondences. Dual route theories argue that surface dyslexia is the consequence of a damaged lexical reading route, which leads to an over-reliance on the grapheme-phoneme correspondence rules. JD showed the typical surface dyslexic pattern in word reading suggesting that her lexical route had become compromised. However, she was able to read unambiguous (DVD) and ambiguous typical (HIV) acronyms at near-ceiling accuracy. It seems unlikely that a deficit in the lexical route would preserve representations for acronyms when words of a similar frequency had been lost. Thus, Playfoot et al (2013) argued that JD's successful reading of typical acronyms was underpinned by a rule based mechanism, either as a separate reading route or as integrated somehow in the grapheme – phoneme conversion route. These are important findings, because they indicate that some acronyms at least (particularly those pronounced a letter at a time) could be successfully read using two different processes. Our work with JD has provided evidence of a non-lexical method for reading acronyms, which is presumably available to normal readers as well. Normal readers are also likely to have access to stored representations of acronym pronunciations. We consider that whether it is the lexical representation or the non-lexical rule that generates acronym pronunciation in readers with an intact reading system may be contingent on the context in which the acronym appears.

Interestingly, some evidence of context effects with acronyms was observed in the data reported in both Izura and Playfoot (2012) and Playfoot et al. (2013). Izura and Playfoot (2012) reported that, presented with a list containing only acronyms, undergraduate participants named ambiguous atypical acronyms (e.g. NASA) significantly slower than ambiguous typical acronyms (e.g., HIV). The authors suggested that the fact that the vast majority of the items to be read required a letter by letter pronunciation meant that participants found it particularly difficult to respond when they encountered a stimulus which needed an alternative spelling to sound conversion. Playfoot et al., (2013) also found context effects in JD, a surface dyslexia patient. For example, when she was presented with a mixed list containing both words and acronyms, JD pronounced the vast majority of the items one letter at a time, irrespective of their type. The same pattern was not observed when words and acronyms were presented in two separate lists. Items in an acronym-only list were still predominantly pronounced a letter at a time (JD was only inaccurate with ambiguous atypical acronyms like NASA). However, the responses in the word-only list predominantly followed GPC rules, which is in line with the pattern of regularization errors commonly reported in surface dyslexia (Marshall & Newcombe, 1973). JD's reading system, therefore, seems sensitive to the characteristics of the items in the list, but is not sufficiently flexible to change strategy on a trial by trial basis (as is suggested by the research with normal participants) – rather a particular type of response bias is formed by context and remains throughout.

Although the above findings suggest an influence of presentation context on acronym reading, our previous work did not deliberately manipulate this potential factor. In this paper we present data from two experiments which intended to assess context effects explicitly. The stimuli of interest were ambiguous acronyms: both those with a typical pronunciation (HIV) and those with an atypical (NASA) pronunciation. These ambiguous acronyms were presented in lists which comprised a large proportion of unambiguous acronyms (BBC) or regular words (CAT). We have argued earlier that typical acronyms are pronounced in the same way, irrespective of whether they are ambiguous such as HIV or unambiguous such as BBC; ambiguous atypical acronyms follow the grapheme-phoneme correspondences which apply to mainstream words. Here, we manipulated the context in which ambiguous acronyms were read by preceding them with either unambiguous acronyms or regular words. Following the work of Baluch and Besner (1999) and Reynolds and Besner (2005; 2008), presenting a large proportion of similarly pronounced items will cue the use of a particular reading strategy. A list of unambiguous (BBC) acronyms will trigger a preference for letter by letter reading; a list predominantly made up of regular words may cue a lexical reading strategy (assuming that the lexical route is intact and viable). Emphasising one of these routes would make responses easier to generate for individual acronyms that followed the same print to pronunciation pattern as the surrounding context. Switch costs would be incurred for any item that requires an alternative process, and this could be manifested in RT, accuracy or both. Specifically, letter by letter acronyms ought to elicit faster responses and greater accuracy than atypical acronyms in a context where letter by letter reading is encouraged. No significant difference between acronym types would be predicted if all items were read via the lexical route (i.e. in the context of regular words).

In Experiment 1, we collected data from undergraduate participants in an attempt to determine a) whether the difference in RT between ambiguous atypical (NASA) and ambiguous typical acronyms (HIV) reported by Izura and Playfoot (2012) was a consequence of presenting a list of stimuli predominantly requiring a letter by letter pronunciation and b) whether a similar context effect would be observed in reading errors. Experiment 2 presented the same task to JD. The rationale for this manipulation is the same as for Experiment 1. However, the nature of JD's dementia is such that lexical reading may be precluded. In this case, the presentation of a set of regular words is expected to cue the non-lexical GPC rules which apply to words. Practically speaking, applying word GPC rules will result in the correct pronunciation of ambiguous atypical acronyms and the incorrect pronunciation of typical letter by letter acronyms. Our previous work indicated that JD had considerable problems in reading ambiguous atypical acronyms whether they were presented with words in mixed lists or in pure blocks of acronyms (Playfoot et al., 2013). If, as we suspect, this was the result of inflexibility in her reading system which prevented her from breaking away from letter naming, then her inaccuracy should be limited to circumstances in which letter naming is strongly cued by the presentation context. It is possible to suggest, on the basis of the above findings, that JD might be more successful in reading atypical acronyms (such as NASA) if they were embedded in a list of words. As most ambiguous atypical acronyms are pronounced following GPC rules, reading accuracy ought to be improved by including ambiguous atypical acronyms in blocks of regular words. The opposite effect should be observed in ambiguous typical acronyms like HIV. We would also argue that by emphasising GPC rules through the presentation of a list which is predominantly regular words, it is likely we will see an increase of instances of ambiguous typical acronyms being read as whole words. By contrast, cueing a letter by letter naming strategy ought to result in accurate ambiguous typical acronym reading.

Experiment 1 – healthy readers

Participants

Thirty native English speakers with a mean age of 20 (range 18 – 26) were recruited as participants in this study. The 3 male and 27 female participants were undergraduate psychology students at Swansea University. None of the participants had been diagnosed as dyslexic or suffered from other reading deficits, and all had normal or corrected-to-normal vision. Participants were given course credit for their participation in this experiment.

Materials and design

Twenty ambiguous acronyms were selected from Izura and Playfoot (2012). Ambiguous acronyms were presented in two contexts. One context consisted of 80 regular words. The second context comprised 80 unambiguous acronyms. Both contexts were presented alongside the ambiguous acronyms. Ambiguous acronyms are formed by vowels and consonants such that a mainstream word-like pronunciation is possible (HIV, NATO). Ten of the ambiguous acronyms chosen for this study were pronounced by naming each letter in turn (HIV, typical pronunciation for acronyms). The remaining 10 ambiguous acronyms (NATO) were pronounced according to grapheme to phoneme correspondences (atypically pronounced acronyms). The ambiguous typical (HIV) and ambiguous atypical (NATO) acronym sets were matched for printed frequency, rated frequency, summed bigram frequency, and age of acquisition as determined by non-significant t-tests (all $p > .1$). Values for these variables were taken from Izura and Playfoot (2012). Participants read aloud the ambiguous acronyms in both contexts. The order of presentation of the reading contexts was counterbalanced across participants. The regular word context contained eighty mainstream words selected from the CELEX database (Baayen et al., 1993). Mainstream words were regular according to the grapheme to phoneme correspondence rules of the DRC model of reading (Coltheart et al., 2001). Regular words contained between 3 and 5 letters (mean = 3.24). The second context used 80 unambiguous acronyms three or four letter (mean = 3.49), drawn from Izura and Playfoot (2012). Unambiguous acronyms are always pronounced in an acronym-typical manner (i.e. naming the letters). Unambiguous acronyms did not differ from the regular words in terms of length [$t < 1$], or printed frequency [$t < 1$]. Frequency values for the acronyms were taken from Izura and Playfoot (2012); regular word frequency from CELEX (Baayen et al., 1993). The stimuli used can be seen in appendix 1.

Procedure

Stimuli were presented in black colour Times New Roman font (size 12 points) on a white background. All stimuli were presented in upper case letters. Trial randomisation and stimulus presentation was controlled using E-Prime software (Schneider, Eschman, & Zuccolotto, 2002). Participants were instructed to read aloud the stimuli as they would do under any other circumstance, such as reading aloud from a magazine article, and that they should do this as quickly and accurately as possible. Once they had understood the instructions, the experiment began by pressing the space bar. Responses were detected by a microphone placed about 10 cm from the mouth. The time that had elapsed between the appearance of the stimulus and the first audible response was automatically recorded by the experiment software. The detection of a response initiated the presentation of a fixation cross which remained onscreen for 1500ms. This was replaced by the next target for reading. The session was audio recorded to allow for the offline analysis and removal of errors. Participants were given 5 practice trials (mainstream words irrespective of which condition the participant had first (i.e., acronym or regular word context)) at the start of the experiment to familiarize them with the procedure and avoid practice effects. The order of presentation of the two lists was counterbalanced across participants.

Results

Reading errors (2.2%) and voice key malfunctions (4.3%) were removed prior to analysis of the reaction times. Following this, the mean and standard deviation for response latencies were calculated for each participant. Response times more than 3 standard deviations above the mean or prior to 300ms were designated as outliers and deleted. This process removed a further 1.7% of all responses. Overall accuracy was high, but two participants were deleted from the analyses because of very low (< 75%) accuracy in reading ambiguous atypical acronyms in the unambiguous acronym context. Therefore the analyses reported here were performed on the data from 28 participants.

Reaction time data was entered into two ANOVAs (2x2). Table 1 shows the mean reaction times and accuracy rates for ambiguous typical and ambiguous atypical acronyms when presented in the context of regular words or unambiguous acronyms.

[Table 1 about here]

Pronunciation typicality and reading context were submitted as within-subjects factor in the analysis by subjects. In the by-items analysis, pronunciation typicality was considered a between-subjects factor and context was treated as within-subjects. The overall main effect of context was significant [F1 (1, 27) = 41.916, MSe = 7791.186, $p < .001$, $\eta^2 = .608$; F2 (1, 18) = 38.674, MSe = 2793.768, $p < .001$, $\eta^2 = .682$] by subjects and by items. Responses were significantly faster in the regular word context than in the acronym context. The main effect of acronym pronunciation typicality [$F1\ (1, 27) = 4.242$, $MSe = 4369.931$, $p < .05$, $\eta^2 = .136$] was significant in the analysis by subjects, but not by items [$F2\ (1, 18) = 2.525$, $MSe = 5065.086$, $p > .1$]. The interaction between acronym pronunciation typicality and context was significant by subjects [$F1\ (1, 27) = 21.043$, $MSe = 3124.558$, $p < .001$, $\eta^2 = .438$] and approached significance by items [$F2\ (1, 18) = 3.882$, $MSe = 2793.768$, $p = .064$]. Post hoc t-test analyses (Bonferroni correction applied at $\alpha/2 = .025$) indicated that naming times for ambiguous atypical and ambiguous typical acronyms were not significantly different when surrounded by regular words ($t\ (27) = 1.85$, $p > .1$). However, when the reading context consisted of unambiguous acronyms, ambiguous atypical acronyms had significantly longer response latencies than ambiguous typical acronyms ($t\ (27) = 3.784$, $p < .005$). The interaction is presented in Figure 1 below.

[Figure 1 about here]

Accuracy rates were arcsine transformed prior to ANOVA analysis. Two ANOVAs (2x2) were performed. Pronunciation typicality and context were treated as within-subjects factors in the analysis by subjects; pronunciation typicality was considered a between-subjects factor in the analysis by items while context was a within-subjects variable. The main effect of context was not significant by subjects [$F1\ (1, 27) = 2.808$, $MSe = 5.284$, $p > .1$] but was by items [$F2\ (1, 18) = 6.291$, $MSe = 8.095$, $p < .05$, $\eta^2 = .259$]. The main effect of pronunciation typicality was not significant by subjects or by items. A significant interaction between pronunciation typicality and context was observed in both the by subjects and by items analyses [$F1\ (1, 27) = 8.411$, $MSe = 6.988$, $p < .01$, $\eta^2 = .238$; $F2\ (1, 18) = 9.047$, $MSe = 8.095$, $p < .01$, $\eta^2 = .334$]. Responses to ambiguous atypical acronyms were more accurate when presented in the context of regular words while ambiguous typical acronyms were pronounced with greater accuracy in the unambiguous acronym context. Bonferroni corrected post hoc tests revealed that this interaction was driven by significantly lower accuracy for typical acronyms in the word context than in the acronym context ($t(27) = 3.400$, $p < .005$). This interaction is depicted in Figure 2.

[Figure 2 about here]

Discussion

A significant interaction between pronunciation typicality and presentation was observed in the reaction time data. In the unambiguous acronym context, ambiguous typical acronyms like HIV were named significantly faster than ambiguous atypical acronyms, mirroring the findings of Izura and Playfoot (2012). The difference between mean RT in this context was 75ms (compared to 71ms in Izura & Playfoot, 2012) suggesting that there were indeed contextual influences in our previous work. We suggest that this is likely the result of the switch cost incurred in changing from an "acronym reading" to a "word reading" routine. In the regular word context, on the other hand, no significant difference in RT between typical and atypical acronyms was observed. Taking into account the significant main effect of context on naming times reported here, with responses being faster overall in the regular word context, we argue that all the items in this list were read using the faster lexical route. A pronunciation typicality by presentation context interaction was also observed in the error data, with greater accuracy for typical acronyms in the acronym context than when presented alongside a large proportion of regular words. **Baluch and Besner (1991) indicated that the GPC route could be used to support reading of lists of items with lexical representations if the task was designed such that non-lexical conversion was a viable option. It is possible that the GPC route was used to support or inform acronym reading here in a similar way, and that errors in ambiguous typical acronym trials reflect that the switch from GPC to letter naming rules was unsuccessful. However, our RT data suggest that all items in the regular word context were read via the lexical route, so finding lower accuracy in this condition is puzzling.**

Experiment 2 – Semantic Dementia

Patient JD

JD's semantic dementia profile has been described extensively elsewhere (Playfoot et al., 2013) so only a brief summary of the key information is included here. At the time of testing, JD was 62 years old. She is female and right-handed, had a university education and had been working as a legal secretary prior to her diagnosis. Her semantic system is considerably impaired, and hence she scores poorly in tests of semantic judgments (e.g. Pyramids and Palm-Trees, Howard & Patterson, 1992) and picture naming (Psycholinguistic Assessment of Language Processing in Aphasia, PALPA; Kay, Lesser & Coltheart, 1992). Her phonological skills are within the normal range in word and non-word repetition (PALPA; Kay et al., 1992). JD is accurate in reading aloud regular words, but inaccurate with irregular words (Castles & Coltheart, 1993) thus exhibiting the typical surface dyslexic reading pattern (see Table 2, below). To reiterate, it was predicted that JD would be more successful in reading acronyms which followed the print to pronunciation pattern of the majority of the items in the list (i.e. greater accuracy for typical acronyms in the context of unambiguous acronyms; greater accuracy for atypical acronyms when presented alongside regular words).

[Table 2 about here]

Materials and procedure

Experiment 2 used the same stimuli as in experiment 1. The trials proceeded exactly as above. JD performed the word context first, followed by a 10 minute break and then the unambiguous context.

Results and discussion

JD's reading accuracy is presented in Table 3. Overall accuracy for ambiguous typical acronyms was greater than for ambiguous atypical acronyms. The proportion of correct responses in each presentation context is exactly the same. Chi-square was used to assess whether reading accuracy for ambiguous atypical acronyms (NASA) was significantly lower than for ambiguous typical acronyms (HIV). It was determined that this difference was significant [χ^2 (1) = 16.162, $p < .001$]. As predicted, there was a significant effect of presentation context on accuracy in naming ambiguous acronyms. In the word context JD named a significantly greater number of atypical acronyms than typical acronyms [χ^2 (1) = 98.990, $p < .001$]. As JD named all of the typically pronounced acronyms correctly in the acronym context, formal analysis was not possible due to a cell count of zero at which point chi square analysis becomes inappropriate.

[Table 3 about here]

Despite the fact that there was no overall difference in the number of errors that JD made in each of the lists, a large context effect was apparent in her responses. Accuracy increased by 70% when the ambiguous acronyms were pronounced using the same process as the context items (i.e. regular words). As predicted, JD's reading system appears to be sensitive to the characteristics of the items presented to her such that strategy used to read the list is adjusted. The remarkably low accuracy for items which do not follow the same pattern as the remainder of the stimuli suggests that once this routine is set it is difficult for her to subsequently adjust. The pattern of errors observed in experiment 2 is similar to that observed in normal readers. However, in JD the deficit for items with unexpected pronunciations was much more severe.

General Discussion

In this paper we have demonstrated that a) presentation context can alter the way in which acronyms are read aloud, b) the normal reading system is flexible enough to accommodate switches between letter by letter and grapheme-phoneme correspondence pronunciation strategies and c) there is a considerable loss of flexibility when the reading system becomes damaged as it does in surface dyslexia. These findings illustrate the importance of context effects in reading, via the utilization of a largely under-used stimulus set – acronyms – and as such complement work with words. In both JD and, to a lesser extent, in healthy participants, acronym reading accuracy was significantly better when the ambiguous acronym (e.g. HIV or NASA) was pronounced in the same way as the majority of the items in the list of stimuli. The reading system seems sensitive to the characteristics of the items in the list, but in JD it is not sufficiently flexible to change strategy on a trial by trial basis. The result of this is that, once set to a particular strategy, JD names the vast majority of the stimuli in that way and is highly inaccurate when other pronunciations are required.

An alternative explanation may account for the pattern of performance we observed in JD in the current study. Simply, it is possible that the damage to JD's lexical reading mechanisms meant that she failed to recognise the acronyms, and hence that she merely pronounced them in line with print to pronunciation conversion she used for other items. That is to say, if she was not able to access a lexical representation for HIV when presented in the word context she may be inclined to use the same grapheme to phoneme correspondences she used for the words that she did not recognise in the list. While this account would allow for the pattern of responses observed in this study, it is not easily reconciled with our previous findings that JD's reading of words was influenced by the presence of letter-by-letter acronyms (Playfoot et al., 2013). Specifically we showed that she made frequent letter-by-letter reading errors in pronouncing written words when the context included acronyms. As JD's lexical route is impaired, she relies upon GPC rules to name words. However, the letter by letter processing strategy applied to acronyms seems to override the GPC rules when words and acronyms are intermixed in the reading task. The assumption that JD's errors in atypical acronym reading are based on a failure to recognise them would therefore also have to apply to word reading errors. This seems unlikely given that a) JD made fewer errors in word reading when no acronyms were presented and b) the types of word reading errors that were made differed across contexts (Playfoot et al., 2013).

In a few aspects, the pattern of performance in normal readers differed from that of JD. For example, the inclusion of a regular word context created an advantage for ambiguous atypical acronyms in JD by emphasising the grapheme to phoneme conversion system. In normal readers no significant differences were observed in the naming rates for ambiguous typical (HIV) and ambiguous atypical (NATO) acronyms, suggesting that the lexical route was used for all ambiguous acronyms. This pattern mirrors those relating to transparent words that were reported by Baluch and Besner (1991). Transparent words (i.e. those with obvious spelling to sound mappings) were processed using the sublexical route when presented alongside non-words but were read lexically when non-words were omitted. The findings we have presented here indicate that items that are ambiguous in some way (in that they can be processed in more than one way to arrive at the same pronunciation) can be affected by the context in which they are presented. If context effects are indeed so pervasive in the reading of all kinds of different letter strings, it is important that reading researchers undertaking work with normal or abnormal population pay heed to such effects – as the consequences can have important implications in interpreting performance (e.g., surface dyslexic severity may be reduced or amplified depending on stimulus testing procedure).

The precise processes that underpin acronym reading have yet to be considered in the framework of influential models of word reading. This may be due, in part, to the fact that relatively little evidence regarding the reading of acronyms to inform such a theory had previously been available. We contend that sufficient data has now been gathered (both from healthy readers and acquired dyslexia) to allow for a dynamic theory of acronym reading to be proposed and thoroughly tested. The data we have gathered here seems easily reconciled with a dual route type of theory. In JD we have demonstrated that there may be a mechanism for pronouncing acronyms a letter at a time which does not require access to lexical representations. It appears that these letter naming rules exist in addition to the normal GPC rules that apply to regular words, though whether it is an entirely separate route or a modification of the non-lexical route proposed in DRC (Coltheart et al., 2001) remains an open question. The data gathered from normal readers, in our own work and that which has been reported by others (Brysbaert et al., 2009; Izura & Playfoot, 2012) indicates that acronyms have stored lexical representations. In the present study we have demonstrated that while all acronyms can be read via a lexical route, lexical reading is particularly necessary for ambiguous atypical acronyms such as NASA. Importantly, our data indicate that all acronyms may be read via more than one processing route (one lexical and one non-lexical) and that which mechanism is employed when an acronym is encountered is highly contingent on the reading context. The choice of reading strategy may be further constrained by damage to the reading system, as in the case of JD, which precludes the use of one of the available routes from print to pronunciation.

References

Baayen, H., Piepenbrock, R., & van Rijn, H. (1993). *The CELEX lexical database*, Linguistic Data Consortium, University of Pennsylvania, Philadelphia.

Baluch, B., & Besner, D. (1991). Visual Word Recognition: Evidence for Strategic Control of Lexical and Nonlexical Routines in Oral Reading. *Journal of Experimental Psychology, Learning, Memory and Cognition, 17(4)*, 644-651.

Brysbaert, M., Speybroeck, S., & Vanderelst, D. (2009). Is there room for the BBC in the mental lexicon? On the recognition of acronyms. *Quarterly Journal of Experimental Psychology, 62 (9),* 1832-1842.

Castles, A., & Coltheart, M. (1993). Varieties of developmental dyslexia. *Cognition, 47 (2)*, 149–180.

Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of reading aloud: Dual-route and paralleldistributed-processing approaches. *Psychological Review, 100 (4),* 589-608.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological Review*, *108*, 204-256.

Coltheart, M., Saunders, S., & Tree, J. (2010). Computational modelling of the effects of semantic dementia on visual word recognition. *Cognitive Neuropsychology, 27(2),* 101-114.

Hodges, J., Patterson, K., Oxbury, S., & Funnell, E. (1992). Semantic dementia. Progressive fluent aphasia with temporal lobe atrophy. *Brain, 115*, 1783–1806.

Howard, D., & Patterson, K. (1992). *Pyramids and palm trees: A test of semantic access from pictures and words.* Bury St. Edmunds, England: Thames Valley Test Company.

Izura, C., & Playfoot, D., (2012). A normative study of acronyms and acronym naming. *Behavior Research Methods, 44 (3)*, 862-889*,*

Kay, J., Lesser, R., & Coltheart, M. (1992) *PALPA: Psycholinguistic Assessments of Language Processing in Aphasia*. Hove: Lawrence Erlbaum Associates.

Laszlo, S. & Federmeier, K. D. (2007b). Better the DVL you know: acronyms reveal the contribution of familiarity to single-word reading. *Psychological Science, 18 (2),* 122-126.

Laszlo, S. & Federmeier, K. D. (2008). Minding the PS, queues and PXQs: Uniformity of semantic processing across multiple stimulus types. *Psychophysiology, 45,* 458-466.

Marshall, J., & Newcombe, F. (1973). Patterns of paralexia: A psycholinguistic approach. *Journal of Psycholinguistic Research,* 2, 175–199.

Playfoot, D., Izura, C., & Tree, J., (2013). Are acronyms really irregular? Preserved acronym reading in a case of semantic dementia. *Neuropsychologia,* 51, 1673-1683.

Reynolds, M., & Besner, D. (2005a). Basic processes in reading: A critical review of pseudohomophone effects in naming and a new implemented computational account. *Psychonomic Bulletin & Review, 12,* 622– 646.

Reynolds, M., & Besner, D. (2005b). Contextual control over lexical and sublexical routines when read English aloud. *Psychonomic Bulletin & Review, 12,* 113–118.

Reynolds, M., & Besner, D., (2008). Contextual effects on reading aloud: Evidence for pathway control. *Journal of Experimental Psychology: Learning, Memory and Cognition, 34(1),* 50-64.

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). *E-Prime 1.0*. Pittsburgh, PA: Psychological Software Tools.

Slattery, T. J., Pollatsek, A., & Rayner, K. (2006). The time course of phonological and orthographic processing of acronyms in reading: evidence from eye movements. Psychonomic Bulletin & Review, 13, 412–417.

Zevin, J., & Balota, D., (2000). Priming and attentional control of lexical and sublexical pathways during naming. *Journal of Experimental Psychology: Learning, Memory and Cognition, 26(1),* 121-135.

Table 1 – Mean response latencies (M) and standard deviations (SD) for ambiguous typical (HIV) and ambiguous atypical (NATO) acronyms presented in different contexts. Percentage accuracy is also included (Accuracy%).

	CONTEXT					
	Unambiguous acronym (BBC)			Regular word (CAT)		
	M	SD	Accuracy%	M	SD	Accuracy%
Ambiguous typical (HIV)	647	114	96	588	115	89
Ambiguous atypical (NATO)	722	154	92	565	87	93
Filler items	668	115	100	566	67	99

Table 2 – JD's performance in standard tests (% accuracy). The mean score for typical adult readers is also included.

		JD	Normal mean
Semantic	Pyramids and Palm Trees	81	96
	Pyramids and Palm Trees (written)	56	96
	Picture Naming (PALPA)	53	100
Reading	Regular	98	100
	Irregular	63	100
	Non-words	83	98
Visual Perception	BORB – foreshortened	92	88
	BORB – minimal features	92	92
Phonology	Non-word repetition (PALPA)	100	99
	Word repetition (PALPA)	100	99
	Rhyme Judgement (PALPA)	78	100

Note: Pyramids and Palm trees (Howard & Patterson, 1992), reading tasks (Castles & Coltheart, 1993), PALPA (Psycholinguistic Assessments of Language Processing in Aphasia, Kay, Lesser, & Coltheart, 1992), BORB (Birmingham Object Recognition Battery, Riddoch, & Humphreys, 1993).

Table 3 – JD's reading accuracy (%) across presentation contexts

	Context		
	Acronym	**Regular word**	**Total**
Ambiguous Atypical (NASA)	10	80	45
Ambiguous Typical (HIV)	100	30	65
Total	55	55	

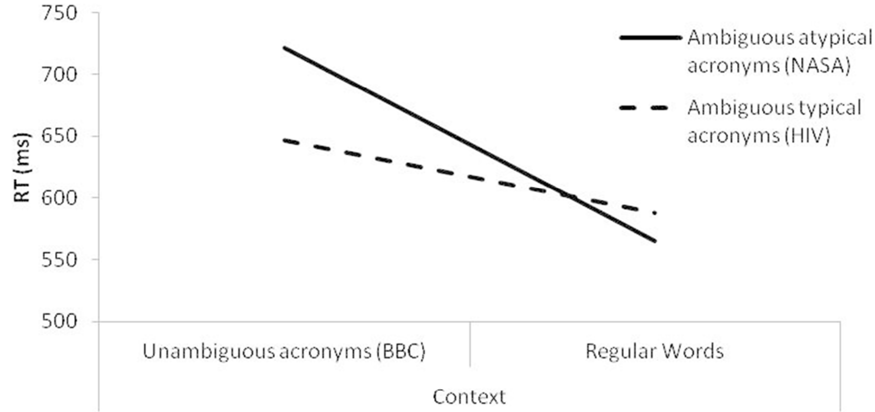

Figure 1 - Mean RT for ambiguous acronym stimuli presented in different contexts to normal readers
151x76mm (150 x 150 DPI)

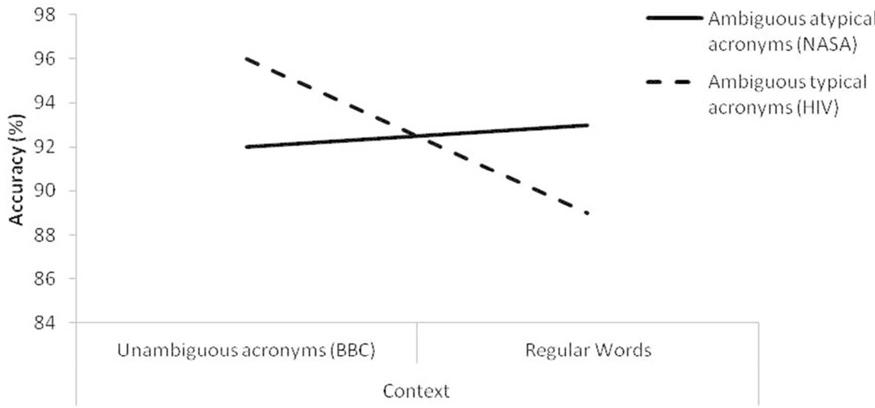

Figure 2 - Mean accuracy (%) for ambiguous acronym stimuli presented in different contexts to normal readers
165x76mm (150 x 150 DPI)