The Intelligibility of a Spelling-Regular English Accent

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ABSTRACT

Regular English Pronunciation (REP) is an artificial accent of English designed to be more logically related to English spelling than modern naturally-occurring English accents. The REP pronunciation of words can be generated automatically with a set of just 200 rules and exceptions. These rules and exceptions have been measured to provide over 75% of standard pronunciations in running spoken English. This paper shows that the while the intelligibility of REP is a little worse than standard pronunciation on a challenging intelligibility task, it is significantly easier to comprehend than a matched control condition in which pronunciation changes are unrelated to spelling. The paper also shows that listeners improve in their ability to recognise REP over a short period of exposure. The results suggest that advocacy of regularised pronunciation has a role to play in the reform of English spelling.

1. INTRODUCTION

The complex and often arbitrary quality of the relationship between English spelling and English pronunciation [2] has been blamed for the prolonged development period of literacy skills by English children [11], the poor standard of their spelling at age ten [10], the higher incidence of dyslexia in English-speaking nations [5], and the errors of second language learners of English [3].

But however convincing the scientific evidence for the reform of English spelling, and despite the advocacy of groups such as the American Simplified Spelling Board and the British Simplified Spelling Society [9], the last significant reforms in English spelling date back to the publication of the American Dictionary of the English Language in 1828 [12]. It was this dictionary that popularised Noah Webster's proposals for the spelling of words like *color*, *center*, *offense*, *traveled*, *organize*, etc.

Why have there been no improvements in English spelling in the last 175 years? There are essentially three *linguistic* arguments against spelling reform, all somewhat weak: (i) that making the spelling follow the pronunciation would lose the spelling similarities between morphologically related words like *nation* and *national*; (ii) that no respelling by pronunciation could be consistent with every accent; and (iii) that competent adult speakers tend to read words and phrases as wholes (ideograms) rather than as phonetic components anyway [8].

However we believe it is the *socio-political* arguments against spelling reform that have prevented change. These include (i) that the size and cost of the task of changing existing materials is immense; (ii) that first-language English speakers treat changes to English as an assault on the cultural heritage of the English-speaking people; and, perhaps most important, (iii) that all respelling systems produce a written form that is perceived as child-like and fundamentally *uneducated*. Since adult speakers of English have battled through to achieve competence in English spelling, non-standard spellings are perceived as sub-standard.

Regular English Pronunciation (REP) is an attempt to open up a second front in the battle to simplify the mapping between spoken and written English. Designed by Huckvale in 2002 [6], REP is based on the observation that if spelling can't be changed to match the pronunciation, maybe the pronunciation can be changed to match the spelling. Since pronunciation change requires little investment and can take place over a number of generations if required, it is likely to be more acceptable than spelling reform. REP is one suggestion for how English would sound if it were pronounced the way it was spelled. You can view REP as either a radical alternative to spelling reform (if you refuse to allow any spelling changes ever), or as a complementary approach (if you let pronunciation and spelling meet half way).

Regularising pronunciation will only make sense as part of the solution to the problems of English spelling if regular pronunciations can be shown to be both intelligible and learnable. This paper studies the intelligibility of REP, and the ability of adult listeners to adapt to the accent.

2. REGULAR ENGLISH PRONUNCIATION

Regular English Pronunciation is a new synthetic accent of English designed to have a simple and logical connection with conventional English spelling [6]. The original design aims for the accent were that the letter-to-sound rules should (i) produce an accent which is highly intelligible to current English speakers; and (ii) be simple enough for a foreign learner of English to remember. To reconcile these conflicting aims an arbitrary upper limit of 200 rules and exceptions was established. The current version, REP 1.01 contains 105 rules and 95 exceptions.

The rule format was chosen to be very simple, with just one layer of ordered context-sensitive rewrite rules, backed up by some final phonotactic post-processing. Each rule

matches a character substring in the context of left and right substrings. The left and right contexts can contain meta characters that can match a vowel letter, a consonant letter, the start of a morph or word, or the end of a morph of word. Exceptions are treated as highly ranked specialised rules. Input to the rule system is a morphologically analysed string, using symbols '+' and '-' to show prefixes and suffixes respectively. Only inflectional and type 2 derivational morphology are marked. Output is a conventional segmental phonological transcription with the addition of a special symbol for optional /r/, a symbol for the plural marker, and a symbol for the past-tense marker. These are mapped to standard transcription in a post-processing stage. Although the phonological transcriptions in REP 1.0 have been developed from Southern British English (SBE), the maintenance of spelled R into the output makes the transcription highly compatible with other accents through modification of the post-processing or by the addition of a layer of phonetic realisation rules.

Transcription of a word can be performed rapidly by a single pass through the rule set. A demonstration transcription system written in JavaScript may be found on the REP web site [6]. Also on the web site is the PRuler program used to develop and test the rules, along with a 10,000 word morphologically analysed dictionary. This program shows that rule set 1.01 generates standard pronunciations for over 75% of running spoken Southern British English. Examples of the rules and exceptions are shown in Table 1.

Rule	Example
#/A\#=eI	A -> eI
#/ARE\#=AR	ARE -> AR
#/AS\#={z	AS -> {z
#/B\#=bi	B -> bi
#/C\#=si	C -> si
#/COULD\#=kUd	COULD -> kUd
#/BE+\=bI	BE+CAME -> bIkeIm
/-ABLE\#=@b@l	RE+MARK-ABLE -> rImAk@b@l
/EA\=i	EACH -> itS
/EE\=i	NINE-TEEN -> naIntin
#^/E\#=i	BE -> bi
^/E\#=	BITE -> baIt
/ER\=3R	WERE -> w3R
/EW\=u	DREW -> dru
/E\=e	WHEN -> wen

Table 1. Example rules and exceptions from REP 1.01 (SAMPA transcription [7] with /R/=optional /r/)

The following paragraph shows the "North Wind and the Sun" in REP. Only the pronunciation differences to standard SBE transcription are highlighted. You will see that some REP forms are actually genuine pronunciations in non-SBE accents.

The North Wind and the Sun were /dIsputIN/ which of them was /strQN3R/, when a /treIvel@R/ came along wrapped in a warm cloak. They agreed that the one who first succeeded in making the /treIvel@R/ take his cloak off should be considered /strQN@R/ than the other. Then the North Wind blew as hard as he could, but the more he blew, the more closely did the /treIvel@R/ /fQld/ his cloak /AraUnd/ him; and at /l{st/ the North Wind gave up the attempt. Then the Sun /S@Un/ out warmly, and /ImedI@tlI/ the /treIvel@R/ took off his cloak. And so the North Wind was obliged to confess that the Sun was the /strQN@R/ of the two.

There are a number of important issues still to be resolved within the design of REP: 1. A formal definition of necessary morphological analysis is still needed. The current morphological analysis is open to the criticism that it has been chosen to maximise rule performance. 2. REP has yet to address the problem of lexical stress assignment. Currently the stress pattern is assumed to be the same as SBE, whereas it should be predicted by rule. This would also allow better prediction of vowel quality in weak syllables. 4. The invertibility of the rules needs to be assessed, to check that pronunciations can be readily converted back to spellings. 5. Better post-processing is required to cope with spellings that generate phonotactically illegal transcription, e.g. "gaol".

Since REP makes significant changes to the phonological form of some words, it is important to know how these changes affect the intelligibility of the accent. Although naturally-occurring accents of English often do differ phonologically as well as phonetically, there seem to have been no studies on how listeners adapt to these different kinds of accent change. Thus we set out to measure the intelligibility of REP with respect to standard SBE pronunciations, and also to examine whether listeners could adapt to its new phonological forms.

3. MEASUREMENT OF INTELLIGIBILITY

Three experimental conditions were established: *Standard* uses standard Southern British English pronunciations; *Regular* uses Regular English Pronunciations; *Random* uses standard Southern British English pronunciations randomly corrupted such that the number and type of changes matches the number and type of changes between the Standard and Regular conditions. Thus if intelligibility is only affected by the number and type of pronunciation changes, the Regular and Random conditions should have the same intelligibility. Also if speakers are able to adapt to the REP accent, we should see a greater increase in the intelligibility of the Regular condition over time than for the Random condition. The use of the Standard condition allows us to control for any changes in the difficulty of the sentences through the test.

Sentences were drawn from the written-texts component of the British National Corpus (BNC) [1]. A random sample of sentences was chosen with the criteria that each sentence should consist of exactly ten words chosen from the most common 65,000 words in the BNC corpus. Sentence

fragments and ungrammatical sentences were rejected to create a list of 200 sentences for testing.

Phonological transcription was performed by the second author for the Standard condition, and by the PRuler program for the Regular condition. The Random condition was automatically generated from a comparison of the two other conditions. Table 2 shows the most common phonological changes used in the Regular and Random conditions over the 200 sentences.

@ to e	94	@ to O:	12
i: to I	72	u: to @U	10
z to s	46	aI to I	10
@ to {	45	eI to {	10
@ to Q	44	e to eI	10
@U to Q	27	@ to del	9
j to del	26	aU to @U	9
u: to V	20	I@ to 3:	8
A: to {	18	@ to @U	8
V to Q	15	@ to A:	8
@ to 3:	14	dZ to g	7
I to aI	13	V to aU	7
O: to @U	12	e to {	7
@ to I	12	i: to eI	6
@ to V	12	i: to e	6

Table 2. Most frequent phonological changes made in Regular and Random conditions across all sentences (del=deleted)

Signals were generated using the MBROLA diphone concatenation speech synthesis system using the EN1 database [4]. Prosody was copied from a male speaker of Southern British English accent. The synthesis was found to be highly intelligible in the Standard condition, so the final stimuli were degraded by the addition of pink noise at a Signal to Noise ratio of 10dB.

Twenty-one final year Speech Therapy undergraduates from UCL took part in the experiment. Seven students were randomly assigned to each condition. They listened to the 200 sentences over four sessions of 50 sentences spread over a period of four weeks. Group listening took place in a quiet room with the material played over a loudspeaker, and with subjects writing their word transcription.

Subjects were not informed about the nature of the experiment nor the conditions; however they all had some previous experience with intelligibility testing and some exposure to synthetic speech.

4. RESULTS AND DISCUSSION

Word transcriptions were marked against the original BNC text. A strict spelling criterion was used, and even approximately correct spellings were rejected. Where subjects missed words or inserted words, alignment with the correct transcription was performed. Although this process under-reports insertion errors, these were less than 10% of the number of deletion and substitution errors

Figure 1. Absolute intelligibility as a function of sentence number
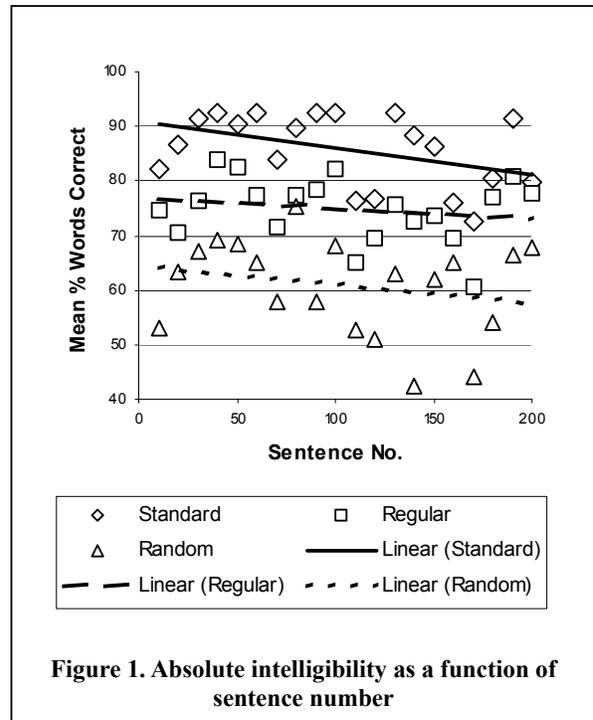
actually counted and did not change systematically across conditions.

The mean word intelligibility for each condition for each session is given in Table 3.

%Words Correct	Standard	Regular	Random
Session 1	88.7	77.6	64.3
Session 2	90.2	77.3	64.9
Session 3	84.0	71.2	54.3
Session 4	80.0	73.2	59.5
Overall	85.7 ± 1.6	74.8 ± 4.0	60.7 ± 9.6

Table 3: Mean Word Intelligibility per Session (overall variance calculated over blocks of 10 sentences)

Word error rate for the Regular condition was thus 1.76 times higher than the Standard condition, while word error rate for the Random condition was 2.75 times higher than the standard condition. The Regular condition is significantly lower in intelligibility than the Standard condition and significantly higher than the Random condition. We thus conclude that the Regular condition is significantly more intelligible than would be predicted by the number of pronunciation changes alone. Listeners must find the pronunciation changes made in the Regular condition less confusing, either because of their connection with spelling or because some sound like valid pronunciations in other accents.

The variation in intelligibility across speakers seems to be greater for the random condition than the regular condition, and greater for the regular condition than the standard condition. This may be due to differences in the skills of listeners, but may indicate variation in accent adaptation difficulty across conditions.
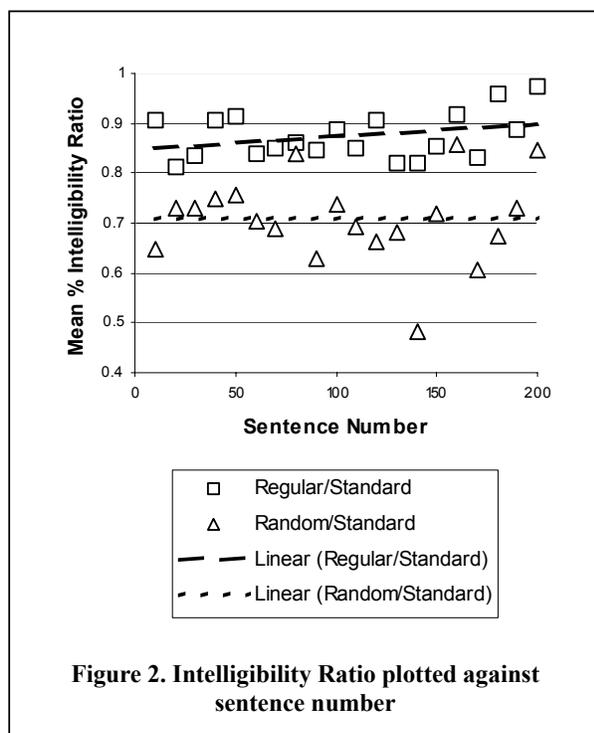
Figure 2. Intelligibility Ratio plotted against sentence number

The change in intelligibility within and across sessions is shown in Figure 1. Here, the intelligibility is plotted for each block of 10 sentences, or 100 words. A linear trend line has been added to each series. The slight downward trend in intelligibility on all conditions may be due to increasing boredom of the listeners or to an increase in the difficulty of the sentences. Our experimental conditions do not allow us to differentiate these two effects.

Although it is possible to see some evidence of adaptation within a session (consider, for example, the first 5 points on each series), we cannot rule out the possibility that this may be an artefact of changes in sentence difficulty from block to block.

To evaluate the ability of the listeners to adapt to the REP accent, Figure 2 plots the intelligibility ratio of the Regular condition to the Standard condition, and the ratio of the Random condition to the Standard condition for each block of ten sentences. A linear trend line has been added to each series. Here it is possible to see that the relative performance on the Regular condition is increasing with time, while relative performance on the Random condition is stationary. This gives us evidence that listeners are indeed able to adapt to the REP accent, and hints that its intelligibility may approach the Standard condition within just a few hours of exposure.

5. CONCLUSIONS

This paper has shown that a spelling-regular accent consisting of just 200 rules and exceptions can be highly intelligible to naïve listeners. Importantly its has shown

than even though such an accent makes substantial changes to the lexical phonological form of some words, listeners are able to accommodate and adapt to such changes.

While Regular English Pronunciation has yet to be properly formalised and rigorously tested, we hope that the idea of regularising English pronunciation is one that will make a significant contribution to the debate about English spelling reform.

ACKNOWLEDGEMENTS

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