Holistic versus analytical processing in word recognition in SLA context

Ali Akbar Ansarin
aansarin@yahoo.com
University of Tabriz

Abstract

According to the controversial word processing theories, second language learners use one of the two main processing approaches, i.e., analytical and holistic processing. In this research we tried to investigate the processing mechanism the participants use in lexical decision tasks. We conducted a word, non-word experiment. Thirty-six Iranian learners of English with high proficiency records acted as the participants in this study. Two sets of words, i.e., actual word and permuted words were presented to the participants. Their reaction time was measured by MRTS software precisely developed for the study. There were significant differences between the reaction time of two sets of word and non-word. The results suggested that participants used analytical route in their lexical decision tasks. Participants recognized non-words faster than words. Such effects existed in all 4 subgroups of high and low words. The results suggest that for both word and non-word and high and low frequent words, analytical route was utilized and words' shape was not a determining factor in lexical decision task. This could be interpreted as negating holistic/lexical processing.

Keywords: Analytical processing, Holistic processing, Word recognition

Introduction

Is word recognition carried out through identifying every single letter component of a lexical item or are words regarded by readers as independent units and identified by the whole-unit images they present? To answer this and other similar questions, different approaches and models have been developed since the early days of such studies. Some studies suggest that learners recognize words through their shapes (holistic/lexical) and other theorists assume that words are recognized via their component letters (analytical/non-lexical). There are, therefore, two main types of word processing; holistic or lexical processing considers word shape as a determining factor in lexical recognition and analytical or non-lexical processing takes component letters of word as the main factor in lexical recognition. Below, we present each approach in detail.

Background

Holistic or Lexical Processing

At word level, features such as 'transletter' or 'supraletter' are analyzed. So in this approach units beyond the individual letters determine the word recognition. Word whole shape is one of these features and words are recognized through comparing their shapes with already stored units in the lexicon. In this approach, words are recognized as whole units rather

than collection of individual discreet units i.e., letters. For the first time, Cattell (1985, 1986) proposed that word recognition is determined by the means of ascending, descending and the neutral pattern of individual lexical item. Some scholars still claim that word shape plays a relatively important role in visual word recognition (Allen, Wallace, & Weber, 1995; Healy & Cunningham, 1992; Healy, Oliver, & McNamara, 1987). Other scholars such as Sanocki (1991) compared word recognition in two conditions based on the font (normal and abnormal). He found that words in their normal (typical) font are easier to be recognized than abnormal (less typical) fonts. Rasid, Shafait and Breuel, (2010) also found that people are slower and less accurate in visual word recognition of permuted words in comparison with normal words. Allen et al, (1995) has proposed one of the most important models in holistic processing which is known as *holistic biased hybrid*. This model consists of two routes for lexical processing: 'letter-level code' and 'word-level codes'. This model predicts word-level codes processing for high frequent words or in other words holistic processing, and letter-level codes or analytical processing for low frequent words.

Analytical or Non-lexical Processing

Analytical or non-lexical processing deals with individual letter characteristics in lexical processing, in other words, it does not consider word's shape as a determining factor in lexical processing. Recent theories mainly deal with such a processing mechanism in lexical processing. Gough (1972) suggested that words are processed serially from left to right in step by step fashion. Different models such as *the search model*, (Forster, 1976), *the multiple read-out model*, (Grainger & Jacobs, 1996), *the interactive-activation model*, (McClelland & Rumelhart, 1981), *the activation-verification model*, (Paap, Newsome, McDonald, & Schvaneveldt, 1982) all adopt analytical processing. Based on the Multiple-Route Model, Besner and Johnston (1989) recommended that word recognition can be achieved by three routes:

1) Using visual familiarity assessment (global word shape),
2) Using an orthographic familiarity assessment based on overall lexical activation in the orthographic lexicon,
3) Word identification on the basis of letter-level codes.

They also predict that holistic route is responsible for high frequent words and low frequent words are recognized through analytical route. Perea and Rosa, (2002) also found that when we use size alteration effect, such effect is greater for low-frequent words than for high-frequent words in a lexical decision task. They also show that the effect of case type (lowercase vs. uppercase) is higher for low-frequent words than high-frequent words. Groff (1975) challenges the idea that holistic route for word recognition is used in a lexical decision task. Some experiments based on the obtained results show that word shape is distinctive to only a small extent , so word whole shape should be incorporated with other features such as orthographic (Walker, 1987), syntactic and semantic features as well (Haber, Haber and Furlin, 1983).

The role of morpheme in word recognition, particularly analytical processing, has been evaluated in several studies in alphabetic languages, such as English (e.g., Marslen-Wilson, Tyler, Waksler, & Older, 1994; Taft, 2004). Additional studies propose that children's word processing is also affected at least in part, by the structure of morphemes within the words

(e.g., Casalis, Dusautoir, Cole, & Ducrot, 2009; McCutchen, Logan, & Biangardi-Orpe, 2009; Schiff, Raveh, &Kahta, 2008; Verhoeven, Schreuder, & Haarman, 2006).

Those studies which used mixed case stimuli in their experiments resulted in different and sometimes contradictory outcomes. These different results are partly due to the fact they are the artifacts of the employed research methods in various experiments; for example, the type of the tasks (lexical decision task and naming task) and word lexicality (high frequency and low frequency words) affect the results in case altering experiments. Consequently, some scholars share the belief that breaking up the shape by case alteration does not affect word recognition (McConkie & Zola, 1979; Smith, 1969; Smith, Lott, & Cronnell, 1969). However, others argue that case alteration influence lexical decision significantly (Mayall & Humphreys, 1996; Besner, 1989; Besner & Johnston, 1989; Besner & McCann, 1987;).

Statement of the Problem

Precisely it was hypothesized that the holistic mechanism would be used by the participants in lexical decision tasks as they react to word and non-word stimuli.

Objectives of the Study

In this study, we presented both words and non-words to the participants and also we controlled lexicality (high frequency and low frequency) and words length (2 to 5 syllables). Rashid, Shafait and Breuel (2012) in a study examined the permuted words in Urdu and German and reported fewer recognition problems by German readers than Urdu readers and concluded that cursive writing of Urdu might the contribution factor for slower reading by their participants. By a permuted word (or non-word) in this it meant that the spelling of the word is altered while its beginning and ending is intact. But in previous studies, words and non-words were presented in separate groups, so participants knew in advance whether the stimuli will be word and non-words, but in our experiment we assigned word and non-words in single group randomly.

Scope of the Study

The main purpose of this study was to examine the way participants recognized words in English as a foreign language. No study has been reported about the type of processing approach of English language by learners of non-romance languages in general and Persian in particular. In methodological terms also, the rationale behind such an experiment was that, if we minimized the differences between items in terms of the information regarding their shape (distortion of the visual pattern), participants would be less able to depend on whole word information in word recognition, and it is expected that high and low frequent words may be treated differentially.

Method

Participants

Thirty six undergraduate English language students at the University of Tabriz participated in this study. Participants were selected based on the academic records from high proficient male and female students. All participants were in their fourth semester and had an

average academic score of A during these years. The age range of participants varied from 21 to 26. All were native speakers of Turkish and Farsi and foreign speakers of English. All had normal or corrected-to-normal vision and voluntarily participated in these experiments. Though the consents of all participants were obtained initially, but they were not given detailed information about the nature of the research so as not to hamper the data.

Materials

For word-non-word experiment, the stimuli were 120 English words, 60 high frequency and 60 low frequency words originally selected at random from the Corpus of Contemporary American English. The design of the study fits the experimental type. Both high and low frequent words were divided into four groups, including 15 words in each group. We classified them based on their syllables, from 2 to 5 syllables. Then, 120 non-words were generated by distorting the words through inverting second and third letter from initial and final of the words. All of the non-words had straightforward and unambiguous pronunciation following English spelling-to-sound translation rule. In lexical decision task two factors were included: lexicality (high frequent and low frequent words on one hand, word and non-word on the other) and number of syllables (2 to 5 syllable-words). We did not select one syllable words because the literature shows that one syllable words act differently. High frequent words rank from 1 to 1500 and low frequent words rank from 3000 to 4500 based on Contemporary American Corpus ranking. It is believed that, the corpus architecture and interface of this system allow for speed, size, annotation, and a range of queries that is believed to be unmatched with other architectures. “For example, in spite of earlier corpora like the American National Corpus and the Bank of English, […] Corpus of Contemporary American English is the only large, balanced corpus of contemporary American English,” (Corpus.byu.edu , 2012). A complete list of the words is presented in Appendix A.

Procedures

Each participant was tested individually in the laboratory. Before starting the experiment, detailed instruction was given to each participant. The stimuli were displayed in lowercase in center of computer screen. Each participant was tested alone on his/her own computer. The stimuli remained on the screen for 3 seconds until the subject responded by pressing “P” bottom from keyboard for word and “W” for non-words. Reaction time was measured from stimulus onset until subjects’ response. We used MRTS software for presenting stimuli and measuring reaction time. MRST is handy software that measures the reaction time of both English and Persian languages at both word and sentence levels in millisecond. Its simple interface could be considered its utmost advantage to other available software. The inter-trail interval was 1 second. Stimulus was presented in different groups of words (high and low frequent words and non-words) and they were randomly assigned to each group. All 240 words and non-words were presented in 20 separate groups. Words and non-words were not assigned to separate groups, so the participant did not know in advance whether they would encounter with words or non-words. The experiment ran approximately for 30 minutes.

Data Analysis

In data analysis we excluded the response times which lasted less than 300 milliseconds and also those which were more than 3 seconds. Our analysis was to determine the response latencies for each group of the data. We compared all groups. Overall, we had two types of comparison. We compared high-frequent words with high-frequent non-words (distorted words) for all 4 groups (2 to 5 syllables). Our second comparison included low-frequent words with low-frequent non-words (distorted words) for all groups (2 to 5 syllables).

As the intention was to compare the scores of a single group we performed T-Test to determine the time response latencies for two types of comparison as it is the most suitable test for this kind of data. Two factors were included in the analysis: types (frequency, words and non-words) and number of syllable (2 to 5 syllables).

Results

As shown in Table 1, the descriptive analysis of the syllables revealed that the lowest mean belongs to 2 syllable words and highest mean belongs to 5 syllable words. Subsequent comparison between the reaction of words and non-words, in the form of two tailed test, as summarized in Table 2, showed significant differences in two to five syllable of words and non-words. The *p*-values for all comparisons are less than .000. Mean differences showed that the participants spent longer time to recognize words than non-words See figure 1 for the details of mean differences.

Table 1. Characteristics of the high frequency words and non-words (distortion) tested in the lexical decision task

	High frequency words			High frequency non-words		
Syllable	N	Mean	Std	N	Mean	Std
Two	15	1.364	0.22257	15	1.194	0.24370
Three	15	1.516	0.27672	15	1.271	0.25788
Four	15	1.660	0.27512	15	1.409	0.28847
Five	15	1.786	0.29148	15	1.547	0.28320

Table 2. T-test comparing high frequency words and non-words

Pair	Mean	Std. Error	t	df	Sig.(2-tailed)
Two syllable	0.1869	0.03159	5.392	35	0.000
Three syllable	0.2967	0.05016	4.886	35	0.000
Four syllable	0.2477	0.04187	6.003	35	0.000
Five syllable	0.2662	0.04500	5.321	35	0.000

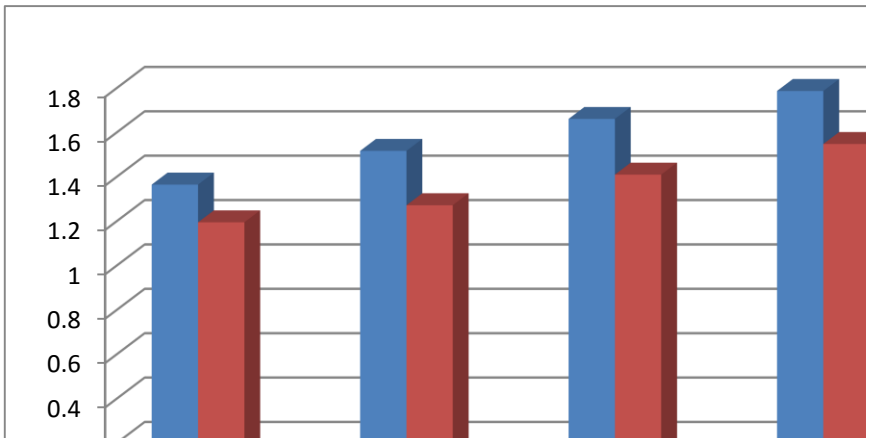

Figure 1. High frequent word vs. non-word comparison

Similar to high frequent words, low frequency words with any syllable composition needed longer time than non-words to be recognized by participants, (see Table 3). In these groups, participants' response times for non-words were significantly shorter than word response times. For example, the response time for two syllable low frequent words is 1.365, whereas it is 1.178 for the low frequency non-words. The results of the T-test comparing the low frequency words and non-words, as reflected in Table 4, showed significant p-values of .000 for all syllables. Figure 2 shows that in all syllables, the reaction time of the words was longer than the non-words.

Table 3. Characteristics of the low frequency words and non-words (distortion) tested in the lexical decision task.

	Low frequency words			Low frequency non-words		
Syllable	N	Mean	Std	N	Mean	Std
Two	15	1.365	0.251	15	1.178	0.262
Three	15	1.62	0.259	15	1.154	0.292
Four	15	1.773	0.244	15	1.399	0.306
Five	15	1.969	0.284	15	1.627	0.296

Table 4. T-test comparing low frequent words, and non-words

Pair	Mean	Std. Error	t	df	Sig.(2-tailed)
Two syllable	0.1867	0.03788	4.934	35	0.000
Three syllable	0.4661	0.04101	11.368	35	0.000
Four syllable	0.3746	0.05789	6.473	35	0.000
Five syllable	0.3426	0.07961	4.304	35	0.000

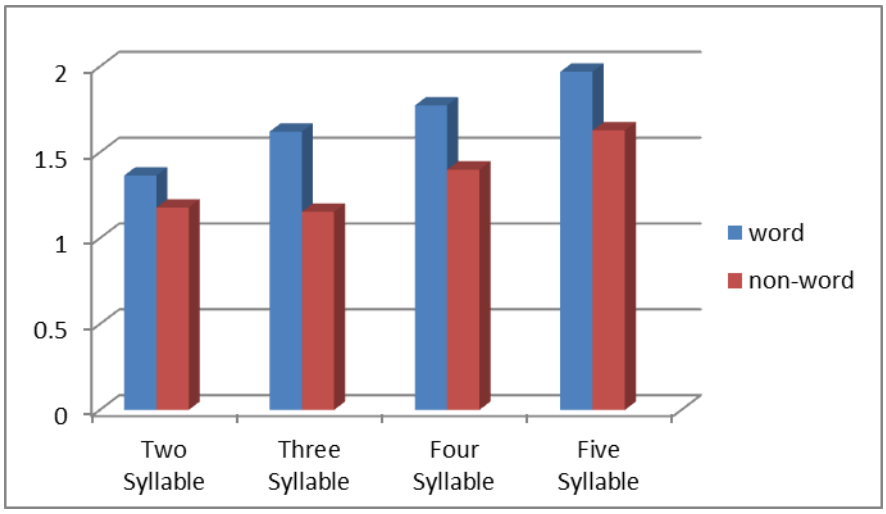

Figure 2. Recognition time of low frequency words, vs. non-words

To summarize, both analyses yielded similar results. In high as well as low frequent groups, even in all sub-groups, participants' reaction time was significantly shorter for non-word than word reaction times.

Discussions and Conclusion

Discussions

In this experiment, since words were distorted to generate non-words and we did not change word shapes, so, participants cannot rely on word shape in non-words recognition. Because the response time for non-words in all groups was significantly shorter than words, we can assume that participants applied analytical processing in their word recognition. In other words, in analytical or lexical processing, participants move from left to right of the words (in English) serially and step by step to test the letter strings through comparing the strings with pre-stored strings in their lexicon.

Thus, we could conclude that if participants apply holistic route, because we did not disturb word shape, the response time for non-words should not be significantly shorter than words. Thus, the results suggest that for both high frequent and low frequent words and non-words, participants applied analytical processing in word recognition. Most of the findings

suggest that for high frequent words, participants apply holistic or non-lexical route, and for low frequent and non-words, they apply analytical processing. This is in contrast with studies which believe that high frequent words are recognized via holistic route (Cattell 1986, 1985; Allen, Wallace, & Weber, 1995; Healy & Cunningham, 1992; Healy, Oliver, & McNamara, 1987) and it is more consistent with and support those studies that suggest words are recognized through analytical or lexical route (Gough, 1972).

Our findings are more suitable with letter position coding models. These models include three major kinds: slot-based coding, local context-sensitive coding and spatial coding. Slot-based coding includes units that code letter identity and position at the same time. In interactive activation model (McClelland & Rumelhart, 1981), for example, letter strings are treated in parallel by a set of length dependent, position specific letter detector. Relative position coding presented anchor points. Therefore, letter position is determined relative to the anchor points.

As it is clear from the letter coding schemes, each letter should be perceived based on its own position on word, whether by comparing it to anchor points or detecting its position which is itself length dependent. As we changed letter position on words, the participants could not fully process the letter and they could not detect each letter's position. For example, if we consider word *notebook* as an English stimuli and we permute it as *ntoebook,* the participants fail to recognize it as word based on letter position coding, because letter "o" should be processed as a second letter of this 8-letter word. But in permuted form of the word, the "o" letter is third-letter of the 8-letter word. Thus, the intended word does not activate based on serial or step by step processing of the word.

One explanation for taking less time to reject non-words than confirming words would be that in the case of real word recognition, as participants' perceive first letter of the word (either through absolute or relative position coding) all words that start with such a letter are activated in their lexicon, then they add the next letter to the first letter to limit the scope of the activated words. If such a string exists in their lexicon they would add next letter to create new cluster and they would continue this route until the word is confirmed or rejected. In terms of the non-words in our experiment, because distortions occurred in the second and third letter (distortion) initially and finally, the time it takes to recognize non-words will be shorter than words. Simply the participants reject the stimuli using three or four letter strings in non-word recognition. For example, if the stimuli were ABCDEFG (7 letter words) and it was distorted as ACBDEFG, the participant could reject it to be the words or not as they reached ACB stage and they did not need to move to next stage, ACBD. But in terms of words, they should confirm the stimuli as a word using all letter clusters, ABCDEFG. So the time it took to confirm words should be longer than the time it would take to recognize non-word.

Conclusion

In summary, the analysis between groups showed that participants recognized non-word in shorter time than words. Such findings lend us support to the analytical processing of words and non-words. We can conclude that participants used word letters for the word and non-word recognition. In English they moved from left to right side of the words step by step. For both words and non-words and high and low frequency words they applied analytical route and did not consider words' shape as a determining factor in lexical decision task.

Recommendations for Further Research

As the limitation of the study, it could be said that we used thirty-six participants as the informants of the study. Later studies should engage a larger pool of informants to verify the results of the present study. Also, it is suggested that the follow-up studies investigate languages with different scripts and text directions such as Persian, Thai, and Chinese. As this study was conducted in a context where English is considered a foreign language, it is expected that learners with different proficiency levels would have unequal approaches in reading and recognizing the English texts, relative to their language proficiency. This should be verified by further investigations.

Reference:

Allen, P. A., Wallace, B., & Weber, T. A. (1995). Influence of Case Type, Word Frequency, and Exposure Duration on Visual Word Recognition. *Journal of Experimental Psychology: Human Perception & Performance*, 21, 914-934.

Besner, D. (1989). On the Role of Outline Shape and Word-Specific Visual Pattern in the Identification of Function Words: NONE. *Quarterly Journal of Experimental Psychology*, 41A, 91-105.

Besner, D., & Johnston, J. C. (1989). *Reading and Mental Lexicon: on the Uptake of the Information*. In W. Marslen-wilson (Ed.), Lexical Representation and Process (pp.291-316). Cambridge , MA:MIT Press.

Besnerm, D. & McCann, R. (1987). Word Frequency and Pattern Distortion is Visual Word Identification and Production: A Examination of Four class models. IN M. Coltheart (Ed), Attention and Performance XII: *The Psychology of Reading*. Hove, UK: Lawrence Erlbaum Associates Ltd.

Casalis, S., Dusautoir, M., Cole, P., & Ducrot, S. (2009). Morphological Effects in Children Word Reading: A priming Study in Fourth Graders. *British Journal of Developmental Psychology*, 27, 761–766

Cattell, J. M. (1985). The Inertia of the Eye and Brain, *Brain*, 8, 295.

Cattell, J. M. (1986).The Time It Takes to See and Name Objects, *Mind*, 11, 63.

Corpus.byu.edu. (2012). *Seven Online Corpora* | 45 – 450 Million Words Each. Retrieved from http://corpus.byu.edu/faq.asp.

Forster, K. I. (1976). *Accessing the Mental Lexicon*. In R. J. Wales & E. W. Walker (Eds.), New Approaches to Language Mechanisms (pp. 257-287). Amsterdam: North-Holland.

Gough, P. B. (1972*). Language by Ear and by Eye*. One Second of Reading, Cambridge, MA: MIT Press.

Grainger, J., & Jacobs, A. M. (1996). Orthographic Processing in Visual Word Recognition: A multiple Read-out Model. *Psychological Review*, 103, 518-565.

Groff, P. (1975). Research Brief: Shape as Cue to Word Recognition. *Visible Languages*, 9, 67-75.

Haber, L. R., Haber, R. N., & Furlin, K. R. (1983). Word Length and Shape as Sources Of Information in Reading. *Reading Research Quarterly, 18*, 165-189.

Healy, A. F., & Cunningham, T. F. (1992). A Developmental Evaluation of the Role of Word Shape in Word Recognition. *Memory & Cognition, 20*, 141-150.

Healy, A. F., Oliver, W. L., & McNamara, T. P . (1987). Detecting Letters in Continuous Text: Effects of Display Size. *Journal of Experimental Psychology: Human Perception & Performance, 13*, 279-290.

Marslen-Wilson, W., Tyler, L., Waksler, R., & Older, L. (1994). Morphology and Meaning in the English Mental Lexicon. *Psychological Review*, 101, 3–33.

Mayall, K., Humphreys, G. W. (1996). Case Mixing the Task Sensitive Disruption of Lexical Processing. *Journal of Experimental psychology: Human perception and performance*, 22, 278-294.

McConkie, G. W., & Zola, D. (1979). Is Visual Information Integrated Across Successive Fixation in Reading. *Perception and Psychologist*, 25, 221-224.

McCutchen, D., Logan, B., & Biangardi-Orpe, U. (2009). Making meaning: Children's Sensitivity to Morphological Information During Word Reading. *Reading Research Quarterly*, 44, 360–376.

McClelland, J. L., & Rumelhart, D. E. (1981). An Interactive Activation Model of Context Effects in Letter Perception: Part 1. An Account of Basic Findings. *Psychological Review*, 88, 375-407.

Paap, K. R., Newsome, S. L., McDonald, J. E., & Schvaneveldt, R. W. (1982). An Activation-Verification Model for Letter and Word Recognition: The Word Superiority Effect. *Psychological Review*, 89, 573-594.

Perea, M., & Rosa, E. (2002). Does "Whole word shape" play a role in visual word recognition? *Perception and Psychophysics*, 64, 785-794.

Rashid, S. F., Shafait, F.l, and Breuel, T. M. (2012).*Visual Recognition of Permuted Words*. Retrieved from http://www.dfki.uni-kl.de/~shafait/papers/Rashid- Permuted-Word-Recognition-SPIE10.pdf.

Sanocki, T. (1991). Intra-and-Inter-Pattern Relations in Letter Recognition. *Journal of Experimental Psychology: Human Perception and Performance*, 17, 924-941

Schiff, R., Raveh, M., & Kahta, S. (2008). The Developing Mental Lexicon: Evidence from Morphological Priming of Irregular Hebrew Forms. *Reading and Writing*, 21, 719–743.

Smith, F. (1969). Familiarity of Configuration versus Discriminability of Features in Visual Identification of Words. *Psychonomic Science*, 14, 261-262.

Smith, F., Lott, D., & Cronnell, B. (1969). The Effect of Type Size and Case Alteration on Word non-Word Classification Task. *Journal of Verbal Learning and Verbal Behavior*, 14, 259-264.

Taft, M. (2004). Morphological Decomposition and the Reverse Base Frequency Effect. *Quarterly Journal of Experimental Psychology*, 57, 745–765.

Verhoeven, L., Schreuder, R., & Haarman, V. (2006). Prefix Identification in the Reading of Dutch Bi-syllabic Words. *Reading and Writing*, 19, 651–668.

Walker, P. (1987). Word Shape as a Cue to Identify of a Word: An Analysis of the Kucera and Francis. *Quarterly Journal of experimental psychology*, 39, 675-700.

Appendix
List of the words and non-words

High frequent	Distorted form	Syllable	Low frequent	Distorted form	Syllable
River	Rvier	2	Create	Craete	2
Notice	Ntoice	2	Hero	Hreo	2
Movement	Mvoemnet	2	Tiny	Tniy	2
Problem	Porblem	2	Consist	Cnosist	2
Reason	Raeson	2	Version	Vresion	2
Purpose	Prupose	2	Conflict	Cnoflict	2
Between	Bteween	2	Mountain	Muontian	2
Accept	Acecpt	2	Emotion	Eomtion	2
Proper	Porper	2	Uniform	Uinfrom	2
Business	Bsuinses	2	Powder	pwoder	2
Public	Pbulic	2	Storage	sotrage	2
Empty	Etmpy	2	Weekend	Wekeend	2
Member	Mebmer	2	Eager	Eagear	2
Present	Persent	2	Silver	Sivler	2
Moment	Moemnt	2	Inverse	Ivnerse	2

High frequent	Distorted form	Syllable	Low frequency	Distorted form	Syllable
Situation	Stiuatoin	3	Comfortable	Cmofortalbe	3
Consider	Cnosiedr	3	Discipline	Dsiciplnie	3
Newspaper	Nwespaepr	3	Medicine	mdeicnie	3
Probably	Porbalby	3	Register	Rgeisetr	3
Opposite	Opopstie	3	Investment	Ivnestmnet	3
Determine	Detremine	3	Calendar	Claendar	3
Important	Ipmortnat	3	Element	Eelment	3
Secretary	Sceretray	3	Contrary	Cnortrary	3
Influence	Ifnluecne	3	Gentleman	Gnetleamn	3
Regular	rgeular	3	Mechanism	Mcehansim	3
Necessary	Ncessray	3	Institute	Isntiute	3
Develop	Dveleop	3	Regional	Rgeioanl	3
Hospital	Hsopiatl	3	Democrats	Dmeocrtas	3
Character	Chracter	3	Assumption	Asusmptoin	3
Condition	Cnoditoin	3	Distinguished	Dsitinguisehd	3

High frequent	Distorted form	Syllable	Low frequency	Distorted form	Syllable
Information	Ifnormatoin	4	Academic	Acdaeimc	4
Experience	Epxeriecne	4	Automatic	Atuomaitc	4
Development	Dveleopment	4	Transportation	Tarnsportatoin	4
Political	Ploitiacl	4	Encouragement	Ecnouragemnet	4
Environment	Evnironmnet	4	Entertainment	Etnertainmnet	4
Particular	Praticualr	4	Recommended	Rceomenedd	4
University	Uinverstiy	4	Complicated	Cmoplicaetd	4
Temperature	Tmeperatrue	4	Contribution	Cnotributoin	4
Education	Eudcatoin	4	Consequently	Cnosequenlty	4
Manufacture	Mnaufactrue	4	Fundamental	Fnudamenatl	4
Approximate	Aprpoximtae	4	Availability	Avialbiltiy	4
Especially	Epsecilaly	4	Vocabulary	Vcoabulray	4
Considerably	Cnosideralby	4	Consideration	Cnosideratoin	4
Application	Aplpicatoin	4	Embarrassment	Ebmarrassmnet	4
Population	Pouplatoin	4	Satisfaction	Staisfactoin	4

High frequency	Distorted form	Syllable	Low frequency	Distorted form	Syllable
Qualification	Qaulificatoin	5	Enthusiastic	Etuhusiasitc	5
Immediately	Imemdiatley	5	Automatically	Atuomatiaclaly	5
Opportunity	Opoprtuntiy	5	Identification	Iedntificatoin	5
Administration	Amdinistratoin	5	Agricultural	Argicultuarl	5
Organization	Oogranizatoin	5	Simultaneously	Smiultaneoulsy	5
Incomprehension	Icnomprehensoin	5	Incomparable	Icnomparalbe	5
Traditionally	Tarditionlaly	5	Subordination	Sbuordinatoin	5
Individuals	Idnividulas	5	Classification	Calssificatoin	5
Approximately	Aprproximatley	5	Incompetency	Icnompetecny	5
International	Itnernatioanl	5	Constitutional	Cnostitutioanl	5
Similarity	Smiliarity	5	Recommendation	Rceommendatoin	5
Congratulation	Cnogratulatoin	5	Discrimination	Dsicriminatoin	5
Representation	Rperesentatoin	5	Civilization	Cviilizatoin	5
Creativity	Cerativtiy	5	Intermediate	Itnermeditae	5
Investigation	Ivnestigatoin	5	Universality	Uinversaltiy	5