Clear Speech for Adults with a Hearing Loss: Does Intervention with Communication Partners Make a Difference?

Rachel Caissie*
Melanie McNutt Campbell†
Wendy L. Frenette‡
Lori Scott**
Illona Howell**
Anouk Roy††

Abstract
Spouses of persons with hearing loss served as talkers to examine the benefits of clear speech intervention. One talker received intervention on clear speech. A second talker was simply instructed to speak clearly. Each talker was recorded reading sentences in three conditions: conversational speech, clear speech one week postintervention, and clear speech one month postintervention. Speech acoustic measures were obtained. Then the sentences were presented to subjects with normal hearing and subjects with hearing loss to measure speech recognition. Results showed that simply asking a talker to speak clearly was effective in eliciting clear speech; however, providing intervention yielded changes in more speech parameters, more stable changes, and better speech recognition. When listening to the talker who received intervention, subjects with hearing loss achieved the same performance as subjects with normal hearing. However, they performed worse than subjects with normal hearing when listening to the talker who received clear speech instructions only. Individuals with hearing loss would receive speech recognition benefits if their partners were provided with clear speech intervention.

Key Words: Audiolologic rehabilitation, aural rehabilitation, clear speech, communication strategies for hearing impaired

Abbreviations: CID = Central Institute for the Deaf; F0 = fundamental frequency; F1 = vowel first formant

Sumario
Se utilizaron cónyuges de personas con hipoacusia como interlocutores para examinar los beneficios de una intervención con lenguaje claro. Un interlocutor recibía instrucción sobre lenguaje claro. Un segundo interlocutor se instruía simplemente para hablar claro. Cada interlocutor fue grabado leyendo frases en tres condiciones: lenguaje de conversación, lenguaje claro una semana después de la intervención, y lenguaje claro un mes después de la intervención. Se obtuvieron mediciones acústicas de dichos mensajes lingüísticos. Luego, las frases se presentaron a sujetos con audición normal y con hipoacusia para...
The speech recognition difficulties experienced by many individuals with a hearing loss can create significant challenges in their daily conversational exchanges. Although the use of hearing aids can greatly improve speech recognition (Dillon, 2001), some communication breakdowns will likely continue to occur, particularly when the conversation is occurring in background noise or in groups (Caissie et al., 1998). The speech used for everyday conversational exchanges is often characterized by a tendency to articulate rapidly, to eliminate unnecessary or redundant speech sounds, to blur words and sounds together, and to fail to project the voice (Schum, 1997). These characteristics of conversational speech can make its perception more difficult for individuals with hearing loss (Payton et al., 1994; Schum, 1996), thus hindering communication success and creating frustration for those involved in the conversation (Erber, 1996).

In addition to amplification, a number of rehabilitative strategies, such as auditory-visual speech perception training and communication strategies training, may be used to help adults with a hearing loss function better in daily communication interaction (Erber, 1996; Tye-Murray, 1998; Gagné and Jennings, 2000). Measures can also be taken by frequent communication partners to improve conversational fluency, for example, using effective repair strategies to solve communication breakdowns (Tye-Murray and Schum, 1994; Erber 1996; Caissie and Gibson, 1997; Tye-Murray, 1998) and producing speech that is articulated clearly and easier to perceive (Erber, 1993; Schum, 1997). Indeed, the use of clearly articulated speech by conversational partners has been advocated as an aural rehabilitation strategy designed to help increase message perception by individuals with a hearing loss (Erber, 1993; Schum, 1997; Clark and English, 2004).

According to Tye-Murray, “Clear speech is characterized by a somewhat slowed speaking rate and good (although not exaggerated) enunciation. Key words are emphasized, and pauses are inserted at clause boundaries” (1988, p. 458). The following example, taken from Clark and English, illustrates how clear speech differs from conversational speech: “Conversational speech: The kids'r swim'n inthepool. Clear speech: The kids [pause] are swimming [pause] in the pool” (2004, p. 202).

Compared to conversational speech, clear speech is characterized by several distinct acoustic parameters. First, speaking rate decreases substantially when clear speech is used (Picheny et al., 1986). As shown by Bradlow et al. (2003), a greater number of pauses and an increase in pause length in sentences contribute to the reduced speaking rate of clear speech. Second, stop bursts and nearly all word-final consonants are released when speaking clearly, and the occurrence of alveolar flapping is reduced (Picheny et al., 1986; Bradlow et al., 2003). Third, consonants and vowels are lengthened (Picheny et al., 1986; Ferguson and Kewley-Port, 2002a), and the consonant-to-vowel intensity ratio increases (Bradlow et al., 2003). Fourth,
acoustic vowel spaces are expanded (Picheny et al, 1986; Bradlow et al, 2003), and the first formant of vowels (F1) tends to be higher in clear speech than in conversational speech (Ferguson and Kewley-Port, 2002a). Fifth, fundamental frequency (F0) mean and range values tend to be greater in clear speech (Picheny et al, 1986; Bradlow et al, 2003). Finally, the long-term spectra of clear speech is 5–8 dB louder than that of conversational speech (Picheny et al, 1986).

The well-documented slower speaking rate appears to be a robust characteristic of clear speech and the most prominent distinction between conversational and clear speech. Researchers have measured speaking rate through examination of average sentence duration (Bradlow et al, 2003), words per minute (Picheny et al, 1986), or syllables per seconds (Uchanski et al, 1996). The reduced speaking rate observed in clear speech is achieved by adding pauses between words and increasing the duration of individual phonemes (Picheny et al, 1989). However, studies by Picheny et al (1989) and Uchanski et al (1996) did not find that a slower speaking rate by itself contributed significantly to the perceptual clarity of clear speech. Moreover, it has been suggested that the reduction in speaking rate may simply be a byproduct of other clear speech strategies that take additional time to implement (Ferguson and Kewley-Port, 2003). For example, enunciating more precisely to produce clear speech would require slightly more time and thus result in less rapid speech. The phonemic changes that are associated with a slower speaking rate may be more important contributors to the perceptual clarity of clear speech than the slower speaking rate alone. Krause and Braida (2002) further showed that experienced professional speakers were able, after extensive training, to learn to produce clear speech while maintaining a normal speaking rate. However, while clear speech at a normal rate was easier to perceive by listeners than conversational speech, it was nevertheless not as intelligible as clear speech produced at a slow rate.

As reported above, many studies have found clear speech to be significantly different from conversational speech on several acoustic parameters. However, the specific boundaries between conversational and clear speech have not been firmly established. That is, the precise crossover points between conversational and clear speech have yet to be identified for each acoustic parameter.

As in many studies on clear speech, Bradlow et al (2003) and Ferguson and Kewley-Port (2002a) simply elicited clear speech by instructing their subjects to speak as if talking to someone with a hearing loss. As pointed out by Erber (1993), talkers have a tendency to raise their voice loudness level when talking to people with hearing loss. Indeed, results obtained by Picheny et al (1986) confirmed that clear speech is associated with an increase in speech intensity. A change in loudness may be partly responsible for the higher F1 noted by Ferguson and Kewley-Port (2002a) and the increase in mean F0 observed by Bradlow et al (2003), as F0 and F1 tend to rise with vocal effort (Traunmüller and Eriksson, 2000). However, overall louder speech may not facilitate perception for people with hearing loss because a louder voice level tends to create some distortion in the signal (Erber, 1993). Instead, producing clearer speech by acoustically emphasizing key words may provide more help for message perception (Erber, 1996; Schum, 1997). This latter strategy would lead to varied intonation and voice animation, which may have been reflected in the wider F0 ranges observed by Bradlow et al (2003).

The benefit of clear speech for improving speech recognition has been measured using perception tasks, where listeners are required to repeat or write sentences presented conversationally or clearly. In studies by Payton et al (1994), Gagné et al (1995), Schum (1996), and Helfer (1997, 1998), people with a hearing loss and people with normal hearing demonstrated an improvement in sentence recognition when listening to speech produced clearly compared to speech produced conversationally. The amount of improvement reported by researchers has ranged from 11 to 34% (see Ferguson and Kewley-Port, 2002a), or roughly 17% (Krause and Braida, 2002). Moreover, clear speech benefits have been shown in a variety of acoustically challenging environments. For example, in the study by Payton et al (1994), subjects with normal hearing and with a hearing loss showed a clear speech benefit when listening to speech in noise, reverberation, and a combination of noise and reverberation. Furthermore, the benefit of clear speech increased as the noise and reverberation
levels increased.

In the studies cited above, except for Krause and Braida (2002), acoustic changes in speech production and improvements in speech recognition were observed after the talkers were simply instructed to speak more clearly or to speak as if talking to someone with a hearing loss. Intervention on clear speech was not provided. This suggests that talkers do not need to be highly trained or experienced in order to be able to produce clear speech. Nevertheless, researchers have varied in the instructions used to elicit clear speech. In some studies, minimal instructions, such as simply asking the person to speak as if addressing a listener with a hearing loss, seemed to be enough to create an increase in speech intelligibility (Ferguson and Kewley-Port, 2002a; Bradlow et al, 2003). However, Gagné et al found that asking subjects to “speak clearly as if you were talking to someone who had difficulty understanding” (1995, p.38) was not enough to increase speech intelligibility in all talkers.

Researchers have also varied in the types of talkers recruited to produce clear speech. Talkers have included graduate students (Gagné et al, 1995), an audiologist (Ferguson and Kewley-Port, 2002a), a professional talker (Uchanski et al, 1996), talkers with at least two years of experience in public speaking (Krause and Braida, 2002), young and elderly talkers with no reported neurological or muscular problems (Schum, 1996), and native talkers of English with no known speech or hearing impairment (Bradlow et al, 2003) or no discernible regional accent (Helfer, 1998). The number of talkers enlisted in studies has also varied. Many researchers have used one or two talkers (Payton et al, 1994; Uchanski et al, 1996; Helfer, 1998; Ferguson and Kewley-Port, 2002a; Bradlow et al, 2003), while some have used five or more talkers (Schum, 1996; Ferguson and Kewley-Port, 2002b; Krause and Braida, 2002). Research with multiple talkers has shown variability among talkers’ clear speech productions (e.g., Ferguson and Kewley-Port, 2002b). Although clear speech is advocated as a technique to be used by communication partners of persons with a hearing loss, most researchers have engaged talkers who have limited need to use clear speech in their everyday lives. It is interesting to note that frequent communication partners of adults with a hearing loss have generally not participated in clear speech research, except for the study by Schum (1996) in which some of the older talkers had spouses with mild to moderate hearing loss.

If instructions to speak more clearly are sufficient to elicit clear speech in most talkers, as research has shown, one would think that simply providing frequent communication partners with information on clear speech would be enough for them to be able to produce clear speech. That is, it would not be necessary to provide an intervention program where partners are given the opportunity to practice clear speech techniques under the guidance of a professional. However, there is a lack of research comparing changes in speech production and in speech recognition after simply asking talkers to speak clearly versus after providing them with clear speech intervention. In the study by Krause and Braida (2002) cited earlier, intervention was provided to professional public speakers to examine the role of speaking rate in clear and conversational speech and to determine if professional talkers could be trained to use clear speech while maintaining a normal speaking rate. It is not known whether clear speech produced by nonprofessional talkers after intervention yields better speech recognition performance than clear speech produced after instructions but without intervention. It is also not known whether talkers who are taught specific clear speech techniques show stability over time and retain the information better than talkers who are simply asked to speak clearly without undergoing an intervention program. As stated above, previous research has used mostly talkers who have limited need to use clear speech daily. Family members of adults with a hearing loss may be more motivated to learn clear speech because they have the opportunity to practice their skills. Therefore, unlike most previous studies, we enlisted spouses of persons with a hearing loss as talkers in order to examine the benefit of clear speech intervention. In the first part of the study, speech acoustic measures were obtained for a talker before and after receiving a clear speech intervention session and for a talker before and after receiving only simple instructions to speak clearly. To determine whether the effects of instructions or training were lasting, measures were again conducted one month later. The second part of the study investigated whether adults with normal
hearing and adults with a hearing loss found clear speech produced after intervention easier to recognize than clear speech produced after instructions only.

**METHODS**

**Subjects**

Two male subjects were recruited as talkers. One talker received intervention on clear speech and served as the experimental talker; the other talker simply received instructions to produce clear speech and served as a control. These two talkers were 73 and 74 years old. Both had spouses who wore hearing aids after acquiring a sensorineural hearing loss in adulthood. Neither of the talkers had previous professional speech training or previous aural rehabilitation designed for partners of adults with a hearing loss. Both were native speakers of English and had university education.

Fifteen subjects with normal hearing and 15 subjects with a bilateral sensorineural hearing loss acquired in adulthood served as listeners. The subjects with normal hearing were between the ages of 26 and 53 years (mean = 38.2), while the subjects with a hearing loss were between the ages of 43 and 66 years (mean = 54.1). The mean pure tone average for the subjects with a hearing loss was 59 dB HL for the right ear (SD = 11.78) and 50 dB HL for the left ear (SD = 17.11). All subjects with a hearing loss were full-time users of amplification and had been wearing hearing aids for several years. Thirteen of these subjects were binaurally aided while two were monaurally aided. English was the first language for all 30 subjects.

**Procedure**

The talkers were told that the purpose of the study was to examine how much instruction communication partners need in order to improve the clarity of their speech so that it becomes easier to understand by people with hearing loss. Neither of the talkers was told about the other’s level of instruction; however, at the close of the study, the control talker was offered the intervention on clear speech. To further control a potential Hawthorne effect, both talkers made the same number of visits to the clinic and were tested at the same intervals.

**Speech Production Measures**

Speech production measures were obtained on the two talkers. The experimental talker was tested pre-intervention, one week postintervention, and one month postintervention. The control talker was also tested at the same time intervals. Thus the speech of each talker, postinstruction or postintervention, could be compared to his own production pre-instruction or pre-intervention, allowing between and within comparisons. Similar to other studies (e.g., Helfer, 1998), talkers were asked to read lists of sentences to elicit conversational and clear speech. During the first recording session, each talker was audiotaped reading aloud a list of ten sentences from the Central Institute for the Deaf (CID) Everyday Sentences Test (Davis and Silverman, 1970), repeating each sentence five times. Talkers were instructed to read each sentence as they would naturally. This first recording session provided a sample of their conversational speech. Each talker read a different list of CID Everyday Sentences. The CID Everyday Sentences Test was chosen because its lists are matched for sentence length and grammatical structure. The recordings were made using a Marantz audio recorder (Model PMD 430) with an AMX lapel microphone (Model 600). All recording sessions occurred in a quiet therapy room.

Immediately after the first recording session, the experimental talker received a 45-minute intervention session on clear speech. The intervention was based on the Clear Speech program available from the Oticon Otiset hearing aid fitting software (version 4.31). Intervention began with an introduction to the concept of clear speech, which included a discussion of speech rate, articulation, pausing, key word identification, and placing acoustic stress on key words. To augment this discussion, we used written sentences with key words underlined and pauses marked (sentence samples are available from Oticon Otiset). Then, using a different set of written sentences, the experimental talker was asked to underline the key words and mark the natural placement of pauses. This was followed by oral demonstrations of how clear speech should be produced, with vowels and
consonants articulated as precisely as possible. Then the experimental talker was requested to produce clear speech while reading sentences aloud. He was encouraged to enunciate more precisely and emphasize keywords acoustically, and he was given feedback on his productions. Additional oral practice was provided using short written stories and simulated conversations. The QUEST?AR activity developed by Erber (1996) was used to practice clear speech during structured, simulated conversations. Toward the end of the intervention session, the talker carried out a short informal conversation using clear speech with the researcher to make the technique more automatic. He was then encouraged to practice using clear speech on a daily basis for one week with his wife, who has a hearing loss. An information booklet summarizing the techniques and exercises covered during intervention was given to the talker to take home.

Both the experimental and control talkers returned one week later for the second recording session. The experimental talker first received a 15-minute refresher course to review the clear speech techniques learned the week before. Both talkers were again audiotaped reading a different list of ten CID Everyday Sentences. They were again asked to repeat each sentence five times. They were given the following instructions (based on Helfer, 1998, p. 236) to elicit clear speech: “Speak as if communicating in a noisy environment or with a listener who has a hearing loss. Enunciate consonants more carefully and with greater effort than in conversational speech and avoid slurring words together” (Helfer, 1998, p. 236).

One month later, the talkers returned for a final recording session. They were given the same instructions as in the second recording session. They were audiotaped reading a different list of ten CID Everyday Sentences. They were again asked to repeat each sentence five times. To summarize, each talker read different lists of CID Everyday Sentences in each of the three recording sessions; thus, a total of six lists of 10 sentences were recorded. Each of the 60 sentences was repeated five times to obtain a broader representation of speech for acoustic analysis.

The resulting 300 sentences were acoustically analyzed. The sentences were digitized at a sampling rate of 20 kHz. They were segmented by hand by the experimenters using the Haskins Analysis/Display/Experiment System (HADES) developed for the Digital VAX 2000 VCL Work Station. Segmenting was done using variable cursors, the head and tail markers. In order to determine where different sentences began and ended, the experimenters used visual and auditory information. In short, they observed the waveform and listened to the edited sample of the sentences. Using HADES, the five repetitions of each sentence were individually analyzed for sentence duration, mean F0, and minimum and maximum F0. A procedure within HADES obtained the length of a sentence in number of samples. It then identified the maximum and the minimum nonzero frequency values among that number of samples and also calculated the average frequency value across those samples. From the minimum and maximum F0, the range was calculated.

While it has been shown that clear speech may vary along a number of different parameters, including segment duration, pause duration, F1 amplitudes, and so forth, our mission was not to describe the many fine-grained dimensions of clear speech. Rather our purpose was to measure treatment outcome. Hence we chose to measure broad production changes as a means to determine if there were any differences following treatment and to validate hypothesized perception changes in listeners. For the speech production measures, we chose to focus on a few salient measures that were closely linked to the focus of the intervention session. The intervention session emphasized using clear speech strategies that would slow down speaking rate (for example, the experimental talker was shown how to take the time to enunciate more carefully and to insert pauses at natural phrase boundaries). A reflection of each talker’s speaking rate was captured by first measuring sentence duration and the total number of syllables per sentence; then the number of syllables per second was calculated for each sentence. In addition, putting acoustic emphasis on key words and using varied intonation were also key components of the intervention session. F0 measures were obtained to provide an indication of whether the varied intonation resulting from acoustic emphasis on certain words would lead to alterations in mean F0 and F0 range. For example, if a talker used...
loudness as a strategy to acoustically highlight words as a result of instruction, the mean F0 would be expected to be raised concomitantly because of the inherent link between amplitude and frequency of vibration of the larynx. However, if a talker also used pitch variation to acoustically highlight phrases and words, the F0 range would be expected to enlarge as the talker engaged in greater pitch excursions.

Sentence Recognition Measures

Following the speech production measures, the first sentence of each set of five repetitions was copied onto an audiotape for the sentence recognition measures. The resulting 60 different sentences, recorded by the two talkers, were randomized for talkers and recording sessions. These included 10 sentences drawn from each of the following six conditions: (1) conversational speech by the experimental talker; (2) conversational speech by the control talker; (3) clear speech by the experimental talker one week postintervention; (4) clear speech by the control talker following instructions to speak clearly but without intervention, at one week; (5) clear speech by the experimental talker one month postintervention; and (6) clear speech by the control talker following instructions to speak clearly but without intervention, at one month.

The subjects with normal hearing were screened at 20 dB HL bilaterally to ensure hearing within normal limits. For the subjects with a hearing loss, air conduction hearing thresholds were obtained bilaterally. All subjects were then asked to listen to all 60 sentences. The subjects were instructed to repeat each sentence exactly as it was heard and to guess if unsure. Each sentence was played only once. Testing occurred in a double-walled soundproof booth meeting ANSI standards (S3.1-1991). The recorded stimuli were played on a Kenwood audiotape player (model CT-405) that was routed through an audiometer (Madsen Electronics OB-822). The sentences were presented in a soundfield at an intensity level of 65 dB HL in the presence of multitalker babble noise (Auditec of St. Louis) delivered at a signal-to-noise ratio of +10. Both the sentences and the noise were presented through two loudspeakers located at a 45° angle on each side of the subjects. The subjects with a hearing loss wore their hearing aids during testing. On the day of testing, a listening check was performed on each instrument using a hearing aid stethoscope to rule out any major hearing aid malfunction.

RESULTS

Speech Production Measures

Results were compared between and within talkers to determine the effect of clear speech intervention on the speech production measures. Statistical analysis was performed using a three-way ANOVA with repeated measures for Talker, Session, and Sentences. The main effects of particular interest were Talker (between), Session (within), and the interaction of Talker and Session. The

Table 1. Speech Characteristics for the Experimental and Control Talker during Each Recording Session

<table>
<thead>
<tr>
<th></th>
<th>Session One (Conversational speech)</th>
<th>Session Two (Clear speech at one week)</th>
<th>Session Three (Clear speech at one month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean number of syllables per second (speech rate)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental talker</td>
<td>3.39</td>
<td>2.20</td>
<td>2.17</td>
</tr>
<tr>
<td>Control talker</td>
<td>4.55</td>
<td>3.10</td>
<td>3.70</td>
</tr>
<tr>
<td>Mean F0 (Hz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental talker</td>
<td>128</td>
<td>138</td>
<td>139</td>
</tr>
<tr>
<td>Control talker</td>
<td>132</td>
<td>136</td>
<td>140</td>
</tr>
<tr>
<td>Mean F0 range (Hz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental talker</td>
<td>124</td>
<td>148</td>
<td>129</td>
</tr>
<tr>
<td>Control talker</td>
<td>118</td>
<td>117</td>
<td>126</td>
</tr>
</tbody>
</table>
dependent variables were speech rate (syllables per second), mean F0, and F0 range (maximum F0 minus minimum F0). The speech production results (average over sentences) are shown in Table 1.

When looking at the main effect of Talker across all Sessions and Sentences, the experimental talker spoke significantly fewer syllables per second than did the control talker (F[1,6] = 88.62, p < .01). Overall, the experimental talker spoke more slowly than the control talker. However, the test of whether clear speech intervention resulted in speech production changes rested in within-subject comparisons. Collapsed across Talkers and Sentences, the main effect of Session was significant (F[2,12] = 95.02, p < .01). That is, there was a significant change in the number of syllables per second spoken by both talkers as a function of Session. Post hoc Least Significant Difference (LSD) tests were performed to further examine differences among means, and a level of significance of .05 was retained for all comparisons. When comparing the first recording to the second and each of these to the third recording, results indicated that there was a statistically significant decrease in the number of syllables per second in both postintervention sessions, compared to the pre-intervention session (Session One = 3.97; Session Two = 2.65; Session Three = 2.94). Therefore, both talkers slowed their speech rate after instructions. However, the second and third sessions differed significantly from each other because the rate increased again slightly at the third session. Collapsed across Sessions and Sentences, the main effect of Talker was significant (F[1, 6] = 17.33, p < .01). The experimental talker exhibited significantly greater F0 range (134 Hz) than did the control talker (120 Hz). Collapsed acrossTalkers and Sentences, F0 range did not significantly differ from the first recording to the second or to the third recording (Session One = 121 Hz, Session Two = 133 Hz; Session Three = 128 Hz). A significant interaction was found between Talker and Session (F[2, 12] = 3.94, p = .05). Post hoc testing was performed to determine if a particular session had a particular effect on F0 for either the experimental talker or the control talker. The experimental talker used a significantly higher F0 in the second and third recordings than in the first recording (see Table 1). However, the second recording did not significantly differ from the third. Similarly, the control talker exhibited a significantly higher F0 in the second recording than in the first recording. F0 in the third recording was also significantly higher than F0 in the first recording. Unlike the experimental talker, F0 for the third recording was significantly higher than F0 in the second recording. Results for F0 range showed that, collapsed across all Sessions and Sentences, the main effect of Talker was significant (F[1, 6] = 17.33, p < .01). The experimental talker exhibited significantly greater F0 range (134 Hz) than did the control talker (120 Hz). Collapsed acrossTalkers and Sentences, F0 range did not significantly differ from the first recording to the second or to the third recording (Session One = 121 Hz, Session Two = 133 Hz; Session Three = 128 Hz). A significant interaction was found between Talker and Session (F[2, 12] = 3.94, p = .05). Post hoc testing was performed to determine if a particular session had a particular effect on F0 range for either the experimental or the control talker. The experimental talker showed a significantly greater F0 range in the second session than in the first (see Table 1). The third recording was not significantly different from the first recording but was significantly different from the second
recording. It is important to note that, in the first recording, the F0 range of the experimental talker was not significantly different from the F0 range of the control talker. However, unlike the experimental talker, the control talker did not show significant changes in F0 range from the first to either the second or third sessions.

**Sentence Recognition Measures**

A three-way ANOVA for repeated measures was conducted to analyze the effects of Hearing Loss, Talker, and Speaking Style on the subjects' ability to correctly repeat CID Everyday Sentences keywords. The between-subjects factor was Listener (hearing loss versus normal hearing). The within-subjects factors were Talker (experimental versus control) and Speaking Style (conversational speech, clear speech at one week, and clear speech at one month). The dependent variable was the percentage of correctly repeated keywords.

Results showed that, collapsed across Speaking Style and Listener, subjects repeated more keywords recorded by the experimental talker (91%) than recorded by the control talker (72%). There was also a significant main effect of Speaking Style (F(2, 26) = 118.36, p < .001). Collapsed across Listener and Talker, the subjects exhibited scores of 75%, 94%, and 90% for the sentences produced conversationally, clearly one week postintervention, and clearly one month postintervention, respectively.

A significant three-way interaction occurred between Listener, Talker, and Speaking Style (F(2, 26) = 11.19, p < .001). Thus, post hoc Least Significant Difference (LSD) tests were performed to examine differences among individual means, and a level of significance of .05 was retained for all comparisons. The sentence recognition results for the subjects with a hearing loss are illustrated in Figure 1. Results showed that subjects with a hearing loss performed significantly better when listening to the experimental talker than when listening to the control talker in each of the three listening conditions. Post hoc testing also revealed that subjects with a hearing loss repeated significantly more keywords when listening to the experimental talker in the clear speech at one week condition than to the experimental talker in the conversational speech condition. Similarly, they performed

![Figure 1. CID Everyday Sentences recognition by subjects with a hearing loss when listening to the experimental and control talkers' conversational speech (Convers.), clear speech one week postintervention (Clear 1W), and clear speech one month postintervention (Clear 1M).](image-url)
significantly better when listening to the control talker in the clear speech at one week condition than to the control talker in the conversational speech condition. However, there was no significant difference between the means when listening to the experimental talker in the clear speech at one week condition and in the one month postintervention condition. That is, the talker who received intervention maintained clear speech performance over time, such that it did not yield a change in speech recognition for subjects with a hearing loss. This was not the case with the control talker. Subjects with a hearing loss performed significantly worse when listening to the control talker's clear speech at one month than to his clear speech at one week. Similar to the performance with the experimental talker, however, they did significantly better when the control talker was instructed to speak clearly in the one month condition as compared to the conversational speech condition.

Results for the subjects with normal hearing are displayed in Figure 2. Similar to the results with the subjects with a hearing loss, post hoc testing showed that the subjects with normal hearing performed significantly better when listening to the experimental talker than when listening to the control talker, in each of the three listening conditions. However, results showed no significant difference when they listened to the experimental talker’s conversational speech and clear speech at one week. It should be pointed out that with a performance of 94% in the conversational speech condition, there was not much room for a significant improvement when listening to the experimental talker’s clear speech. However, there was a significant difference when listening to the control talker’s conversational speech and clear speech at one week. That is, subjects with normal hearing performed significantly better after the control talker was instructed to speak clearly. Similar to subjects with a hearing loss, subjects with normal hearing did not perform differently when listening to the experimental talker in the clear speech at one week condition and in the one month postintervention condition. Unlike subjects with a hearing loss, subjects with normal hearing did not perform differently when listening to the control talker in the clear speech at one week condition and the one month postintervention condition.

Figures 3 and 4 further compare the performance of subjects with a hearing loss to that of subjects with normal hearing with each talker in each listening condition. When listening to the experimental talker, subjects with a hearing loss performed significantly worse than subjects with normal hearing in the conversational speech condition only (see Figure 3). No significant differences were observed between the performance of subjects with a hearing loss and subjects with normal hearing for the two clear speech conditions.

![Figure 2. CID Everyday Sentences recognition by subjects with normal hearing when listening to the experimental and control talkers’ conversational speech (Convers.), clear speech one week postintervention (Clear 1W), and clear speech one month postintervention (Clear 1M).](image-url)
That is, when listening to the experimental talker’s clear speech one week postintervention and one month postintervention, subjects with a hearing loss performed as well as subjects with normal hearing. However, as shown in Figure 4, when listening to the control talker, subjects with a hearing loss performed significantly worse than subjects with normal hearing in the conversational speech, clear speech at one week, and clear speech at one month conditions.

Examination of the amount of improvement obtained when listening to clear speech (i.e., the difference in recognition scores for the conversational speech and clear speech conditions) revealed that greater gains were made when subjects with a hearing loss listened to the experimental talker. That is, their recognition of the experimental talker’s speech improved by 42% one week after clear speech intervention. Moreover, this amount of improvement was maintained for the clear speech recorded one month later (40%).
contrast, when the subjects with a hearing loss listened to the control talker’s clear speech, their recognition performance improved by 33% for the first recording of clear speech and by 18% for the clear speech recording obtained one month later. On the other hand, the subjects with normal hearing achieved high recognition scores when listening to the experimental talker’s conversational speech (94%) and the control talker’s conversational speech (81%), such that there was little room for improvement with clear speech. Their sentence recognition performance reached 100% when listening to the experimental talker’s clear speech one week postintervention and 96% when listening to the control talker’s clear speech.

**DISCUSSION**

The purpose of this study was to examine whether spouses of persons with a hearing loss require intervention to achieve and maintain clear speech over time. This study also investigated whether clear speech following an intervention session yields better sentence recognition performance than clear speech following routine instructions. Overall, results showed that simply asking a talker to speak more clearly can be effective in producing clearer speech and more easily perceived speech by both subjects with normal hearing and subjects with a hearing loss. However, providing clear speech intervention is more effective than simply asking a talker to speak more clearly, in that more speech acoustic parameters are changed, these changes are more stable over time, and greater improvements in speech recognition performance are achieved.

Similar to results obtained by others (e.g., Payton et al, 1994; Helfer, 1997), the present study showed that when communication partners are simply instructed to speak clearly, the intelligibility of their speech improves compared to that of their conversational speech. This trend was demonstrated by the results for the control talker. That is, despite the fact that he did not receive intervention, he altered his speech characteristics when asked to speak clearly; indeed, he decreased his speech rate, increased his F0, and produced speech that was easier to perceive by both adults with normal hearing and adults with a hearing loss. However, results of the current study further indicate that it is more effective to provide clear speech intervention in addition to instructions. Like the control talker, the experimental talker decreased his speech rate and increased his mean F0, but he also showed increases in F0 range when asked to speak clearly immediately following intervention. Moreover, although both the control and experimental talkers produced clear speech that was easier to understand than conversational speech, the improvements were more substantial when the subjects, particularly those with a hearing loss, listened to the experimental talker’s clear speech than when they listened to the control talker’s clear speech. Thus, the provision of clear speech intervention tended to yield speech production changes for more acoustic parameters, and these changes were associated with better speech recognition scores.

It is well known that speakers of English use duration, loudness, and pitch to place stress or emphasis on words or phrases. It is also well known that voice sound level and F0 are not independent; that is, raising one’s voice level can result in an increase in F0. Thus, speaking louder overall could result in an increase in F0. However, an increase in F0 range is consistent with the use of a broader spectrum of low- and high-frequency excursions. The experimental talker increased both his F0 and F0 range when asked to speak clearly immediately following intervention. These changes may have resulted from the experimental talker putting acoustic emphasis on key words and using more varied intonation, postintervention. On the other hand, the control talker increased his F0 when asked to speak clearly but did not increase his F0 range. He may simply have been speaking louder overall, which is a less skilled strategy. It should be pointed out that the increase in F0 range exhibited by the experimental talker one week postintervention was not maintained one month later, nor was the increase in F0; however, the latter is a desirable result in clear speech because one does not want the client to speak louder overall, but instead to emphasize key words.

Despite the fact that the experimental talker’s increase in F0 range was not maintained one month later, the speech recognition performance of adults with a hearing loss and adults with normal hearing
was maintained over time when listening to the experimental talker’s clear speech. It is possible that changes in F0 range, or putting emphasis on key words, may not be, by themselves, very important contributors to improved recognition of clear speech. Other attributes of clear speech, such as a more precise enunciation, which can result in a slower speaking rate, may be more closely associated with improved speech recognition. It is interesting to note that the experimental talker’s speaking rate was slower than that of the control talker in each of the three conditions and that his speech was also easier to perceive than that of the control talker in each condition. Moreover, the increase in speaking rate exhibited by the control talker between the second and third sessions was associated with a deterioration in speech recognition performance from the second to the third session by adults with a hearing loss. On the other hand, the experimental talker maintained his slower speaking rate during the two clear speech recording sessions postintervention, and he produced clear speech that continued to be recognized nearly 100% of the time by both subjects with normal hearing and subjects with a hearing loss. These observations suggest that a slower speaking rate and/or the phonemic changes that are associated with speaking more slowly may be key elements responsible for the improved recognition of clear speech. Future research is needed to further examine the benefit of putting acoustic emphasis on key words to improve clear speech recognition. Research should also explore other speech acoustic changes, besides changes in F0 range, that may be associated with using varied intonation, and how the phonemic dimensions of speech may change following clear speech produced with and without intervention.

Apart from this, a promising finding was that subjects with a hearing loss exhibited the same level of sentence recognition performance in background noise as did the subjects with normal hearing, in both recording sessions where the talker who received intervention used clear speech. Their sentence recognition scores approximated 100%. However, when listening to the control talker’s clear speech, subjects with a hearing loss continued to perform significantly more poorly (70% and 55%, for the first and second clear speech recordings, respectively) than subjects with normal hearing (96% and 92%). Moreover, it should be pointed out that the control talker’s clear speech was 33% (first clear speech recording) and 18% (second clear speech recording) more intelligible for subjects with a hearing loss than his conversational speech. The amount of improvement exhibited by the trained talker falls outside the improvement range reported for untrained talkers (Ferguson and Kewley-Port, 2002a). In comparison, the experimental talker’s clear speech was 42% (first clear speech recording) and 40% (second clear speech recording) more intelligible than his conversational speech. The amount of improvement exhibited by the trained talker falls outside the improvement range reported for untrained talkers, suggesting that intervention provided benefit. The results suggest that if frequent communication partners are trained to use clear speech, rather than simply being provided with instructions or general information on clear speech, the recognition of their speech by adults with a hearing loss, in the presence of background noise, potentially can reach levels attained by adults with normal hearing. Nevertheless, caution should be exercised in the interpretation of the results. Previous research has found that untrained talkers vary in their ability to produce clear speech and that some talkers become more intelligible than others when asked to speak clearly (Gagné et al, 1995; Ferguson and Kewley-Port, 2002b). Thus, it is unclear how much of the improvement exhibited by the trained talker can be attributed to the intervention per se and how much to talker variability. That is, the trained talker may still have shown better performance than the control talker had he been provided with instructions only. However, the fact that the experimental talker improved his speech to a greater extent than the improvement range reported for untrained talkers (Ferguson and Kewley-Port, 2002a) suggests that intervention was at least partly responsible for his better performance.

The results also suggest that the clear speaking style of untrained talkers may vary over time. That is, despite the fact that the control talker was given exactly the same instructions before each clear speech recording, his clear speech changes were not all stable. His speaking rate and his F0 were significantly different between the first and second clear speech recordings, and the
recognition of his clear speech by adults with hearing loss also varied over time. In contrast, the experimental talker exhibited less variability between his first and second clear speech recordings. His speaking rate and F0 did not significantly change between the first and second clear speech recordings, and the recognition of his speech remained roughly the same. The results suggest that some talkers may not show stability in their clear speech techniques when they are simply instructed to speak clearly. Based on these results, the notion in the literature that clear speech occurs with minimal instructions or when untrained talkers are simply asked to speak as if speaking with someone with a hearing loss should be viewed with caution. Not only do different talkers respond differently to these instructions, it appears that talkers can respond differently at different times. It would be interesting to further examine test-retest differences for a group of untrained talkers.

For this study, the selection of talkers and the decision of which of the two talkers was to receive intervention was based on subject availability. The speech characteristics of each subject were not known prior to selecting a talker for intervention. Results later showed that both talkers did not hold the same degree of speech intelligibility prior to clear speech instruction and/or intervention, in that the talker who received intervention was initially easier to understand than the control talker. Consequently, both groups of subjects performed better when the experimental talker used conversational speech than when the control talker used conversational speech. It is difficult to determine whether subjects with a hearing loss would show the same amounts of improvement in speech recognition if talkers with varying degrees of speech clarity, prior to intervention, received clear speech intervention. Future research may wish to examine how clear speech intervention with talkers who have initial differences in speech clarity would affect sentence recognition for subjects with a hearing loss. Studies with a larger number of talkers will be required to address the issue of the possible interaction of talker variability and degree of benefit of clear speech intervention.

In clinical settings, audiologists do not always provide thorough clear speech intervention as part of their aural rehabilitation programs. That is, family members may receive information or handouts describing various communication strategies, including clear speech, that they can use to facilitate message perception for the person with a hearing loss. However, many frequent communication partners do not undergo an intervention session where they have an opportunity to practice clear speech techniques under the guidance of a clinician. Although the present study shows that simply asking communication partners to speak more clearly can elicit speech that is clearer and easier to perceive, results also show that individuals with a hearing loss would receive greater benefits if their partners underwent clear speech intervention. That is, partners who are trained to produce clear speech can produce speech that is more easily recognized than clear speech produced by untrained partners, and the clarity of their speech is better maintained over time. It should be pointed out that these benefits were achieved with one clear speech intervention session that was less than one hour in duration. Moreover, learning to use clear speech places some of the responsibility for communication success on the communication partner, thereby reducing the struggle of the person with a hearing loss to understand the message.

In summary, results show that the provision of clear speech intervention yields changes in more speech acoustic parameters, more stable changes, and better speech recognition in noise particularly by individuals with a hearing loss. Simply asking a person to speak clearly can improve speech recognition performance for individuals with a hearing loss or normal hearing; however, the performance of subjects with a hearing loss tends to remain below that of subjects with normal hearing. However, if talkers are provided with an intervention session on clear speech, then the speech recognition performance of adults with a hearing loss can potentially reach that of adults with normal hearing.

REFERENCES


Picheny MA, Durlach NI, Braida LD. (1989) Speaking clearly for the hard of hearing II: acoustic charac-


