Assessment of Telephone Amplifiers Using an Alternating Treatments Design

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The advantage of using a single-subject alternating treatments design in conjunction with the continuous discourse tracking procedure to demonstrate the effectiveness of telephone amplifiers was investigated. Four subjects with hearing-impairment were tested using two telephone amplification devices. Results suggested that the alternating treatments design in conjunction with continuous discourse tracking is an acceptable method for comparing amplification devices. However, certain limitations do exist. Clinical implications are discussed.

No standard procedure currently exists for evaluating the effectiveness of communication strategies and assistive-listening devices for persons with hearing-impairments while they use the telephone. One informal method of evaluating different devices is to have the client listen to someone talk over an extension line telephone and then judge whether the speech signal sounds acceptable (Stoker, 1982).

Several formal studies have analyzed different telephone devices by measuring speech discrimination for monosyllabic word lists (Holmes, 1985; Holmes & Chase, 1985; Tannahill, 1983). However, monosyllabic words do not represent the typical signal that we listen to in everyday conversation. Because connected speech is an approximation of the type of stimuli that hearing-impaired individuals encounter during everyday communication (Cox, Alexander, & Gilmore, 1987), it would seem to be an ideal stimulus for use in the evaluation of telephone amplification devices. Continuous discourse has been widely used as a means for training the hearing-impaired to use the telephone (Castle, 1978; Erber, 1982,

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1985). However, no research exists concerning the use of connected speech when evaluating the effectiveness of various telephone amplification devices.

Continuous discourse tracking (De Filippo & Scott, 1978) is a process in which a subject repeats groups of words read by another person. Tracking approximates conversational structuring in that a talker's behavior depends on the receiver's performance. When the receiver responds correctly, the talker moves on to the next segment of the text. When an error interferes with receiving the message, the respondent must use a communication repair strategy to overcome the block in order to continue. In this fashion, the receiver benefits from the repetitions and modifications that occur in everyday communication (De Filippo, 1988). Performance is quantified by the number of words correctly repeated per minute.

According to De Filippo and Scott (1978), tracking rate may be influenced by such factors as sender skills and the type of material tracked. These factors can introduce variability, especially when comparisons are made with different senders or receivers. The use of single-subject designs with tracking may provide a paradigm by which this inherent variability can be controlled since all comparisons are made within sender-receiver dyads.

For example, Brainard, Lesner, and Lynn (1990) and Lesner, Lynn, and Brainard (1988) found that continuous discourse tracking used in conjunction with a single-subject design provides an effective means for evaluating the benefit of an FM assistive-listening device with hearing-impaired individuals in reverberant conditions. It is reasonable to expect that a similar single-subject design can be used in the evaluation of telephone amplification devices.

Single-subject research designs do not rely on either parametric or nonparametric statistical analysis to identify effects of treatment(s) on dependent variables (McReynolds & Kearns, 1983). Rather, changes in dependent variables are identified visually from graphical representation. Clinically, the designs provide a means to demonstrate differences between listening conditions such as aided versus unaided listening or two different aided listening conditions.

An alternating treatments design (ATD) is a form of a single-subject design used when comparing two or more treatments (Kearns, 1986). The treatments to be compared in an ATD are administered in an alternating fashion. For example, during the first session, treatment "A" would be administered first, followed by treatment "B." In the second session, which would occur at a later time, treatment "B" would precede treatment "A." The use of counterbalancing is required to control for order effects and the presence of extraneous variables. These extraneous variables might include the number of experimenters providing the treatment, the time of presentation for the different treatments, and the settings where the treatment is administered if more than one is required. Within an alternating treatments design, subjects serve as their own control receiving both treatments. If a subject characteristic affects one treatment, it will also influence the other, thereby eliminating subject variables as a possible confound to the study (McReynolds & Kearns, 1983).

The three phases typically included in an ATD study are a baseline phase, an experimental treatments phase, and a phase in which the most effective treatment from the experimental phase is administered. The baseline phase is administered to determine if the stability criterion is met before treatment is administered. However, inclusion of a baseline phase is not required in an ATD study (Barlow & Hersen, 1984) since the main purpose of the ATD is to compare two treatment conditions and not one treatment to a non-treatment condition.

During the experimental treatments phase, the number of repetitions of each treatment is determined by experimental requirements, however, one repetition is a minimum (McReynolds & Kearns, 1983). In the final phase, the most effective treatment is administered to demonstrate performance maintenance from the experimental phase. This phase is not essential and may be omitted.

The purpose of the present study was to investigate the advantage of using an alternating treatments single-subject design with continuous discourse tracking to compare two telephone handset amplification devices.

METHOD

Subjects

Subjects for this study included two male and two female adults with hearing-impairment who ranged in age from 47 to 72 years. All subjects had acquired sensorineural hearing losses with pure-tone averages that ranged from 35 to 60 dB HL for the ear used most often with the telephone. None of the subjects had had prior experience with the tracking procedure.

Speech Stimuli

The short stories used for tracking were from a series developed by Owens and Raggio (1987). The 16 specific stories used in treatment were selected on the basis of an equivalency study performed by Lynn and Lesner (1989) and were read live voice by an experienced talker who spoke general American Dialect. Eight additional stories were used as training material. Previous research has demonstrated that eight practice stories are sufficient to reach asymptotic tracking performance (Brainard et al., 1990; Lesner et al., 1988).

Instrumentation

An Audiometer Telephone Interface (ATI) was used to direct monitored speech input (tape or live voice) into a Grason-Stadler Model 16 audiometer and through a telephone handset. The ATI modifies the speech sent through the audiometer to "approximate the actual effects of the switching networks, relays, miles of wire and the unique band-limiting and distortion characteristics of a typical telephone loop" (Stoker, 1982, p. 29).

All testing was done in a single-wall audiometric test booth. For calibration purposes, a 1000 Hz calibration tone from a tape of "The Synthetic Sentence Identification Test" (SSI) from Auditec of St. Louis was fed through the in-

strumentation. The output was measured with a Bruel and Kjaer Type 2203 sound level meter and an NBS 9A coupler. This was done in order to set the audiometer-ATI output to 86 dB SPL at the telephone receiver when measured through a standard telephone handset. This instrumentation was calibrated daily during data collection.

PROCEDURE

The subjects were tested individually. Prior to data collection, each subject participated in a training sequence of eight tracking stories so that practice effects would not occur during data collection. The experimental treatment procedure consisted of eight sessions with two measures per session. The treatment sequence included 16 tracking stories with one story per measure; each subject received the stories in the same sequence. The title of each story was verbally introduced as the topic prior to tracking. Within each session, two treatments were administered: one with an AT&T G6 amplified handset adjusted to MCL, and the other with an AT&T portable adapter set at MCL when attached to the receiver of a standard 500 series handset. Prior to treatment, MCL was obtained by using the competing message from the SSI tape. Each subject was instructed to adjust the volume control of each amplifier to their most comfortable listening level for 10 trials during two different sessions. The average MCL output of the 10 trials from the second session for each device was used during the entire experiment. The obtained MCL output for each telephone amplifier type was set prior to each treatment session using the 1000 Hz calibration tone from the SSI tape and measured with the sound level meter and an earphone coupler. The order of administration of the two treatments was alternated with each consecutive session.

RESULTS AND DISCUSSION

Tracking rate was calculated by dividing the number of words in a story by the time required to track the story. Tracking rates in words per minute (WPM) are graphically displayed in Figure 1. For each subject the eight treatment sessions are plotted. The two treatments were compared by visual inspection to determine which treatment (i.e., telephone amplifier type) provided an overall better performance rate for each individual.

No strong indication of superiority for either treatment across all subjects was seen in Figure 1. Further, the alternating treatments design identified no overall, sustained differences in treatment within each subject. Subjects 1 and 2 initially tracked at a faster rate with the amplified handset as compared to the portable amplifier. However, this difference was not observable in the subsequent tracking session results. Since all of the subjects were tracking at asymptotic WPM rates prior to treatment, the initial differences observed between the two treatments for Subjects 1 and 2 might be attributed to an initial performance difference between the telephone amplifiers. However, in subsequent tracking sessions,

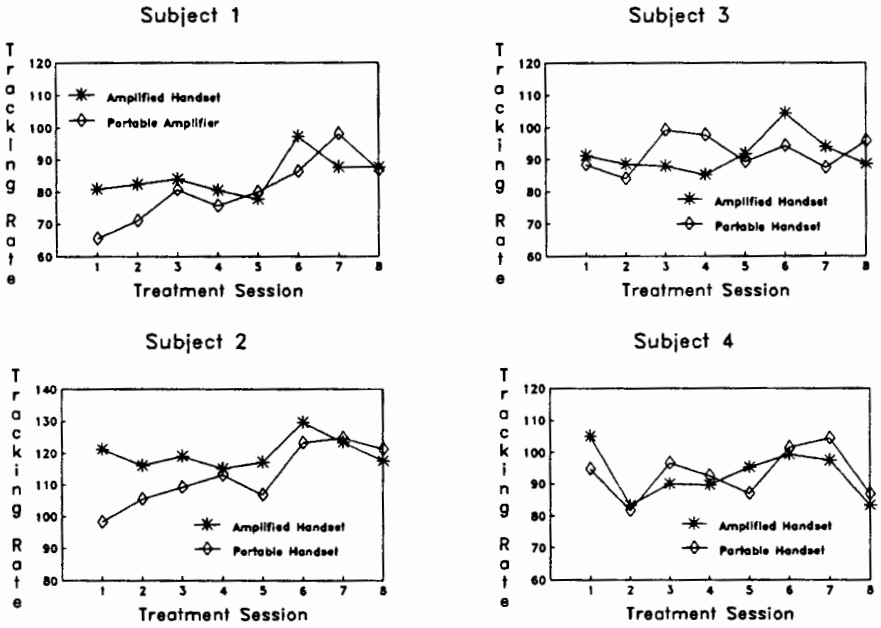

Figure 1. Tracking performance in words per minute (WPM) for Subjects 1-4 in the treatment condition.

these subjects may have compensated for these initial differences in some way and, as a result, performance was equivalent. These findings are acceptable for an ATD method (Kearns, 1986).

Overall, the alternating treatments design in conjunction with continuous discourse tracking holds promise as a method for comparing amplification devices on the basis of its face validity. The method provided a systematic means of using continuous discourse for research purposes. However, certain limitations were observed in the tracking procedures and the design of the study.

Procedural Requirements

In the present study, the Tye-Murray and Tyler (1988) suggestions for control of variables related to sender, receiver, and test materials were followed. Different story topics were introduced for each tracking session, a verbatim response was required, stories of equivalent difficult level were used, and all comparisons were made with the same sender-receiver dyad. However, additional sources of experimental control appeared to be necessary. For example, a baseline phase of data collection prior to the alternating treatments phase would provide a means of comparing treatment and no treatment conditions (Kearns, 1986). In addition, a final phase of treatment performance maintenance is recommended whenever a difference is demonstrated between treatments.

Number of Sessions

The present study was carried out over eight sessions. While it may be that a difference would be apparent if more sessions were adminstered (Barlow & Hayes, 1979), it was not considered likely in that all subjects had completed extensive pre-treatment training and were tracking at asymptotic rates at the initiation of treatment. Indeed, our experience suggests that an ATD-Tracking study should incorporate a minimum of five sessions: one training, one baseline, two treatment sessions, and one maintenance. Brainard et al. (1990) and Lesner et al. (1988) found no overall improvement in WPM rate during the training phase. Therefore, one training session should be adequate to introduce the tracking procedure for comparison of amplification devices when using these equated difficulty, tracking materials.

Ceiling Effects

Finally, additional research is recommended to determine if tracking rates within this ATD study could have been influenced by ceiling effects. De Filippo and Scott (1978) indicated that the average tracking rate for persons with normal hearing, given ideal conditions, is around 100 WPM. Three of the 4 subjects in this study were tracking near or above this rate during treatment. The sensitivity of the proposed method to identify differences between treatments might be increased by implementing adverse conditions such as reduced presentation level and/or background noise within the treatment condition when tracking rates are near the maximum.

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