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EVERYDAY SPEECH PRODUCTION ASSESSMENT MEASURE (E-SPAM): RELIABILITY AND VALIDITY

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ABSTRACT OF THESIS

THE EVERYDAY SPEECH PRODUCTION ASSESSMENT MEASURE (E-SPAM): RELIABILITY AND VALIDITY

Purpose: The Everyday Speech Production Assessment Measure (E-SPAM) is a novel test for assessing changes in clients' speech production skills after intervention. This study provides information on reliability and validity for the test and overviews its clinical application.

Method & Procedures: E-SPAM, oral reading, and sequential motion rate tasks were administered to 15 participants with motor speech disorders (MSDs). E-SPAM responses were scored using a 5-point system by four graduate students to assess inter-scorer and temporal reliability and to determine validity for E-SPAM.

Results: Findings of this study indicate that the E-SPAM can be scored with sufficient reliability for clinical use, yields stable scores on repeat administrations, and that its results correlate highly with other accepted measures of speech production ability, specifically sentence intelligibility and severity.

Conclusions: While the results of this study must be considered preliminary because of the small sample size, it does appear that the E-SPAM can provide information about aspects of speech production such as intelligibility, efficiency, and speech naturalness, that are important when treatment focuses on improving speech. The E-SPAM also appears to be a "clinician-friendly" test as it is quick to administer and score and can be administered to patients across the severity continuum.

KEYWORDS: motor speech, test, intervention, apraxia, dysarthria,

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THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
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By

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DEDICATION

I would like to dedicate this thesis to my family, Chris, Becky and Mark Watts and my fiancé Steven Tolliver. My dad has always helped me see the importance of working hard through everything. My mom, through her love for speech language pathology, has inspired me to pursue this career. I am truly blessed to have the love and support from all of them.

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Chapter One

Introduction

Under most circumstances, adult speech is produced with an ease and at a speed that belies the complexity of the operations underlying it. Disorders of the nervous system, however, interfere with the production of speech and speech motor control resulting in motor speech disorders (MSDs; Duffy, 2005). The two most common MSDs encountered by speech-language clinicians are dysarthria and apraxia of speech (AOS). Dysarthria refers to a group of speech disorders caused by disturbances of neuromuscular control of the speech production systems (Darley, Aronson, & Brown, 1975). AOS is a "neurologic speech disorder reflecting an impaired capacity to plan or program sensorimotor commands necessary for directing movements that result in phonetically and prosodically normal speech" (Duffy, 2005, p. 5). Other, less frequently occurring neurological deficits can also interfere with speech production. Some of these include phonological errors and frequent self-corrections associated with conduction aphasia (Gandour, Marshall, Kim, & Neuburger, 1991), aprosodia (Monrad-Krohn, 1947; Ross, 1981), foreign accent syndrome (Ardilla, Rosselli, & Ardilla, 1988), palilalia (Horner & Massey, 1983; LaPointe & Horner, 1981), and neurogenic fluency disorders (Duffy, 2005; Marshall & Karow, 2002).

MSDs impact communication in different ways. Clients with severe MSDs have difficulty communicating orally because of reduced speech intelligibility (the degree to which a listener understands the acoustic signal produced by the speaker) and/or comprehensibility (the degree to which a listener understands speech on the basis of the acoustic signal produced by the speaker plus all other information provided). Clients with moderate MSDs may communicate orally, but their speech may lack efficiency (the rate at which intelligible or comprehensible information is conveyed) and limit communication in certain situational contexts. Individuals with mild-to-moderate MSDs may have intelligible speech, but their speech may sound unnatural. Speech naturalness connotes the degree to which speech conforms to the listener's standards of rate, rhythm, intonation, and stress patterning (Yorkston, Beukelman, Strand, & Bell, 1999). In these cases, the person's speech may call attention to the speaker and result in maladjustment or social penalties. Since speech production is the most effective way for humans to

communicate, MSDs, regardless of their severity, can limit one's ability to participate in culturally relevant social, educational, vocational, and other activities.

MSDs often occur in combination with language and/or cognitive deficits. For example, AOS frequently co-occurs with aphasia, a multi-modal language disorder caused by damage to the language dominant hemisphere of the brain (Brookshire, 2003; Duffy, 2005; Wambaugh & Shuster, 2008). Dysarthria may be the result of a unilateral upper motor neuron lesion caused by a right or a left-hemisphere stroke (Duffy, 2005). In many instances this MSD is "masked" by the client's aphasia and/or AOS (Duffy, 2005; Duffy & Folger, 1996) or cognitive-communication disorders associated with right-hemisphere damage (Ropper, 1987). Sometimes MSDs occur in conjunction with cognitive disorders resulting from nervous system damage or disease. For example, the prevalence of dysarthria in clients with traumatic brain injury (TBI) ranges from 8% to 100% depending on the population studied (Beukelman & Yorkston, 1991). Degenerative diseases of the nervous system not only result in various forms of dysarthria, but they can also are accompanied by cognitive deficits that worsen over time (Yorkston et al., 1999). Representative examples include conditions such as Parkinson's disease (Levin, Tomer, & Rey, 1992), amyotrophic lateral sclerosis (Kent, Kent, Weismer et al., 1990), and Huntington's disease (Lundervold & Reinvang, 1991). Recently, research has shown that some cases AOS can also be progressive and clients ultimately develop co-occurring cognitive deficits (Duffy, 2006, Duffy & McNeil, 2008).

Diagnosis of MSDs

Since the Mayo Clinic Dysarthria studies of the late 1960s (Darley, Aronson, & Brown, 1969 a, b) clinicians have diagnosed MSDs by listening for the presence of deviant speech characteristics in the client's speech and comparing what is heard to a normal reference. The process of diagnosis consists of affixing a general label to the problem (Wertz, LaPointe, & Rosenbek, 1984; Duffy, 2005), e.g., dysarthria, AOS, neurogenic stuttering. Once it has been determined a MSD is present, the clinician may generate a list of diagnostic possibilities, consider the client's history, and carry out further assessments, both formal and informal. Ultimately, based on her perceptions and what has been learned about the client via the assessment process, the clinician will make a differential diagnosis. This might involve specifying a type of dysarthria or concluding

the client has AOS or some other type of MSD. Sometimes, information from the motor speech evaluation may provide clues about the nature of the underlying pathophysiology responsible for the MSD (Duffy, 2005). For example, a strained-strangled voice quality is considered a hallmark of spastic dysarthria and associated with excessive muscle tone and bilateral damage to the upper motor neuron system (Duffy, 2005).

Treatment of Motor Speech Disorders

Treatment of MSDs seeks to improve the client's speech production skills and facilitate oral communication. In some cases treatment may be restorative and seek to strengthen, increase the speed of, or improve the coordination of the affected speech subsystems. For example, a clinician might work with the client to develop more respiratory support or improve laryngeal-respiratory coordination. Alternatively, treatment of MSDs may seek to help the client compensate for damaged speech components that cannot be improved by restorative treatment. One way of doing this might be to have the client point to the first letter of each word said using an alphabet supplementation board. This would have the effect of slowing the client's speaking rate and hopefully facilitate better articulation (Yorkston et al., 1999). It would also supply the listener with supplementary orthographic cues (Beukelman & Yorkston, 1977; Crow & Enderby, 1989). When working directly on speech production, the clinician's goals are to reduce the client's disability by improving speech intelligibility, comprehensibility, and efficiency. There are occasions, however, when clients' speech production capabilities are so limited that communication needs are unmet. In these instances, the clinician may work with the client to develop the use of the most appropriate augmentative and alternative communication (AAC) system (King, 2010).

Measuring Outcomes

Clinicians are mandated to measure the outcomes of their treatments to justify provision and costs of their services (Fratalli, 1998). Outcomes reflect the results of interventions (Fratalli, 1998). Broadly speaking outcomes are changes, both favorable and unfavorable, in the actual or potential health status of persons that can be attributed to prior or current care (Donabedian, 1985). Outcome measures in MSDs can be clinically derived (e.g., increasing maximum phonation time from 5-to-15 seconds), functional

(speaking intelligibly on the phone), social (e.g., employability), or client-defined (e.g., reported improvement in quality of life).

Currently there are only a few outcome measures clinicians can use to quantify changes in speech production ability over time or following intervention for a client with a MSD. The tasks of the motor speech examination are helpful in establishing a diagnosis and in making a differential diagnosis, but for the most part, these tasks were designed to "tax" the client's speech production system and aid diagnosis rather than measure the outcome of an intervention (Duffy, 2005; Kent, Kent, & Rosenbek, 1987). There is a need for a clinical outcome measure that will permit clinicians to measure, quickly and simply, changes in speech production ability over time and/or as a consequence of intervention. The present study presents information on a clinical tool intended for this purpose, the Everyday Speech Production Assessment Measure (E-SPAM). Accordingly, this preliminary study of the E-SPAM sought to answer the following questions:

1. Are inter- and intra-scorer reliability for the E-SPAM adequate for clinical purposes?
2. Are test-retest scores for the E-SPAM sufficiently stable to allow clinicians to use the test to measure changes in speech production ability over time or following intervention?
3. Is the E-SPAM a valid measure of speech production ability?

Chapter Two

Assessment of Motor Speech Disorders

For the most part, the assessment of a client with a MSD focuses on diagnosis, establishing the severity of the disorder, and obtaining information to plan treatment. In conducting a motor speech examination (MSE) the clinician listens to the client's speech as he or she performs a series of tasks. Duffy (2005) indicates that the MSE includes a small number of well-selected tasks that allow the clinician to obtain the necessary information to describe clients' abnormal speech and make a differential diagnosis. These tasks, described in Table 2.1, include (1) vowel prolongation, (2) alternate motion rates, (3) sequential motion rates, (4) contextual speech, (5) stress testing, and (6) various tasks to assess motor speech planning and programming. Clinicians employ these tasks discretionarily taking into consideration the severity of the MSD, the client's medical status, time allocated for assessment, and other factors. In some cases, the clinician may compare a client's performance on tasks of the MSE (e.g., producing a sustained vowel) with data from persons without MSDs. For example, Kent and colleagues have provided a set of normative data for assessing maximum performance on tasks included in the MSE by normal subjects (Kent et al. 1987).

When listening to the client's speech as he or she goes through the tasks of the MSE shown in Table 2.1, the clinician makes perceptual judgments about the presence and/or absence of deviant speech characteristics in pitch, loudness, and voice quality. Table 2.2 shows a form for rating deviant speech characteristics in clients with dysarthria used at the Mayo Clinic and adapted from seminal studies in the dysarthrias by Darley and colleagues (Darley et al., 1969 a, b).

Oral Motor Examination

The oral motor examination (OME) is an important component of the MSE. The OME is a semi-structured process by which a clinician obtains information about the integrity of the speech mechanism, e.g., strength, range of motion, speed, and coordination (Duffy, 2005). Specifically, the OME consists of making observations about the client's speech structures at rest (e.g., observing the face in repose for presence of adventitious movements), during the performance of non-speech (protruding the tongue), and speech acts (prolonging a vowel). Again, clinician uses the various tasks of the OME

discretionarily and will modify and/or supplement procedures according to the needs and age of the client (Yorkston, Miller, & Strand, 1995). Figure 2.1 shows a typical example of an OME developed by Strand (1995). In most cases, hospitals and clinics have developed forms for the OME that suit the needs of their particular working situations. There are, however, some published OMEs. The Frenchay Dysarthria Assessment (FDA; Enderby, 1983), a diagnostic test to be presented subsequently, contains an OME form. Dworkin and Culatta (1980) and Vitali (1986) have published commercially available forms for conducting OMEs. Robbins and Klee have developed a protocol for assessing oropharyngeal motor development in young children (Robbins & Klee, 1987). Other protocols for assessing the integrity and functioning of the speech mechanism can be found in published texts on motor speech disorders (Caruso & Strand, 1999; Duffy, 2005; Freed, 2000; Yorkston et al., 1999).

Tests for Dysarthria

The Frenchay Dysarthria Assessment (FDA; Enderby, 1983) is the only published diagnostic test for the dysarthrias. The FDA uses a rating scale to assess client-provided information, observations of non-verbal structures and functions, and speech. It also includes measures of intelligibility and speaking rate, and judgments about the client's hearing, vision, dentition, language, mood, posture, and sensation.

Tests for Apraxia of Speech

Speech sound errors and prosodic abnormalities are characteristic features of apraxia of speech (Duffy, 2005; Wambaugh & Shuster, 2008). Diagnosis of AOS, similar to diagnosis of the dysarthrias, is often based on the clinician's perceptual judgments. Ordinarily, when evaluating clients with AOS, the clinician has the client produce words and sentences of sufficient complexity and length to elicit speech sound production errors, determine where the client's speech breaks down, and make a diagnosis. There is only one published test for AOS in adults, the Apraxia Battery for Adults – Second Edition (ABA; Dabul, 2000). The ABA was developed to verify the presence of apraxia in the adult patient and to estimate the severity of the disorder. It contains six domains five assessing speech and speech-related responses and a sixth test assessing limb apraxia. Most clinicians, rather than use the ABA, have developed test batteries of their own to assess AOS. An example is an unpublished battery of speech and other tasks to

evaluate clients with AOS developed at the Mayo Clinic (See Wertz, et al. 1984; and Duffy, 2005).

Treatment Outcome Measures

In general, a treatment outcome reflects a change for the better or worse in communication performance during the treatment process (Schyve, 1995). Outcomes are measured by collecting data on the behavior of interest at the beginning and end of treatment (Campbell, 1996). Generally, clinicians try to link their outcome measures to objectives of treatment (Marshall, 2000). For example, if the goal of treatment was to improve intelligibility of single words, the clinician might obtain pre- and post-treatment measure of single word intelligibility, but not necessarily sentence intelligibility because the client might be unable to produce intelligible sentences at this point in the course of treatment. Ideally, a speech production outcome measure for a client with a MSD would inform the clinician if the client's oral communication is better after than before treatment. In addition, clinicians, families, clients, and payers are interested in functional outcomes (Fratalli, 1992; 1998), that is do the communication behaviors acquired during treatment increase the client's independence in real-life situations?

Tasks included in the MSE, the OME, and the clinician's perceptual evaluation are helpful aids to diagnosis, gauging the severity of the client's MSD, and in planning treatment. Repeat administration of these tasks can also provide information about how treatment has reduced the client's impairment. The World Health Organization defines impairment as any loss or abnormality of psychological, physiologic, or anatomic structure or function (WHO, 1980). For example, if treatment resulted in the client increasing the length of time he could sustain a vowel, the speed and regularity of alternate and sequential motion rates, or vocal loudness, these improvements might reduce the impairment. While positive changes in these behaviors might reflect the results of intervention, improvement on these measures does not necessarily mean the client is better off in a real-world sense. Measures that inform the clinician about the effects of treatment, outcome measures, are decidedly different from those used to diagnosis the problem. Outcome measures that are useful with clients with MSDs often attempt to measure intelligibility, comprehensibility, rate of information exchange, or speech naturalness.

Intelligibility. Intelligible speech is usually the primary goal for a client with a MSD and considered by most to be the functional common denominator of verbal behavior (Kent, Miolo, & Bloedel, 1994). Intelligibility is defined as the degree to which a listener understands the acoustic signal produced by a speaker in the absence of any other supportive information (Duffy, 2005; Yorkston, Strand, & Kennedy, 1996). Intelligibility is measured by having the client produce words and sentences. Typically, to assess intelligibility, at least two people must be involved. One person, usually the clinician, selects the words and sentences, to be produced by the client. Another person, unfamiliar with these words and sentences, listens to the client's recordings of the utterances, and transcribes the utterances or responds to a multiple-choice format to the recorded sample. There are two published tests to assess intelligibility of speakers with MSDs, the Assessment of Intelligibility in Dysarthric Speakers (AIDS; Yorkston & Beukelman, 1981a) and the Sentence Intelligibility Test (SIT; Yorkston & Beukelman, 1996). There are also word lists that have been developed by researchers to assess intelligibility. These include two lists of single words developed by Kent and colleagues (Kent, Weismer, Kent, & Rosenbek, 1989), the Tikofsky word list (Tikofsky, 1970), and the Preschool Speech Intelligibility Measure (PSIM: Morris, Wilcox, & Schooling, 1995). Rating scales have also been used to estimate speech intelligibility. For example, Duffy (2005) provides a 10-point scale for estimating speech intelligibility that takes into consideration the factors of environment, content, and efficiency. Yorkston, Miller and Strand (1995) use a 10-point descriptive speech severity scale to quantify disability in the degenerative dysarthrias. The FDA also uses a graded scale for assessing intelligibility of words, sentences, and speech in a conversation (Enderby, 1983); and the National Outcomes Measurement System (NOMS; ASHA, 1998) has proposed the use of a 7-point scale for measuring motor speech performance.

Comprehensibility. Comprehensibility refers to the degree to which a listener understands the acoustic signal produced by the speaker with the support of all other information that contributes to what has been said (Duffy, 2005; Yorkston et al. 1996). Comprehensibility is measured similarly to intelligibility; however, when measuring comprehensibility, the listener is provided with additional information that supports what the speaker is saying (Yorkston et al., 1996). For example, a study by Hammen,

Yorkston, and Dowden (1991) found that the single word intelligibility of speakers with dysarthria improved when listeners transcribed words from known semantic categories. Another study examining the impact of semantic support on intelligibility by Dongilli (1994) found listeners' transcriptions of sentences of speakers with dysarthria were significantly more accurate when known target words (e.g., school) were embedded in sentences produced by speakers with flaccid dysarthria (e.g., the boy rides the bus to school every day). Supplemental or supportive information to increase comprehensibility can be provided in many forms. These not only include semantic support, but also syntactic, gestural, orthographic, and physical information as well. Table 2.3 gives some of the strategies for increasing comprehensibility. The use of these strategies is intended to help the person with a MSD become an effective communicator, particularly in the case when he or she is not able to fulfill all communicative needs verbally (Yorkston et al., 1999).

Efficiency. Efficiency refers to the rate at which intelligible or comprehensible information is conveyed (Duffy, 2005). Some speakers with MSDs may have intelligible but inefficient speech because they speak at abnormally slow rates. Speaking rate in spontaneous speech is measured by (1) recording a speech sample, (2) transcribing the sample to count the number of words or syllables produced, (3) measuring the duration of the sample, and (4) computing speaking rate in words or syllables per minute (Yorkston et al., 1999). Normative data on speaking rate are available from a number of sources for adults and children in the fluency disorders literature (Guitar, 2006) and other sources (Goldman-Eisler, 1968). Beukelman and colleagues (Beukelman, Yorkston, & Tice, 1997) have developed a computerized method for assessing speaking rate in speakers with MSDs. Measurement of speaking rate can be important in assessing treatment outcomes for MSDs because the goal of therapy may sometimes include increasing or decreasing the individual's rate of speaking (Marshall & Karow, 2002; Yorkston et al., 1999). Further, some studies have found a positive relationship between information transfer by speakers with MSDs and speaking rate (Yorkston, Beukelman, & Flowers, 1980; Yorkston & Beukelman, 1981b).

Naturalness. Speech naturalness is a perceptually derived term that describes the overall prosodic adequacy of one's speech. Speech is considered natural if it conforms to

the listener's expected standards of rate, rhythm, intonation, and stress patterning and if it coincides with the syntactic structure of the utterance produced (Yorkston et al., 1999). Darley et al (1975; 1969a, b) used the term "bizarre" to describe speech that sounded unnatural. Speech naturalness is often measured using a 1-7 point equal appearing interval scale with the anchor points "1" reflecting natural speech and "7" reflecting highly unnatural speech (Schiavetti & Metz, 1997). Listeners asked to rate speech naturalness tend to agree on speech naturalness judgments for persons who stutter (Martin, Haroldson, & Triden, 1984) and for clients with MSDs (Southwood, 1996; Southwood & Weismer, 1993). Man-on-the street descriptions of the speech of persons with MSDs with intelligible, but unnatural sounding speech include terms such as "monotonous," "drunk sounding," and "sounds like he has mush in his mouth."

Outcome Measurement and Managed Care

Few would dispute the need to measure outcomes of treatment for clients with MSDs. Today's clinicians, however, have far less time to measure the outcomes of their interventions than before the era of managed care (Golper & Cheney, 1999). This is particularly troublesome when it comes to assessing outcomes with what is considered the "gold standard," intelligibility testing (Kent, 1992; Kent et al., 1994). Intelligibility testing takes time. In addition, the clinician often needs to assess outcomes earlier rather than later and also assess them at different points in the treatment course. Thus a clinician might have the need to measure outcomes that are immediate (right after a procedure such as fitting of a palatal lift), intermediate (after a period of treatment), and long-term (at the conclusion of treatment) (Schyve, 1995).

This study provides preliminary reliability and validity information on a new and novel test for assessing treatment outcomes in clients with MSDs, the Everyday Speech Production Assessment Measure, hereafter referred to as the E-SPAM.

E-SPAM

The E-SPAM is a clinical tool rather than a diagnostic tool. It was designed to measure changes in speech production ability over time and/or following intervention. It can also be used to quantify the severity of a client's speech production impairment. The E-SPAM contains a number of unique features that make it particularly adaptable for use

in clinical settings. These features will be reviewed prior to describing the methods of the study.

Materials. The E-SPAM is shown in Table 2.4. The test has seven parts, A, B, C, D, E, F, and G. Stimuli included in each part of the test are the following:

Part A: 30 one-syllable CV, VC, or CVC words.

Part B: 24 one-syllable words with an initial consonant cluster

Part C: 16 three-syllable words

Part D: 16 four-syllable words

Part E: 12 five-syllable words

Part F: 12 sentences 4-6 words long

Part G: 12 sentences 7-10 words long

The words and the sentences included in the E-SPAM are reflective of words and sentences a client would be likely to produce in everyday communication situations and to work on in treatment with the therapist. All of the single words and the words contained in the sentences in parts F and G are included in the first 3000 words of the Thorndyke and Lorge (1944) word list.

Elicitation context. On the E-SPAM, the client is required to repeat words and sentences after the examiner. While speech production can also be assessed using reading and sentence completion formats (Wambaugh & Shuster, 2008), repetition was selected as the elicitation context for the E-SPAM because of its simplicity and the fact that this procedure would be least likely to interfere with the speech production abilities of clients with co-occurring language and/or cognitive difficulties.

Length. The E-SPAM requires the client to repeat 42 words and 12 sentences after the examiner for a total of 54 responses. Table 2.4, however, shows that the aggregate number of words and sentences across the various parts of the E-SPAM is 114. The reason for inclusion of additional words sentences is to allow the clinician to construct different versions of the test when it is necessary to test the same client repeatedly. To administer the E-SPAM , the clinician selects 10, 10, 8, 8, 6, 6, and 6 items from parts A, B, C, D, E, F, and G respectively. Because the clinician can select items for each E-SPAM test administered, it is possible to administer the E-SPAM repeatedly to the same

client using different items, but maintaining some similarity in the length and complexity of the test items. This is advantageous in assessing treatment effects.

Organization. The items the client repeats on the E-SPAM increase in length and phonemic complexity from part A to Part G of the test. For example, part A requires the repetition of one-syllable CV, CVC, and VC words (e.g., wait) where as part B requires repetition of one-syllable words beginning with a consonant cluster (e.g., through). Parts C, D, and E require the client to repeat three (e.g., banana), four (e.g., society), and five-syllable (e.g., examination) words. And parts F and G require the client to repeat 4-6 and 7-10 word sentences respectively. Order of difficulty of items on the E-SPAM was guided by findings from earlier literature in AOS and the impact of factors such as phonemic complexity, word length, and utterance length on production accuracy in speakers with AOS (Darley, 1982; Deal & Darley, 1972; LaPointe & Johns, 1975; Johns & Darley, 1970; Shankweiler & Harris, 1966; Trost & Canter, 1974).

Scoring. Responses to the E-SPAM are scored with a 0-to-5 point scoring system shown below:

5 = NORMAL

4 = CORRECTED/RESTARTED. Initial response is partially or completely incorrect, but final response is normal in every aspect except for the fact that it occurs after an immediate self-correction or restart.

3 = APPROXIMATED. The final response is recognizable as the target response, but is altered prosodically, distorted, stiffly produced, or occurs after an effortful period of self-correction. Although the utterance is intelligible, it would still be perceived as abnormal by a listener.

2 = MARGINAL. The final response is produced with and/or after considerable effort and only recognizable because the listener knows the target utterance; the listener would be able to select the target utterance from a list of choices if given.

1 = UNRECOGNIZABLE. The client produces a spoken response, but the word or sentence is not recognizable, and the production offers the listener little-to-no basis for making a guess.

0 = NO RESPONSE. The client is unable to produce a verbal response, informs the examiner he/she can't respond, refuses to respond, or produces the same response repeatedly.

The descriptive scoring system of the E-SPAM provides the clinician with information about the client's speech production skills as they relate to intelligibility, efficiency, and speech naturalness. Intelligibility can be defined as the extent to which a listener understands the speech of a client with a MSD (Yorkston et al., 1999). Efficiency refers to the rate at which intelligible speech is conveyed (Duffy, 2005). Some clients with obvious MSDs may have intelligible speech, but speak at slow rates, make false starts, and correct their faulty articulation so frequently that their speech sounds unnatural (Yorkston et al., 1999). Speech naturalness is a global term used to describe the prosodic adequacy of one's speech (Yorkston et al., 1999). When speech is perceived to sound unnatural, the speaker is usually considered to sound monotonous.

Weighted scoring. Scores on the E-SPAM are weighted. The client is given more credit for producing utterances that are longer and more complex. In other words, the client can get more points for repeating a multisyllabic word like "authority" than a CVC word like "took." Table 2.4 shows that after the clinician has scored all of the client's responses to the E-SPAM with the 0-5 point system, item scores are summed for each part of the test. For example, on part A, the client repeats 10 one-syllable, CV, CVC, and VC words. If each response received a score of 5, the total points for part A would be 50. The clinician would then multiply this number by the weighted value for part A of the test which is .10. The client would receive five points for this portion of the test (50 x .10 = 5). She would then perform similar computations for the remaining parts of the test. Table 2.5 shows the number of items, weighted values, and number of possible points the client can earn when the E-SPAM is scored in this manner, and that the total number of points possible for the test is 100.

Table 2.1 Motor speech examination task descriptions

Vowel prolongation	Vowel prolongation is used to assess the integrity of the respiratory /phonatory system for speech. Patients are instructed to take a deep breath and say "ah" for as long and as steadily as possible. The clinician attends to the dimension of pitch, loudness, voice quality and record the maximum duration of the vowel.
Alternate motion rates (AMRs)	AMRs are useful for determining speed and regularity of jaw, lip and tongue movements. Patients are instructed to take a breath and repeat "puh-puh-puh-puh" as quickly as possible until instructed to stop. Patients will follow the same procedure with /t^/ and /k^/.
Sequential motion rates (SMRs)	SMRs measure the ability to move quickly from one articulatory position to another. Patients will say "puh-tuh-kuh" repeatedly. Patients are required to sequence sounds together and SMRs are especially useful when apraxia of speech is suspected.
Contextual speech	Contextual speech samples might include conversation, monologue, or oral reading. These would be speaking tasks that would permit a clinician to analyze the integrated function of all speech components.
Stress testing	Patients with motor speech disorders often show signs of fatigue and speech deterioration. During stress testing a patient is asked to count as precisely as possible at a rate of two digits per second; this should be continued without rest for 2-4 minutes.
Tasks to assess motor speech planning or programming capacity	Patients will often have articulation errors including substitutions, omissions, repetitions and additions. To assess motor speech planning and programming capacity in patients whose speech is mildly impaired the patient should complete SMRs and repeat complex multisyllabic words and sentence. In patients whose speech is more impaired, tasks that place little demands on motor programming should be attempted; tasks include singing a familiar tune, counting, or saying the days of the week.

Table 2.2 Rating scale form for deviant speech characteristics

Name:_____		Speech Diagnosis: _____	
Age: _____		Neurologic diagnosis: _____	
		Date of examination: _____	
Dysarthria Rating Scale Rate speech by assigning a value of 0-4 to each of the dimensions listed below (0 = normal, 1 = mild; 2 = moderate; 3 = marked; 4 = severely deviant). A + should be used to indicated excessive or high; - should be used to indicated reduced or low when appropriate.			
Pitch	Pitch level (+/-) _____ Pitch breaks _____ Monopitch _____ Voice tremor _____ Myoclonus _____ Diplophonia _____	Respiration	Forced inspiration-expiration _____ Audible inspiration _____ Inhalatory stridor _____ Grunt at end of expiration_____
Loudness	Monoloudness _____ Excess loudness variation_____ Loudness decay _____ Alternating loudness_____ Overall loudness (+/-) _____	Prosody	Rate _____ Short phrases _____ Increase rate in segments____ Increased rate overall_____ Reduced stress _____ Variable rate _____ Prolonged intervals _____ Inappropriate silences_____ Short rushes of speech_____ Excess & equal stress_____
Voice quality	Harsh voice _____ Hoarse (wet) _____ Breathy voice (continuous)_____ Breathy voice (transient)_____ Strained-strangled voice___ Voice stoppages _____ Flutter _____	Articulation	Imprecise consonants_____ Prolonged phonemes_____ Repeated phonemes _____ Irregular articulatory breakdowns _____ Distorted vowels _____
Resonance (&intraoral pressure)	Hypernasality _____ Hyponasality _____ Nasal emission _____ Weak pressure consonants_____	Other	Slow AMRs _____ Fast AMRs _____ Irregular AMRs _____ Simple vocal tics _____ Palilalia _____ Coprolalia _____
Intelligibility _____ Bizarreness _____			

Table 2.3 Therapy strategies for improving comprehensibility (Yorkston, Strand & Kennedy, 1996).

Strategy	Description
Semantic Context	The semantic context strategy provides the listener with the semantic category to which a word belongs. The semantic category improves intelligibility and can be used during therapy to improve single word intelligibility. For example when discussing what fruit to buy at the grocery store, having the semantic context of "types of fruit" would be helpful in improving comprehension.
Gestures	Body language and gestures can be used to improve comprehensibility. For example when saying the sentence "come over here" and hand wave in the direction the person should come improves the comprehension of the spoken message paired with the gesture.
Orthographic Cues	Using orthographic cues to improve comprehensibility involves using an alphabet board as an aid. The patient is asked to point to the first letter of each word spoken as he/she is speaking. The alphabet board improves comprehensibility because it slows the speaker down and gives a first letter of the word cue to the listener.
Communication Partner Strategies	Communication partner training requires the training of both the speaker and the listener. When communicating it is important to train the listener to monitor the speaking environment, and maximize hearing acuity. The speaker and the listener need to prepare strategies for possible communication breakdowns. Through this training the communication partners learn how to better communicate with the speaker and comprehensibility improves.

Table 2.4 E-SPAM assessment tool

Everyday Speech Production Assessment Measure
E-SPAM

A. CV, VC, and CVC words without consonant clusters (select 10 words):

1. Wait ____
2. Fine ____
3. Got ____
4. Fall ____
5. Push ____
6. Gym ____
7. Eat ____
8. Wall ____
9. Took ____
10. When ____
11. Deep ____
12. Wash ____
13. Meet ____
14. Rise ____
15. Bush ____
16. Her ____
17. Type ____
18. Thin ____
19. Cut ____
20. Look ____
21. Gave ____
22. View ____
23. Take ____
24. June ____
25. Car ____
26. Up ____
27. Each ____
28. Mouth ____
29. Night ____
30. Sick ____

Total:____x (.10)
=_____(maximum =5)

B. One syllable words with initial consonant cluster (select 10):

1. Skin ____
2. Step ____
3. Black ____
4. Brook ____
5. Clean ____
6. Cross ____
7. Snow ____
8. Drive ____
9. Flow ____
10. Glad ____
11. Plant ____
12. School ____
13. Stretch ____
14. Slow ____
15. Smoke ____
16. Through____
17. Trade ____
18. Sleep ____
19. Ground____
20. Sweet ____
21. Spread ____
22. Prince ____
23. Please ____
24. Spot ____

Total :____ x (.20)____(maximum= 10)

Table 2.4 (continued)

C. Three syllable words (select 8):

1. According ____
2. Avenue ____
3. Telephone ____
4. Government ____
5. Everything ____
6. Different ____
7. National ____
8. Officer ____
9. Carefully ____
10. Beautiful ____
11. Yesterday ____
12. Understand ____
13. Expression ____
14. President ____
15. Already ____
16. Department ____

Total: ____x (.30) _____
(maximum=12)

D. Four syllable words (select 8):

1. Material ____
2. California ____
3. Community ____
4. Accountable ____
5. Republican ____
6. American ____
7. Society ____
8. Authority ____
9. Democratic ____
10. Development ____
11. Impossible ____
12. Organizer ____
13. America ____
14. Education ____
15. January ____
16. Pennsylvania ____

Total :____x(.40)_____
(maximum= 16)

E. Five syllable words (select 6):

1. Considerable ____
2. Opportunity ____
3. Organization ____
4. North America ____
5. University ____
6. Association ____
7. Philadelphia ____
8. Individual ____
9. Immediately ____
10. South America ____
11. Administration ____
12. Possibility ____

Total:_____x(.50) _____
(maximum=15)

F. Short sentences 4-6 words in length (select 6):

1. I drive the car. ____
2. The man is too old. ____
3. She will go west. ____
4. Bob was born in June. ____
5. I live in the house ____
6. Please don't go yet. ____
7. The game will end. ____
8. She wore a red dress. ____
9. The mail was late. ____
10. The grass is short. ____
11. My car needs gas. ____
12. He went to the office. ____

Total ____ x(.60) _____(maximum=18)

Table 2.4 (continued)

G. Longer sentences with 7-10 words (select 6):

1. I want a book to read please. _____
2. He went to pick her up. _____
3. My aunt will visit in June. _____
4. I heard the bell ring all day. _____
5. He will get a good job. _____
6. Please have a drink with me. _____
7. The score of the game was a tie. _____
8. I am going to eat with a friend. _____
9. The old car is in need of work. _____
10. We can go to the store. _____
11. Come over and we will watch the game. _____
12. The boss will speak to the press. _____

Total: _____ x (.80) _____ (maximum = 24)

The scoring system to be used is as follows:

5 = NORMAL
4 = CORRECTED/RESTARTED. Initial response is partially or completely incorrect, but final response is normal in every aspect except for the fact that it occurs after an immediate self-correction or restart.
3 = APPROXIMATED. The final response is recognizable as the target response, but is altered prosodically, distorted, stiffly produced, or occurs after an effortful period of self-correction. Although the utterance is intelligible, it would still be perceived as abnormal by a listener.
2 = MARGINAL. The final response is produced with and/or after considerable effort and only recognizable because the listener knows the target utterance; the listener would be able to select the target utterance from a list of choices if given.
1 = UNRECOGNIZABLE. The client produces a spoken response, but the word or sentence is not recognizable, and the production offers the listener little-to-no basis for making a guess.
0 = NO RESPONSE. The client is unable to produce a verbal response, informs the examiner he/she can't respond, refuses to respond, or produces the same response repeatedly.

Summary: A ___+ B ___ + C ___ + D ___ + E ___ + F ___ + G ___ =

Total ESPAM Score _____

Name: _____

Date: _____ Diagnosis: _____

Table 2.5 Weighted scoring procedure and total possible scores for sections of E-SPAM.

	Total score if receive a score of 5 for each item	Weighted formula	Total possible weighted score
Part A – 10 words	50	x 0.1	5
Part B – 10 words	50	x 0.2	10
Part C – 8 words	40	x 0.3	12
Part D – 8 words	40	x 0.4	16
Part E – 6 words	30	x 0.5	15
Part F – 6 sentences	30	x 0.6	18
Part G – 6 sentences	30	x 0.8	24
Total Maximum Score: 100			

Figure 2.1 Evaluation of structure and function of the speech production mechanism

Name: _____

Date: _____

Jaw

Symptoms checklist

	Atrophy (temporalis/masseter)
	Reduced Contraction
	Structural restrictions
	Fatigue w/ chewing
	Adventitious movement (specify:)
	Other (specify:)

	ROM	Strength	Resp to Instruct
Opening			
Closing			
L-Lat			
R-Lat			

Summary Statement

Lips

Symptom checklist

	Atrophy
	Resting asymmetry
	Adventitious movement:

Function

	ROM	Strength	Resp to Instruct
Pucker			
Retraction			
Upper left			
Upper right			
Lower left			
Lower right			

	Coordination of movement
	Ability to plose
	Ability to vary tension
	Precise labial consonants

	Forehead		Dentures
	Right face		Mucosa
	Left face		Saliva
	Tongue		Lesions
	Chin		Tissue char:

Summary Statement

Codes:

0 – WNL
1 – Mild
2 – Moderate
3 – Severe

Figure 2.1 continued

Tongue

Symptom checklist

	Atrophy
	Resting asymmetry
	Advent movement:

Function

	ROM	Strength	Resp to Instruct
Elevation			
Protrusion			
Left-lat			
Right-lat			

	Ability to vary muscular tension
	Ability to plose
	Consonant Precision
	Vowel differentiation
	Other:

Summary Statement:
Tongue:

VP:

Respiratory/Phonatory:

	Rate	Vce Er	Rsp sx
DDK /pa/			
DDK /ta/			
DDK /ka/			
DDK /i/			

Velopharyngeal Function

Symptom checklist

	Nasal emission
	Hypernasal speech
	Inability to use straw
	Nasal reflux
	Perceptual changes with occlusion
	Abn Gag (weak / strong)
	Asymmetrical gag
	Resting asymmetry
	Advent movement:
	Other (specify:)

Function

	Initial elevation
	Asymmetry (weaker than)
	Ability to sustain

Respiration Phonation

Symptom checklist

	Abn loudness (reduced/exc.)
	Loudness variation
	Complaints of fatigue
	Shortness of breath
	Abn Quality (harsh/breathy)
	Phonation breaks
	Instability
	Stridor (insp/expir)
	Wet phonation
	Anb vol cough (Wk/Abs)
	Other (specify:

VC (Seated): _____
VC (Supine): _____
Sustain phonation (secs): _____

Swallowing Screening

	Signs of aspiration		Lack of laryngeal elevation
	Incoor/audible swallow		Airway congestion
	Multiple swallows		Other:

Chapter Three

Methods

Subjects

Fifteen adults, 10 men and 5 women, with MSDs volunteered to participate in this study. Subjects were Native English speakers ranging in age from 35-to-85 years of age (M = 59.87, SD = 15.55) and had between 14 and 20 years of education (M = 16.73, SD = 2.46). Twelve subjects presented with AOS in conjunction with aphasia. Three subjects presented with dysarthria. Twelve subjects developed a MSD following a left hemisphere stroke; etiologies for the three non-stroke subjects were surgical trauma, amyotrophic lateral sclerosis, and viral encephalitis. The time elapsing from the onset of the MSD to subjects' participation in the study ranged from 8-to-93 months (M = 40.6, SD = 24.04). Table 3.1 summarizes the background and medical information on the subjects.

Testing

Subjects were administered the Western Aphasia Battery (WAB; Kertesz, 2006), a sequential motion rate (SMR) task, an oral reading task (ORT), and the E-SPAM. The E-SPAM was administered twice, Time 1 and Time 2, approximately one week apart. Thirteen subjects were tested in two sessions. The WAB, SMR, ORT, and one E-SPAM test were administered at the first session. The second E-SPAM test was administered during the second session. Session one lasted approximately 30 minutes and session two lasted approximately 15 minutes. Because of travel considerations, two subjects (Numbers 12 and 13) completed all of the testing on the same day. These subjects followed the same schedule as the other subjects with the exception that their E-SPAM tests were separated by only one hour. All subjects were given the E-SPAM, SMR, and ORT in quiet rooms, free from distractions by the experimenter. Most subjects were also administered the WAB by the experimenter, however, for some subjects, WAB test results were available from previous records.

Subjects' responses to the SMR, ORT, and both administrations of the E-SPAM were audio recorded on a Marantz digital recorder using a head mounted microphone at a mouth-to-microphone distance of 5".

Western Aphasia Battery. The WAB (WAB; Kertesz, 2006) is a standardized aphasia test battery designed to diagnose localization-based aphasic syndromes on the basis of test scores. Only the oral language portion of the WAB was administered in this study. It contains 10 subtests to assess spontaneous speech (i.e., content and fluency), auditory comprehension, repetition, and naming. Based on the scores on these subtests, the clinician calculates an Aphasia Quotient (AQ) from 0-to-100 which serves as an overall measure of language impairment. Subjects' AQ scores are shown in Table 3.1.

Sequential motion rate. Sequential motion rate (SMR) tasks require the speaker to repeat sequences of syllables as rapidly as possible. These tasks permit the clinician to determine the accuracy and speed with which the client moves the articulators, e.g., tongue, lips from one position to another. For this study subjects were instructed to "take a breath and repeat the sequence 'puh-tuh-kuh' over and over again" until being told to stop by the examiner. A model was provided by the examiner before the subject was allowed to start the task. The subject was asked to stop after he or she had produced four or five repetitions of the three syllables.

Oral reading task. Subjects read the Rainbow Passage (Fairbanks, 1960) aloud. To simplify the reading of the passage for the subjects, the word *prism* was changed to the word *light*:

> "When the sunlight strikes raindrops in the air, they act like a light and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow."

If a subject had difficulty reading the passage or informed the experimenter he or she might have difficulty reading the passage aloud, a brief personal script was constructed for the subject to read. The script, created by the experimenter during the initial session, contained three sentences about the subject. Usually these were the subject's name, where they lived, and the recording site. An example script would be "My name is Tracy Smith. I live in Louisville. I am at the University of Kentucky." The

subject rehearsed the script with the examiner and it was recorded in lieu of the Rainbow Passage. Four of the 15 subjects read the script in lieu of the Rainbow passage.

E-SPAM. Two different 54 item forms of the E-SPAM, A and B, were created by selecting the appropriate number of stimuli from each part of the test protocol in Table 2.4. Form A items included:

Part A: wait, fine, got, fall, push, gym, eat, wall, took, and when

Part B: skin, step, black, brook, clean, cross, snow, drive, flow, and glad

Part C: according, avenue, telephone, government, everything, different, national, and officer

Part D: material, California, community, accountable, republican, American, society, and authority

Part E: considerable, opportunity, organization, North America, university and association

Part F: I drive the car. The man is too old. She will go west. Bob was born in June. I live in the house. Please don't go yet.

Part G: I want a book to read please. He went to pick her up. My aunt will visit in June. I heard the bell ring all day. He will get a good job. Please have a drink with me.

Form B items included:

Part A: her, type, thin, cut, look, gave, view, take, June, and car

Part B: stretch, slow, smoke, through, trade, sleep, ground, sweet, spread, and prince

Part C: carefully, beautiful, yesterday, understand, expression, president, already and department

Part D: democratic, development, impossible, organizer, America, education, January, and Pennsylvania

Part E: Philadelphia, individual, immediately, South America, administration, and possibility

Part F: The game will end. She wore a red dress. The mail was late. The grass is short. My car needs gas. He went to the office.

Part G: The score of the game was a tie. I am going to eat with a friend. The old car is in need of work. We can go to the store. Come over and we will watch the game. The boss will speak to the press.

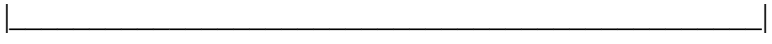
The two E-SPAM tests, Form A and B, were administered to the participants in counterbalanced order starting with Subject 1. Subject 1 was administered Form A, then Form B; Subject 2 was administered Form B, then Form A. The rotation continued for all of the subjects.

Preparation of Listening Tapes

Three listening tapes were prepared, one to obtain ratings of the severity of subjects' MSDs, a second to assess sentence intelligibility, a third to score the responses to the E-SPAM tests.

Severity Tape. The first tape contained subjects' recordings of the SMR and ORT tasks. Three experienced speech language pathologists (SLPs) listened to this tape and rated the severity of each subject's MSD with the 100 mm visual analog scale shown below. The SLPs listened to the tape in a quiet, sound treated environment using a computer and high quality Sony speakers. Speakers were placed approximately 1 meter from listeners. Visual barriers were placed between the SLPs to ensure that scoring was done independently. Ratings were completed in a single session lasting approximately an hour and a half.

Directions: You are going to listen to a tape of some individuals with motor speech disorders. You will hear them perform two tasks, a sequential motion rate task during which they repeat the sequence, puh-tuh-kuh over and over and an oral reading task. Draw a line on the scale to rate the severity of the motor speech disorder (MSD) after listening to the tape.



Severe MSD No MSD

The experimenter converted the SLP's visual analog ratings to numerical scores using a 100 mm ruler. The experimenter measured where on the scale the SLP made her mark, and designated that number from 0-to-100 as a severity rating. Ratings of the three SLPs were averaged to obtain a severity rating for each subject. In this case, higher ratings indicated that the subject had little-to-no MSD and lower ratings indicted a more severe MSD. Eighteen of the 45 ratings (40 %) were re-measured to assess reliability of this procedure. Differences between the two ratings were 1% or less for all comparisons.

Intelligibility Tape. The second tapes were prepared to measure sentence intelligibility. A total of 15 tapes, one per subject, were made. The tapes contained subjects' productions of the sentences from parts F and G of form A of the E-SPAM. The 15 tapes were sent separately via email to 15 different adult volunteers unfamiliar with the sentences of the E-SPAM. Volunteers were instructed to listen to their tape, no more than three times, and transcribe the 12 sentences. The experimenter reviewed the volunteers' transcriptions and calculated the percentage of words (0-100) correctly transcribed for each subject.

Scoring Tape. A third tape contained subjects' responses to the two administrations of the E-SPAM. This tape was used to score subjects' responses E-SPAM with the scoring system shown in Chapter 2. The tape was edited so it did not include the examiner's repetition of the stimulus items, and to ensure that responses were separated by gaps of approximately 5 seconds to give listeners time to score each response. In addition, the scoring tape included 22 duplicated words and sentences, 11 from Form A and 11 from Form B. The duplicate responses were randomly selected and identical for each subject.

Scoring Procedure

Four graduate students in Communication Sciences and Disorders scored subjects' responses to the E-SPAM using the five-point descriptive scoring system described in Chapter 2. No students reported having any hearing deficits and none were familiar with the subjects in the study. Before scoring the E-SPAM, the students received approximately one hour of training. This began with an explanation of the test's scoring system. Then the students listened to two tapes. The first tape was that of an adult speaker who made no errors or aberrant productions on the test and was intended to familiarize

the students with how the stimuli would be presented. The second tape was that of another adult speaker who produced variable errors (e.g., misarticulations, false starts, self-corrections, distorted response, prolonged speech, and stutters) on most of the responses. The students scored these productions, compared scores, and discussed reasons for the scores assigned among themselves and with the experimenter.

The graduate students scored the responses at the same time. Scoring was done in a quiet sound treated room, in two sessions, on two consecutive days. E-SPAM stimuli were presented via a computer using two high-quality Sony speakers at a comfortable loudness level. Visual barriers were placed between the four scorers to ensure scoring was done independently. Responses were replayed if requested, but this was seldom necessary. Subjects' responses on Form A of the E-SPAM were scored first; those from Form B were scored second. The order in which the tapes from the 15 subjects were played for the students was randomly determined by the experimenter using a random number generator.

Scoring sheets for the students to record their scores were created for forms A and B. The forms, shown in Appendix A, contained all of the E-SPAM items as well as the 22 duplicate words and sentences. Each part of the E-SPAM was presented on a separate page of the form. The student scorers were provided with abbreviated scoring guidelines on every page of the recording sheet. They were also provided with the full scoring guidelines shown in Chapter Two. The students were encouraged to refer to the scoring guidelines if needed to score the responses. Appendix A also shows that the recording forms contained information about whether or not the subject had repeated all or only part of a word or sentence. The reason for this was that some subjects did not repeat words or sentences in their entirety. To ensure that the students scored the responses uniformly, they were instructed to score the response on the basis of what had been produced orally, and ignore any missing information.

Data Preparation

The graduate students' scores from the tests were entered on data processing forms, one per subject. Appendix B provides an example of a completed data processing form for one subject. This shows that the form permitted the experimenter to enter scores for each part of the E-SPAM and to compare scores of each of the four students on a

point-to-point basis to determine the number of scoring agreements and disagreements. In addition, the data processing form was used to calculate item scores for the E-SPAM, derive weighted scores, and sum weighted scores to obtain a total score for each test.

Table 3.1 Participant information

Subject	Age	Education (in years)	Speech/ Language Diagnoses	Etiology	Months Post Onset	AQ from WAB
1M	65	14	Broca's aphasia **AOS** **Cortical stuttering**	CVA	64	84.5
2M	48	16	Conduction aphasia	CVA	16	86.9
3M	58	20	**Broca's aphasia** **AOS**	CVA	41	33.4
4M	54	20	*Broca's aphasia* AOS	CVA	47	48.4
5M	40	14	Ataxia dysarthria	Surgery	36	100
6M	35	16	**Ataxic dysarthria**	Infection	18	99.2
7F	77	16	**Mixed dysarthria**	ALS	24	99.2
8M	79	16	*Broca's aphasia* *AOS* *Spastic dysarthria*	CVA	93	78.8
9M	44	20	**Global aphasia** **AOS**	CVA	48	31.2
10F	83	18	**Broca's aphasia** *AOS* *Spastic dysarthria*	CVA	81	48.3
11F	71	13	Broca's aphasia **AOS**	CVA	36	61.1
12F	60	20	Unclassifiable aphasia AOS	CVA	48	78
13F	43	18	Broca's aphasia AOS	CVA	25	91
14M	64	14	Unclassifiable aphasia AOS	CVA	8	94.8
15F	77	16	**Broca's aphasia** **AOS**	CVA	24	34

Key: underlined = mild; *italicized = moderate;* **bolded = severe**

Chapter Four

Results

Reliability

Two components of reliability, inter-scorer and intra-scorer, were determined for the E-SPAM. To assess inter-scorer reliability, point-to-point comparisons of the scores of the graduate students were made for subjects' responses on the two E-SPAM tests. Since four students scored the tests, this involved a total of six comparisons per students' responses: 1-2, 1-3, 1-4, 2-3, 2-4, and 3-4. For each subject there were 648 comparisons (54 responses for Form A + 54 responses for Form B = 108 x 6). The comparisons for the 15 subjects were a total of 9720 scoring comparisons (15 subjects x 648). Table 4.1 shows the number and percentage of inter-scoring agreements. These data indicate that the percentage of agreements for individual subjects ranged from 56.6% to 96.6% and that the point – to – point scoring comparisons agreed on 7471 of 9720 occasions or 76.9% of the time.

To assess intra-scorer agreement for each of the four students, point-to-point comparisons were made for scores given to the duplicate responses and the original scores. This involved a total of 330 scoring comparisons per student (22 x 15 = 330) and a total of 1320 intra-scorer comparisons (4 x 330). Table 4.2 shows the number of scoring agreements (330 possible) was 252 (76.36%), 269 (81.52%), 268 (81.23%), and 238 (72.13%) for students 1, 2, 3, and 4 respectively and that the aggregate number of intra-scorer agreements for all the student scorers was 1027 of 1320 (77.8%).

Test-retest stability

To assess stability of the overall scores for the E-SPAM, scores were averaged for the Time 1 and Time 2 tests. Table 4.3 shows that the mean scores for the 15 subjects differed minimally for the Time 1 and Time 2 tests. The group mean scores for Time 1 and Time 2 tests were 64.43 (SD = 24.62) and 62.98 (SD = 25.27) respectively. Results of a paired t-test revealed that the Time 1 and Time 2 means did not differ significantly, t = (1, 14) 1.368, p = .193.

Form A versus Form B

Table 4.3 shows subjects' overall mean scores on Forms A and B of the E-SPAM were nearly equivalent. The group mean scores for Form A and B were 64.45 (SD =

24.61) and 62.96 (SD = 25.27) respectively. Results of a paired t-test revealed that the mean scores for the two forms of the test did not differ significantly, t = (1, 14) 1.410, p = .180. Secondly, to assess the reliability of the alternative forms used in this study, a correlation coefficient was calculated to determine the coefficient of equivalence, between individuals' scores on form A and form B. The correlations between Form A and Form B were calculated for each subject and by each judge. All Pearson correlations were high with the lowest being r = .95 and all correlations were significant (p < .01). These findings suggest high reliability between form A and form B of the E-SPAM. Additional data confirming the lack of differences in subjects' performance on Forms A and B can be found in Table 4.5. This shows overall E-SPAM scores for every subject from each of the four student scorers. These data reflect minimal differences among the overall scores for the two versions of the test.

Validity

Table 4.3 shows the mean MSD severity rating from the SLPs, sentence intelligibility score, and overall E-SPAM scores for each subject. To examine validity for the E-SPAM, 2-tailed Pearson correlations were computed among the severity, intelligibility, and E-SPAM scores. Table 4.4 shows that the correlations for all of the measures are highly positive and significant (<.01).

Individual Scores

Since the E-SPAM would be scored by individual clinicians in clinical practice settings, it is of interest to examine the relationship among overall scores for the test for the individual judges. Table 4.5 shows the overall scores on the E-SPAM for each subject for Forms A and B for each of the four judges. These data indicate that the overall scores for subjects do not differ markedly from judge-to-judge. Pearson correlations computed to examine the relationships among scores for both forms of the test are shown in Table 4.6(a, b). In all cases correlations were significant (<.01) with the lowest of the 12 correlations being .977.

Performance Patterns

Since the client is required to repeat stimuli of increasing length and complexity from Part A to G of the E-SPAM, patterns of performance were examined in relationship type and severity of the subjects' MSDs. To do this subjects with AOS (n=12) and

dysarthria (n =3) were grouped separately. The performance of these subgroups was then examined on parts A-G of the E-SPAM. To do this, the percentage of points earned for each part of the E-SPAM were averaged for the groups of subjects with mild AOS, severe AOS, and dysarthria. For example, part A of the test requires the client to repeat 10 CV, VC, or CVC words. Each response is scored 0-5 and the weighted value for this section of the test is .10. In this case the maximum points possible are 5. Thus if the subject had a total of 40 points, he or she would receive 4 points (40 x .10 = 4). For the purpose of this analysis, this would be scored at 80%. Figure 4.1(a, b) show the performance for the two subgroups across the parts of the E-SPAM. These data reflect that the group of subjects with AOS reflect a similar pattern where performance decreased from part A to G of the test. However, the performance of the subjects with mild AOS is vastly superior to those with severe AOS. Conversely, subjects with dysarthria appear to perform similarly across all parts of the E-SPAM shown in Figure 4.1b.

Table 4.1 Number and percentage of inter-scorer agreements for E-SPAM scores

Subject	1 vs. 2	1 vs. 3	1 vs. 4	2 vs. 3	2 vs. 4	3 vs. 4	# agree (%)	
1	62	68	63	60	61	53	367	56.6%
2	91	100	93	95	96	93	568	87.7%
3	88	85	87	92	83	79	514	79.3%
4	73	80	73	81	79	77	463	71.5%
5	84	85	79	83	87	82	500	77.2%
6	69	77	64	92	53	55	410	63.3%
7	75	83	80	94	79	81	492	75.9%
8	70	75	79	70	71	64	429	66.2%
9	69	78	68	73	59	69	416	64.2%
10	71	83	68	71	68	69	430	66.4%
11	76	81	78	75	77	80	467	72.1%
12	103	106	103	105	98	101	616	95.1%
13	105	104	103	105	104	105	626	96.6%
14	102	104	101	106	103	103	619	95.5%
15	86	104	98	88	82	96	554	85.5%
Total	1224	1313	1237	1290	1200	1207	7471	76.9%

Table 4.2 Number and percentage of intra-judge agreements for E-SPAM scores

Subject	Student 1	Student 2	Student 3	Student 4	# agree (%)	
1	5	14	16	17	52	59.1%
2	21	18	22	19	80	90.9%
3	18	21	19	17	75	85.2%
4	18	20	18	14	70	79.5%
5	14	19	17	20	70	79.5%
6	17	22	19	9	67	76.1%
7	17	20	22	16	75	85.2%
8	12	14	11	10	47	53.4%
9	15	13	13	15	56	63.6%
10	15	14	11	13	53	60.2%
11	18	13	15	13	59	67.0%
12	22	21	21	22	86	97.7%
13	22	22	22	20	86	97.7%
14	21	21	21	18	81	92.0%
15	17	17	21	15	70	79.5%
Total	252	269	268	238	1027	77.8%

Table 4.3 Mean overall E-SPAM scores for Time 1 and Time 2 administrations, mean severity ratings, and intelligibility scores. Maximum value obtainable on all scores is 100

Subject #	Time 1 Average	Time 2 Average	Severity Rating	Intelligibility
1	Form A - 73.50	Form B - 62.70	21.5	80
2	Form B - 78.15	Form A - 85.25	74.3	98.5
3	Form A - 69.93	Form B - 65.08	28.3	33.8
4	Form B - 70.35	Form A - 64.83	45.3	27.7
5	Form A - 85.08	Form B - 85.53	66	86.2
6	Form B - 53.18	Form A - 51.30	18	60
7	Form A - 57.23	Form B - 54.80	25	81.5
8	Form B - 58.23	Form A - 56.98	15	56.9
9	Form A - 35.63	Form B - 34.88	22	3
10	Form B - 40.98	Form A - 44.60	26.7	30.8
11	Form A - 26.85	Form B - 24.50	19.3	7.7
12	Form B - 95.88	Form A - 96.48	84.7	96.9
13	Form A - 96.80	Form B - 98.23	82	98.5
14	Form B - 98.88	Form A - 96.50	90.7	98.5
15	Form A - 25.80	Form B - 23.08	14.5	4.6

Table 4.4 Correlations for mean severity rating, sentence intelligibility and E-SPAM A and E-SPAM B scores

Correlations

		Severity Rating	Intelligibility	ESPAM (A)	ESPAM (B)
Severity Rating	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	15			
Intelligibility	Pearson Correlation	.726**	1		
	Sig. (2-tailed)	.002			
	N	15	15		
ESPAM (A)	Pearson Correlation	.866**	.886**	1	
	Sig. (2-tailed)	.000	.000		
	N	15	15	15	
ESPAM (B)	Pearson Correlation	.883**	.856**	.987**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	15	15	15	15

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.5 Overall scores for each subject on Form A and Form B from each student scorer for Form A and Form B

Subject #	Student1 Form A	Student1 Form B	Student2 Form A	Student2 Form B	Student3 Form A	Student3 Form B	Student4 Form A	Student4 Form B
1	82.9	56.9	77.4	69	66.2	59.3	67.5	65.6
2	89.4	78.4	80.7	76.4	86.9	79.2	84	78.6
3	65.2	66.5	74	65.8	69.8	62.5	70.7	65.5
4	61.6	69.6	65.6	75.1	66.6	64.7	65.5	72
5	90.8	87.1	85.2	85.2	84.6	83.5	79.7	86.3
6	48.4	51.3	56.2	58.6	56.6	55.6	44	47.2
7	57.1	51.3	59.4	56.7	59	57.9	53.4	53.3
8	57.2	55.8	59.1	61.9	57.2	57.9	54.4	57.3
9	34.3	33.9	38	36	36	32.9	34.2	36.7
10	44.6	39.2	47.8	46.7	46.5	37.7	39.5	40.3
11	25	24.3	31.8	24.4	25.3	25.4	25.3	23.9
12	97.8	95.8	96.3	97.7	97.8	98.2	94	91.8
13	96	98.5	97.6	99	98	98.5	95.6	96.9
14	97.8	97.4	97.3	99.4	98.1	99.3	92.8	99.4
15	25.6	23	27.2	24.9	25.3	23.3	25.1	21.1

Table 4.6 (a, b) Pearson correlation tables comparing relationships among score for both E-SPAM forms. Table 4.6a shows correlations for E-SPAM Form A and Table 4.6b shows correlations for E-SPAM Form B

Table 4.6a Correlations for E-SPAM Form A

Correlations

		Student1-A	Student2-A	Student3-A	Student4-A
Student 1- Form A	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	15			
Student2 – Form A	Pearson Correlation	.986**	1		
	Sig. (2-tailed)	.000			
	N	15	15		
Student3 – Form A	Pearson Correlation	.977**	.989**	1	
	Sig. (2-tailed)	.000	.000		
	N	15	15	15	
Student 4 –Form A	Pearson Correlation	.981**	.988**	.990**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	15	15	15	15

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.6b Correlations for E-SPAM Form B

Correlations

		Student1-B	Student2-B	Student3-B	Student4-B
Student1-Form B	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	15			
Student2-Form B	Pearson Correlation	.988**	1		
	Sig. (2-tailed)	.000			
	N	15	15		
Student3-Form B	Pearson Correlation	.993**	.987**	1	
	Sig. (2-tailed)	.000	.000		
	N	15	15	15	
Student4-Form B	Pearson Correlation	.992**	.990**	.985**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	15	15	15	15

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 4.1(a, b) Percentage scores for subjects with AOS, and dysarthria on parts of the E-SPAM.

Figure 4.1a Percentage scores for subjects with AOS

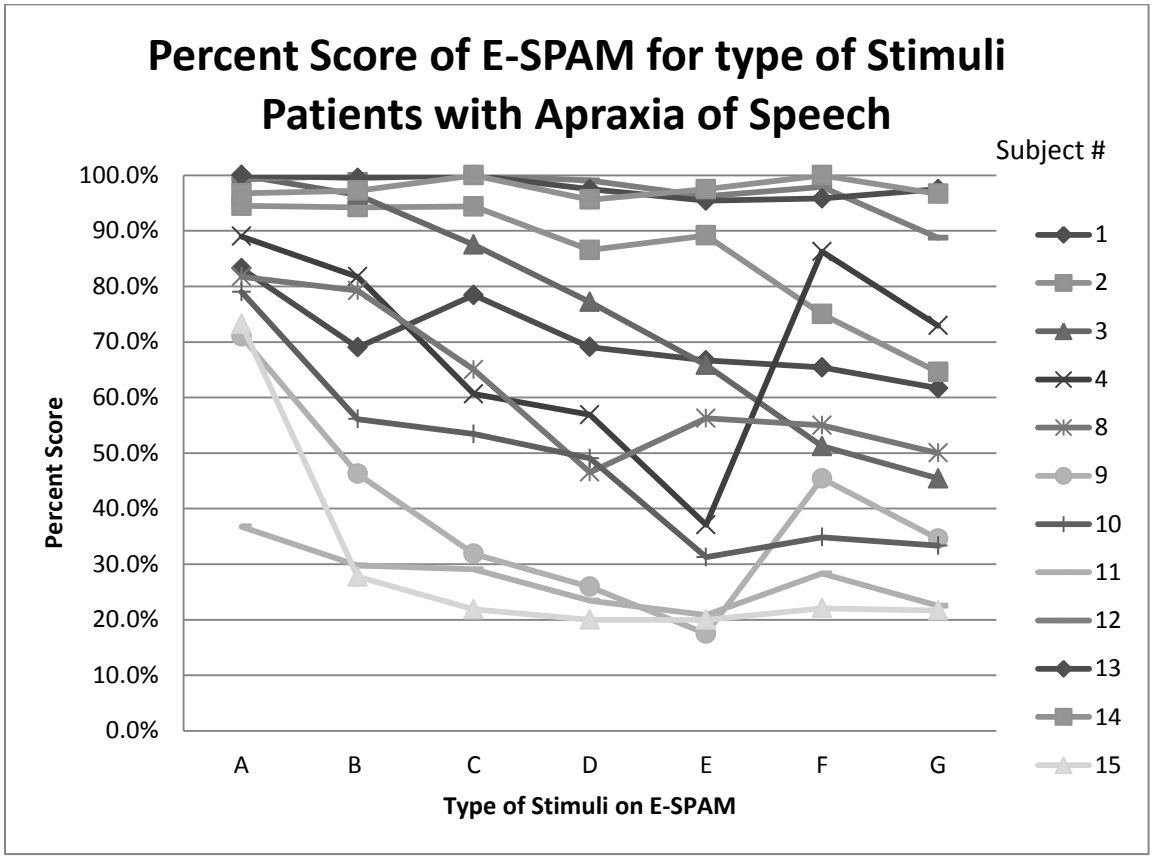
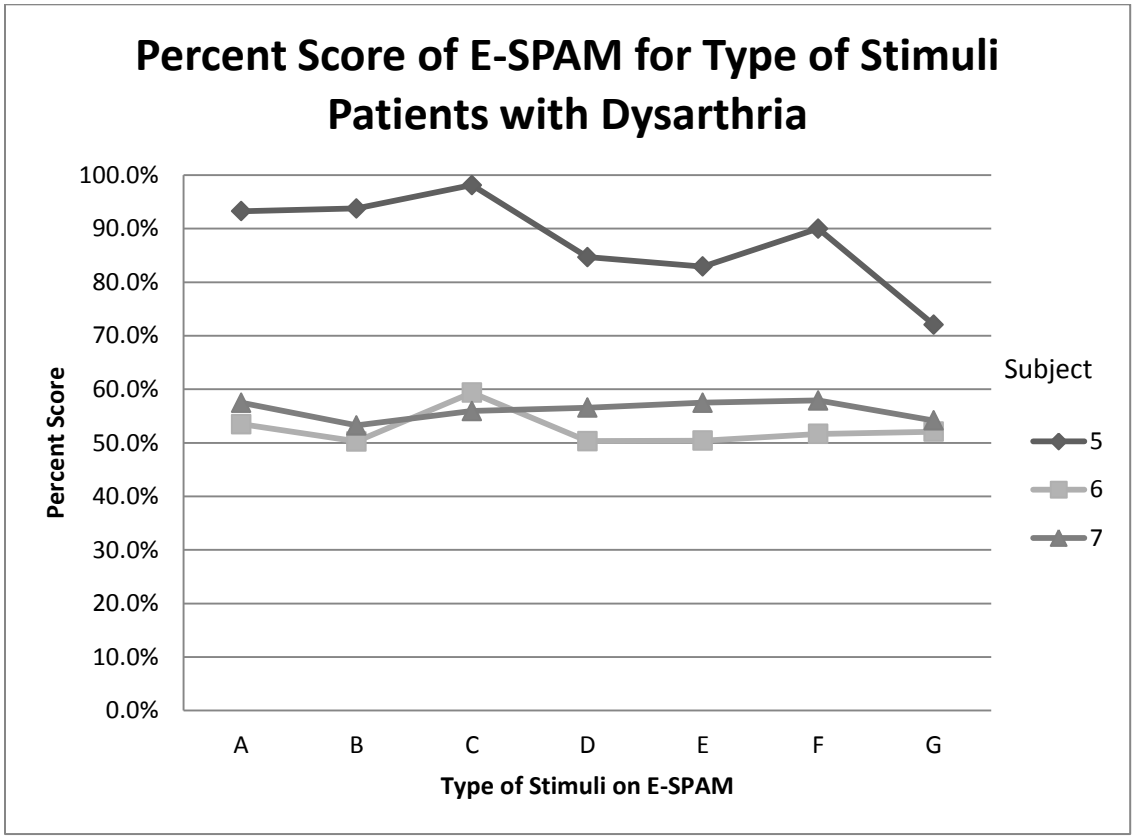


Figure 4.1b Percentage scores for subjects with dysarthria



Chapter Five

Discussion, Limitations, and Clinical Implications

Discussion

The E-SPAM was developed to provide clinicians with an easy-to-administer, objective test to assess changes in a client's speech production after intervention. While this study did not determine the time needed to administer the E-SPAM empirically, the experimenter's observation was that it took less than 10 minutes to give the test to most subjects. Similar to the tasks of the motor speech examination, the E-SPAM requires the client to repeat words and sentences after the examiner. E-SPAM stimuli, however, are "every day" words and sentences selected from the Thorndyke and Lorge (1944) word list and as such are representative of words and utterances the client is likely to work on during treatment. The E-SPAM stimuli differ from words (e.g., catastrophe) and sentences (Arthur was an oozy oily sneak) clients are typically asked to produce on the motor speech examination because they do not necessarily "tax" the system to evoke errors. For this reason, E-SPAM is best used to assess changes in day-to-day speech production abilities than for diagnosing a MSD.

The client's responses on the E-SPAM are scored with a five-point descriptive scoring system: 5 = normal; 4 = correct/restarted; 3 = approximated; 2 = marginal; 1 = unrecognizable; and 0 = no response. The results of this study suggest this system can be used reliably to score the E-SPAM. Inter-scorer agreement was assessed by making point-to-point comparisons of the scores of four students to responses from 15 subjects with MSDs on two different forms of the E-SPAM test. Results indicated that the scores were in agreement for 7471 of 9720 comparisons or 76.9% of the time. Each of the four students also demonstrated relatively high intra-scorer agreement. Intra-scoring agreement was determined by having each student score 320 duplicated responses from the master scoring tape and comparing these scores on a point-to-point basis with their original scores. Table 4.2 shows that students 1, 2, 3, and 4 demonstrated point-to-point agreement on their scores for 252 (79%), 269 (84%), 268 (84%), and 238 (74%) of 320 comparisons respectively. Overall, the total percentages of intra-scorer agreements were slightly higher than the inter-scorer agreements with students agreeing with themselves on 1027 of 1320 comparisons or 77.8% of the time. These indices of inter- and intra-

scorer agreement compare favorably with other tests that utilize similar scoring systems such as the Porch Index of Communicative Ability (PICA; Porch, 1981) and Kentucky Aphasia Test (KAT; Marshall & Wright, 2008).

Ideally, a client's overall score on a speech production test should not change markedly from one test to the next. This should particularly be the case if the MSD is chronic, the two tests are administered in close in proximity, and the client has not received any intervention. Table 4.3 shows the mean overall E-SPAM scores for each subject for the Time 1 and Time 2 administrations of the test averaged across the four individuals scoring the test. Paired t-tests examining differences in group means for the Time 1 and Time 2 administrations did not differ significantly. Table 4.5 shows the overall E-SPAM scores for each scorer. These data also show that the overall scores of individual subjects do not differ markedly from one test to the next. In general, the results of this study indicated good test-retest stability for the E-SPAM and suggest clinicians can administer the test repeatedly to the same patient with confidence. This is not surprising as the subjects in the study had chronic MSDs and would be expected to demonstrate stable performance. Tables 4.3 and 4.5, however, show that subject 1 had a substantially lower E-SPAM score for the Time 2 test than the Time 1 test. Since his performance markedly deviated from the other 14 subjects, his spouse was asked if there was something that happened during the week than might have affected his speech. She reported that he had learned his sister was very ill. While no firm conclusions can be drawn about how this news might have affected performance on the E-SPAM, his lower Time 2 score could be considered as preliminary evidence that the E-SPAM is sensitive to changes in speech production brought about by factors such as fatigue (Marshall & King, 1973; Tompkins, Marshall, & Phillips, 1980) and medication (Vogel, Carter, & Carter, 2000).

When preparing to give the E-SPAM, the clinician selects the appropriate number of words and sentences from the test E-SPAM protocol to create a 54-item test for the client. This is an important feature of the E-SPAM because it allows the clinician to create different, but equivalent versions, of the test and enhances the ability to assess the same patient repeatedly. In this study, subjects' overall performance on the test was compared on two different versions of the E-SPAM. Table 4.3 shows that when subjects'

overall E-SPAM scores are averaged across the four scorers, mean differences in Form A and B scores are quite small. Statistical comparisons examining differences in group means were non-significant and high correlations were determined between individuals' scores on Form A and B of the E-SPAM. Similarly, Table 4.5 shows that when the overall scores of the four scorers are considered separately, scores for Form A and B tests again are nearly identical. This suggests that different versions of the E-SPAM can be administered repeatedly and yield equivalent results.

Validity reflects the extent to which a test measures what it says it measures (Justice, 2010). To assess validity E-SPAM, Pearson correlations were computed to examine the relationships among three measures of speech production ability, (1) overall scores on the E-SPAM, (2) mean MSD severity ratings from the three SLPs who listened to the oral reading and SMR tasks, (3) and sentence intelligibility. Scores for these measures for all subjects are provided in Table 4.3. Table 4.4 presents the results of a correlation analysis examining the relationships among these scores. This shows that the smallest correlation among the three scores was .726 (Intelligibility and Severity) and the highest correlation was .987 (E-SPAM A and B). In all cases, the computed Pearson correlations were significant beyond the .01 level. Table 4.5 shows the overall E-SPAM scores from each of the four students for the two E-SPAM tests. Pearson correlations (Table 4.6) were carried out to examine relationships among judges' scores for each form of the test. In all cases the computed correlations were greater than .987 and highly significant. This suggests that different individuals scoring the E-SPAM tests of the same client would come up with equivalent overall scores on the test.

Limitations

The E-SPAM is a verbal test. It is intended to be used as a tool to assess changes in speech production secondary to intervention rather than changes in communicative ability. In fact, if E-SPAM results are used as a measure of communication ability, a clinician might be misled. For example, a client who could repeat E-SPAM words and sentences, but had pervasive language, cognitive or executive function limitations might have a near-perfect score on the E-SPAM, but be incapable of communicating. Conversely, a client who could successfully augment his or her limited speech with

gesture, writing, drawing, or pointing, might score poorly on the E-SPAM, but communicate effectively.

The E-SPAM test appears able to detect changes in the speech production skills of clients with MSDs. This should be useful when intervention has focused on improving speech production. While this study was primarily intended to examine scoring and temporal reliability of the E-SPAM and establish its validity, most study participants did not have isolated MSDs. Twelve subjects had AOS, but this MSD occurred in conjunction with aphasia. Persons with aphasia are known to have reduced verbal retention spans (Schuell, Jenkins, & Jiminez-Pabon, 1964), a problem more recently referred to as a working memory (WM) deficit (Wright & Shisler, 2005). WM deficits can impair the ability of the patient to repeat words and sentences, particularly when the utterances are presented without a communicative context. In this study WM limitations may have confounded scoring the E-SPAM, particularly the repetition of sentences on parts F and G of the test. To compensate for this, the judges doing the scoring were provided with information as to how much of the word (all or part) or sentence (all, some, little, none) the subject had repeated. They were cautioned to base their scoring of the response on only what the subject produced, not what was supposed to be produced. Without this information, it is not possible to determine the impact of this methodological control on judges' scoring decisions.

While the E-SPAM appears to be a potentially useful test, findings of the study warrant cautious interpretation. The generalizability of the findings of the study are limited by its small sample size and a disproportionate number of subjects with AOS and aphasia. To enhance the clinical utility of the E-SPAM, it seems important to administer the test to a more diverse group of individuals with MSDs. Specifically this might include clients with (a) MSDs other than dysarthria and AOS, (b) different types of dysarthria (e.g., flaccid, hypokinetic), and different forms of AOS (e.g., center lesion and disconnection). Increasing sample size and diversity in the types of clients examined might be useful in determining if individuals with MSDs demonstrate identifiable "patterns of performance" on the E-SPAM. The findings of this study warrant exploration of this possibility. Figures 4.1a and 4.1b suggest that subjects with AOS or dysarthria reflect different patterns of performance on the E-SPAM. Those with mild AOS (See top

portion of Figure 4.1a) demonstrate consistently high performance across the various parts of the test, whereas those with relatively severe AOS (See bottom of Figure 4.1a) perform worse as the test progresses suggesting their performance in affected by length and complexity of stimulus items, a factor supported by some AOS research (Wertz, et al., 1984). Conversely subjects with dysarthria (See Figure 4.1b) tend to perform similarly across all parts of the test suggesting their speech production is not affected by length and complexity of the stimulus. These findings suggest that the weighted scoring system of the E-SPAM might one day be useful in elucidating "performance patterns" on the test for different types of MSDs.

The students scoring the E-SPAM reported that it would have been easier to score the test face-to-face with a "live" patient than from the audiotapes. Their commentaries indicated that they frequently perceived struggle and effort on the part of the speaker to produce the intended word or sentence but since they could not see the behaviors associated with this struggle, assigning a score of was problematic.

Most subjects could repeat or give reasonable approximations of the words on parts A-E of the E-SPAM, but many of the subjects had difficulty reproducing the sentences on parts F and G of the test in their entirety. Some subjects repeated only a word or two of a sentence; others repeated the majority of the sentences. Since the individuals scoring the test were instructed to score only what was produced, this sometimes resulting in an "artificial" elevation of overall scores for some subjects. Consider, for example the performances of Subject 4 as shown in Figure 4.1a. This subject had marked difficulty repeating the multi-syllabic words on parts C, D, and E. His WM deficits made it impossible for him to repeat all of the words in the sentences on parts F and G. However, he repeated a few words of each sentence quite accurately, and as a consequence received higher scores on parts F and G than C, D, and E. This suggests a need to reconsider the inclusion of sentence repetition demands on the E-SPAM for all clients and to re-evaluate how sentence repetitions are scored E-SPAM in future research with the test.

Clinical Implications

This study has shown that minimally trained individuals can score the E-SPAM reliably for clinical purposes and that the test-retest scores for subjects with chronic

MSDs are relatively stable. It has also shown that different forms of the test can be administered to the same client with equivalent results. These findings suggest that the E-SPAM can be used to assess changes in speech production. This is good news for clinicians in need of a quick, easily administered test to quantify changes in speech production over time, following intervention, or to assess the effects of factors such as medication, fatigue, and anxiety on speech production.

In this study, subjects' responses to the E-SPAM were audio taped and scored by four graduate students who received a minimal amount of training (less than an hour) in how to score the test. This was necessary to examine aspects of reliability for the test and assess validity. This time-consuming procedure would not be necessary in clinical practice. Of course, since the primary use of the E-SPAM is to assess changes in speech production following an intervention, it seems counterintuitive for the clinician providing the treatment to administer and score the test. A treating clinician could easily be biased by her familiarity with the patient. Nevertheless, clinicians are required to be consistent in how they go about assessing changes in speech production (Yorkston, Beukelman, Strand, & Bell, 1979). For example, it might be feasible for the treating clinician to (a) administer the E-SPAM and (b) have another clinician unfamiliar with the client score the test face-to-face or from an audio tape. Another option would be to train a speech-language pathology aide (SLPA) or volunteer to score the test.

For many clients with MSDs, therapy focuses on drill, repetition, movement, and rhythm guided by the principles of motor learning. In other cases, treatment may be restorative and seek to improve strength, speed, and coordination of the affected speech subsystems. In either case, the clinician is in need of a means of assessing how his or her treatment impacts speech production. The E-SPAM provides such an instrument and provides a way for assessing changes in speech production apart from language by virtue of its repetition elicitation context.

From a practical standpoint, the E-SPAM should be considered as a "hybrid" test. It provides the clinician with information about several aspects of speech production, specifically intelligibility, efficiency, and speech naturalness, that are important when treatment focuses on improving speech. The E-SPAM is similar to an intelligibility test because the clinician does need to select words and sentences for the client to repeat. It

also has some relationship to comprehensibility testing because the person administering and/or scoring test is aware of the words and sentences the client repeats. It differs from both intelligibility and comprehensibility testing in two respects. First, a listener does not have to listen to and transcribe the client's utterances and the clinician does not have to compute percentages of intelligible words. This saves some time for the clinician. Second, its five-point descriptive scoring system may provide a better means of assessing changes in speech production ability than intelligibility or comprehensibility testing where responses are usually considered right or wrong. Further, the weighted scoring incorporated into the E-SPAM allows the clinician to determine if the client is producing longer and more complex utterances after a period of treatment.

The E-SPAM is a clinical and not a research tool. More importantly, it is a "clinician-friendly" test. Clinician friendliness is a term that has recently been used discussing features of assessment tools needed by clinicians working under the constraints of managed care (Marshall & Wright, 2008; Milman & Holland, 2008). Specifically, clinician-friendly tests can be (a) administered in a short time frame, (b) used with clients across the severity continuum, and (c) given in all patient care settings.

Future research with the E-SPAM needs to (a) assess more clients with MSDs with the E-SPAM, (b) give the test to clients with MSDs other than AOS and dysarthria, (c) examine the feasibility of administering the test in a variety of patient care settings, and (d) consider the level of training needed to score the test.

Appendix A: Judgment recording forms A and B for E-SPAM. Stimulus items that are in bold and italics indicate the words used to determine intra-rater scoring agreement.

Everyday Speech Production Assessment Measure (E-SPAM)

Form A, Subject 3

A. CV, VC, and CVC words without consonant clusters:

		Whole word produced:	
1. Wait	____	**YES**	No
2. Fine	____	**YES**	No
3. Got	____	**YES**	No
4. Fall	____	**YES**	No
5. Push	____	**YES**	No
6. Gym	____	**YES**	No
7. Eat	____	**YES**	No
8. Wall	____	**YES**	No
9. Took	____	**YES**	No
10. When	____	**YES**	No
11. ***Her***	____	**YES**	No
12. ***Type***	____	**YES**	No

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Appendix A (continued)

B. One syllable words with initial consonant cluster:

		Whole word produced:	
1. Skin	____	**YES**	No
2. Step	____	**YES**	No
3. Black	____	**YES**	No
4. Brook	____	**YES**	No
5. Clean	____	**YES**	No
6. Cross	____	**YES**	No
7. Snow	____	**YES**	No
8. Drive	____	**YES**	No
9. Flow	____	**YES**	No
10. Glad	____	**YES**	No
11. ***Stretch***	____	**YES**	No
12. ***Slow***	____	**YES**	No

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Appendix A (continued)

C. Three syllable words:

		Whole word produced:	
1. According	____	**YES**	No
2. Avenue	____	**YES**	No
3. Telephone	____	**YES**	No
4. Government	____	**YES**	No
5. Everything	____	**YES**	No
6. Different	____	**YES**	No
7. National	____	**YES**	No
8. Officer	____	**YES**	No
9. ***Carefully***	____	**YES**	No
10. ***Beautiful***	____	**YES**	No

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Appendix A (continued)

D. Four syllable words:

		Whole word produced	
1. Material	____	**YES**	No
2. California	____	**YES**	No
3. Community	____	**YES**	No
4. Accountable	____	**YES**	No
5. Republican	____	Yes	**NO**
6. American	____	**YES**	No
7. Society	____	**YES**	No
8. Authority	____	**YES**	No
9. ***Democratic***	____	Yes	**NO**
10. ***Development***	____	Yes	**NO**

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Appendix A (continued)

E. Five syllable words:

			Whole word produced: Yes	**NO**
1.	Considerable	____		
2.	Opportunity	____	**YES**	No
3.	Organization	____	**YES**	No
4.	North America	____	**YES**	No
5.	University	____	**YES**	No
6.	Association	____	**YES**	No
7.	***Philadelphia***	____	**YES**	No

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Appendix A (continued)

F. Short sentences:

			Basis
1.	I drive the car.	____	**ALL**-Most-Some-Little
2.	The man is too old.	____	All -Most-Some-**LITTLE**
3.	She will go west.	____	All-Most-Some- **LITTLE**
4.	Bob was born in June.	____	All -**MOST**-Some-Little
5.	I live in the house.	____	All – **MOST**-Some-Little
6.	Please don't go yet.	____	All -Most-**SOME**-Little
7.	***The game will end***.	____	All - Most -Some- **LITTLE**

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Basis: How much of the target utterance was available for scoring?
ALL: Exact repetition
MOST: Minor alterations or omissions
SOME: At least half of the target utterance
LITTLE: Target utterance grossly altered or predominantly missing

Appendix A (continued)

G. Longer sentences:

			Basis
1.	I want a book to read please.	_____	All –Most-**SOME**-Little
2.	He went to pick her up.	_____	All -Most- **SOME** -Little
3.	My aunt will visit in June.	_____	All -Most-Some- **LITTLE**
4.	I heard the bell ring all day.	_____	All -Most-Some- **LITTLE**
5.	He will get a good job.	_____	All -Most- **SOME** -Little
6.	Please have a drink with me.	_____	All -Most-Some- **LITTLE**
7.	***The score of the game was a tie.***	_____	All -Most-Some- **LITTLE**

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Basis: How much of the target utterance was available for scoring?
ALL: Exact repetition
MOST: Minor alterations or omissions
SOME: At least half of the target utterance
LITTLE: Target utterance grossly altered or predominantly missing

Appendix A (continued)

Everyday Speech Production Assessment Measure (E-SPAM)

Form B, Subject 3

A. CV, VC, and CVC words without consonant clusters:

		Whole word produced:	
1. Her	____	**YES**	No
2. Type	____	**YES**	No
3. Thin	____	**YES**	No
4. Cut	____	**YES**	No
5. Look	____	**YES**	No
6. Gave	____	**YES**	No
7. View	____	**YES**	No
8. Take	____	**YES**	No
9. June	____	**YES**	No
10. Car	____	**YES**	No
11. ***Wait***	____	**YES**	No
12. ***Fine***	____	**YES**	No

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Appendix A (continued)

B. One syllable words with initial consonant cluster:

	Whole word produced:	
1. Stretch ____	**YES**	No
2. Slow ____	**YES**	No
3. Smoke ____	**YES**	No
4. Through____	**YES**	No
5. Trade ____	**YES**	No
6. Sleep ____	**YES**	No
7. Ground ____	**YES**	No
8. Sweet ____	**YES**	No
9. Spread ____	**YES**	No
10. Prince ____	**YES**	No
11. ***Skin*** ____	**YES**	No
12. ***Step*** ____	**YES**	No

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Appendix A (continued)

C. Three syllable words:

		Whole word produced:	
1. Carefully	____	**YES**	No
2. Beautiful	____	**YES**	No
3. Yesterday	____	**YES**	No
4. Understand	____	**YES**	No
5. Expression	____	**YES**	No
6. President	____	**YES**	No
7. Already	____	**YES**	No
8. Department	____	yes	**NO**
9. ***According***	____	**YES**	No
10. ***Avenue***	____	**YES**	No

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Appendix A (continued)

D. Four syllable words:

		Whole word produced	
1. Democratic	____	yes	**NO**
2. Development	____	yes	**NO**
3. Impossible	____	**YES**	No
4. Organizer	____	**YES**	No
5. America	____	**YES**	No
6. Education	____	**YES**	No
7. January	____	**YES**	No
8. Pennsylvania	____	**YES**	No
9. ***Material***	____	**YES**	No
10. ***California***	____	**YES**	No

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Appendix A (continued)

E. Five syllable words:

			Whole word produced:	
1.	Philadelphia	____	**YES**	No
2.	Individual	____	**YES**	No
3.	Immediately	____	yes	**NO**
4.	South America	____	**YES**	No
5.	Administration	____	yes	**NO**
6.	Possibility	____	**YES**	No
7.	***Considerable***	____	yes	NO

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Appendix A (continued)

F. Short sentences:

			Basis
1.	The game will end.	____	All - Most -Some- **LITTLE**
2.	She wore a red dress.	____	All - Most -Some- **LITTLE**
3.	The mail was late.	____	All –Most-**SOME**-Little
4.	The grass is short.	____	**ALL** -Most-Some-Little
5.	My car needs gas.	____	All –Most-**SOME**-Little
6.	He went to the office.	____	All - Most -Some- **LITTLE**
7.	***I drive the car***.	____	**ALL** -Most-Some-Little

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Basis: How much of the target utterance was available for scoring?
ALL: Exact repetition
MOST: Minor alterations or omissions
SOME: At least half of the target utterance
LITTLE: Target utterance grossly altered or predominantly missing

Appendix A (continued)

G. Longer sentences:

			Basis
1.	The score of the game was a tie.	_____	All - Most -Some- **LITTLE**
2.	I am going to eat with a friend.	_____	All - Most -Some- **LITTLE**
3.	The old car is in need of work.	_____	All - Most -Some- **LITTLE**
4.	We can go to the store.	_____	All - Most -Some- **LITTLE**
5.	Come over and we will watch the game.	_____	All - Most -Some- **LITTLE**
6.	The boss will speak to the press.	_____	All - Most -Some- **LITTLE**
7.	***I want a book to read please.***	_____	All –Most-**SOME**-Little

Use the following scoring system to rate each word or sentence produced by the speaker:

5= NORMAL

4= CORRECTED/RESTARTED

3= APPROXIMATED

2= MARGINAL

1= UNRECOGNIZABLE

0= NO RESPONSE

Basis: How much of the target utterance was available for scoring?
ALL: Exact repetition
MOST: Minor alterations or omissions
SOME: At least half of the target utterance
LITTLE: Target utterance grossly altered or predominantly missing

Appendix B: Data processing forms for each student scorers responses for Subject 3.

Data Processing Form

E-SPAM Part A – Subject 3

A.	Student 1	Student 2	Student 3	Student 4	# Agree	# Disagree
wait	5	5	5	5	6	0
fine	5	5	5	5	6	0
got	5	5	5	5	6	0
fall	5	5	5	5	6	0
push	5	5	5	5	6	0
gym	5	5	5	5	6	0
eat	5	5	5	5	6	0
wall	5	5	5	5	6	0
took	5	5	5	5	6	0
when	5	5	5	5	6	0
E-SPAM	50 X .1 = 5	50 X .1 = 5	50 X .1 = 5	50 X .1 = 5		

B.	Student 1	Student 2	Student 3	Student 4	# Agree	# Disagree
her	5	5	5	5	6	0
type	5	5	5	5	6	0
thin	5	5	5	5	6	0
cut	5	5	5	5	6	0
look	5	5	5	5	6	0
game	5	5	5	5	6	0
view	5	5	5	5	6	0
take	5	5	5	5	6	0
June	5	5	5	5	6	0
car	5	5	5	5	6	0
E-SPAM	50 X .1 = 5	50 X .1 = 5	50 X .1 = 5	50 X .1 = 5		

Appendix B (continued)

Data Processing Form

E-SPAM Part B – Subject 3

A.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
skin	5	5	5	5	6	0
step	5	5	5	5	6	0
black	5	5	5	5	6	0
brook	5	5	5	5	6	0
clean	5	5	5	5	6	0
cross	5	5	5	5	6	0
snow	5	5	5	5	6	0
drive	5	5	5	5	6	0
flow	5	5	5	5	6	0
glad	5	5	5	5	6	0
E-SPAM	50 X .2 = 10	50 X .2 = 10	50 X .2 = 10	50 X .2 = 10		

B.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
stretch	5	5	5	3	6	0
slow	5	5	5	5	3	3
smoke	5	5	5	5	6	0
through	4	3	3	4	6	0
trade	5	5	5	5	2	4
sleep	5	5	5	5	6	0
ground	5	5	5	5	6	0
sweet	5	5	3	5	3	3
spread	5	5	5	5	6	0
prince	4	4	4	4	6	0
E-SPAM	48 X .2 = 9.6	47 X .2 = 9.4	45 X .2 = 9	46 X .2 = 9.2		

Appendix B (continued)

Data Processing Form

E-SPAM Part C – Subject 3

A.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
according	5	5	5	5	6	0
avenue	3	5	5	5	3	3
telephone	5	5	5	5	6	0
government	3	3	3	5	3	3
everything	5	5	5	5	6	0
different	5	5	5	5	6	0
national	5	5	5	5	6	0
officer	5	5	5	5	6	0
E-SPAM	36 X .3 = 10.8	38 X .3 = 11.4	38 X .3 = 11.4	40 X .3 = 12		

B.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
carefully	5	5	5	5	6	0
beautiful	5	5	5	5	6	0
yesterday	5	5	5	5	6	0
understand	3	3	3	5	3	3
expression	3	3	3	2	3	3
president	3	5	5	2	1	5
already	5	5	5	5	6	0
department	2	3	1	2	1	5
E-SPAM	31 X .3 = 9.3	34 X .3 =10.2	32 X .3 = 9.6	31 X .3 = 9.3		

E-SPAM Part D - Subject 3

A.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
material	5	5	5	5	6	0
California	5	5	5	5	6	0
community	2	2	2	2	6	0
accountable	5	5	5	5	6	0
republican	1	2	1	1	3	3
American	5	5	5	5	6	0
society	2	5	5	3	1	5
authority	3	3	3	3	6	0
E-SPAM	28 X .4 = 11.2	32 X .4 = 12.8	31 X .4 = 12.4	29 X .4 = 11.6		

B.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
democratic	2	3	3	2	2	4
development	2	2	2	2	6	0
impossible	5	5	5	3	3	3
organizer	5	5	5	5	6	0
America	5	5	5	5	6	0
education	2	3	5	3	1	5
January	5	5	3	5	3	3
Pennsylvania	5	5	5	5	6	0
E-SPAM	31 X .4 = 12.4	33 X .4 = 13.2	33 X .4 = 13.2	30 X .4 = 12		

Appendix B (continued)

Data Processing Form

E-SPAM Part E – Subject 3

A.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
Considerable	1	1	1	1	6	0
Opportunity	5	3	5	5	3	3
Organization	3	3	3	2	3	3
North America	3	5	3	5	2	4
University	5	5	3	3	2	4
Association	5	5	3	5	3	3
E-SPAM	22 X .5 = 11	22 X .5 = 11	18 X .5 = 9	21 X .5 = 10.5		

B.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
Philadelphia	5	3	3	2	1	5
individual	2	3	3	2	2	4
immediately	2	5	2	3	1	5
South America	5	3	3	5	2	4
administration	1	1	1	1	6	0
possibility	5	5	5	5	6	0
E-SPAM	20 X .5 = 10	20 X .5 = 10	17 X .5 = 8.5	18 X .5 = 9		

E-SPAM Part F - Subject 3

A.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
I drive the car	3	3	3	3	6	0
The man is too old	1	1	1	1	6	0
She will go west	1	1	1	1	6	0
Bob was born in June	5	5	5	5	6	0
I live in the house	2	5	3	3	1	5
Please don't go yet	2	2	5	3	1	5
E-SPAM	14 X .6 = 8.4	17 X .6 = 10.2	18 X .6 = 10.8	16 X .6 = 9.6		

B.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
The game will end	0	0	1	0	3	3
She wore a red dress	3	3	3	3	6	0
The mail was late	3	2	2	3	2	4
The grass is short	3	3	3	3	6	0
My car needs gas	3	3	3	3	6	0
He went to the office	3	3	2	3	3	3
E-SPAM	15 X .6 = 9	14 X .6 = 8.4	14 X .6 = 8.4	15 X .6 = 9		

Appendix B (continued)

Data Processing Form

E-SPAM Part G - Subject 3

A.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
I want a book to read please	2	2	2	2	6	0
He went to pick her up	2	2	2	2	6	0
My aunt will visit in june	2	2	2	2	6	0
I heard the bell ring all day	2	5	2	3	1	5
He will get a good job	2	5	5	5	3	3
Please have a drink with me	1	1	1	1	6	0
E-SPAM	11 X .8 = 8.8	17 X .8 = 13.6	14 X .8 = 11.2	15 X .8 = 12		

B.	Student 1	Student 2	Student 3	Student 4	Agree	Disagree
The score of the game was a tie	1	1	1	1	6	0
I am going to eat with a friend	3	2	2	3	2	4
The old car is in need of work	2	2	2	3	3	3
We can go to the store	3	2	2	2	3	3
Come over and we will watch the game	2	2	2	3	3	3
The boss will speak to the press	3	3	2	3	3	3
E-SPAM	14 X .8 = 11.2	12 X .8 = 9.6	11 X .8 = 8.8	15 X .8 = 12		

Summary – Subject 3

Time 1 (A)	Student 1	Student 2	Student 3	Student 4	# Agreements
Part A	5	5	5	5	60
Part B	10	10	10	10	60
Part C	10.8	11.4	11.4	12	42
Part D	11.2	12.8	12.4	11.6	40
Part E	11	11	9	10.5	19
Part F	8.4	10.2	10.8	9.6	26
Part G	8.8	13.6	11.2	12	28
Total Score	65.2	74	69.8	70.7	

Time 2 (B)	Student 1	Student 2	Student 3	Student 4	# Agreements
Part A	5	5	5	5	60
Part B	9.6	9.4	9	9.2	50
Part C	9.3	10.2	9.6	9.3	32
Part D	12.4	13.2	13.2	12	33
Part E	10	10	8.5	9	18
Part F	9	8.4	8.4	9	26
Part G	11.2	9.6	8.8	12	20
Total Score	66.5	65.8	62.5	65.5	

Total Agreements: 514/648 (79.3%)

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