I, Lisa M Houston, hereby submit this as part of the requirements for the degree of:

Master of Arts

in:

Audiology

It is entitled:

A Standardization Study of the Time Compressed Sentence Test

Approved by:

Robert W Keith Ph.D.

Don Hayes Ph.D.
A STANDARDIZATION STUDY OF THE TIME COMPRESSED SENTENCE TEST

A thesis submitted to the

Division of Research and Advanced Studies
of the University of Cincinnati

In partial fulfillment of the
requirements for the degree of

MASTER OF ARTS

In the Department of Audiology
of the College of Communication Sciences and Disorders

2002

by

Lisa M Houston

Bachelor of Science, West Liberty State College, 2000

Committee Chair: Robert W. Keith PhD.
   Don Hayes PhD.
ABSTRACT

This study obtained normative data for the standardization of the Time Compressed Sentence Test (TCST) (Keith 2002). The TCST is used to identify disorders of auditory timing, referred to as temporal processing disorders and contains a practice subtest, two subtests consisting of 40% time compression, and two subtests consisting of 60% time compression.

The TCST was administered to normal typically developing children. This data was imperative to establishing the norms for each subtest for each age group. 117 children between the ages of 6 years 0 months and 11 years and 11 months were utilized for this study. Of the 117 subjects, 58 were males and 59 were females.

To determine whether there was a significant difference between 40% time compression and 60% time compression, a 1 Within X 1 Between Repeated Measures analysis of variance (ANOVA) was carried out. There was a significant compression effect. A significant age effect was also found across the five groups of children. The ANOVA was also used to test for a Compression X Age interaction. The interaction was found to be significant.

A second ANOVA (1 Within X 1 Between) was used to determine if there was a significant difference between the right and left ear scores. There was a significant Ears Main Effect. There was not a significant Ears X Age interaction.

In light of the significant Compression main effect and the presence of a significant Age effect, a series of pairwise comparisons were obtained using the Tukey
Honestly Significant Difference test. Comparisons were first obtained across age groups at the 40% and 60% compression levels. It was found that the oldest age group (10-11) performed significantly better than the three youngest age groups (6-8) at 40% compression and that the youngest age group (6 yr) performed significantly worse than the other four groups. All age groups performed more poorly at 60% compression than at 40% compression.

In addition, since there was a significant Ear main effect and the presence of a significant Age effect, a series of pairwise comparisons were obtained utilizing the Tukey Honestly Significant Difference Test. Comparisons were obtained across age groups for the right and left ears. It was found that the oldest age group (10-11) performed significantly better than the 6 and 8 year-olds in the Right ear. These comparisons were also obtained for the left ear indicating that the youngest age group (6yr) performed more poorly than the older age groups (7-11).
ACKNOWLEDGEMENTS

First and foremost, I would like to extend my most sincere gratitude to my thesis advisor, Dr. Robert W. Keith whose support, guidance, and assistance in data collection were invaluable throughout this study. His expertise and research in the field of central auditory processing assessments was an integral component of this investigation.

I would also like to thank Dr. Don Hayes for his time and effort in serving as a member of my committee. Without him, the statistics would not have been possible.

I am also extremely grateful to the many audiologists who took time out of their busy schedules to acquire data for this study. Moreover, I am thankful to the many subjects who were attentive and willing to participate in the research for this thesis. Without their dedication, patience, and willingness to participate, this thesis would not have been possible.

I would also like to thank my classmates who have supported me throughout this Master’s thesis. We are all going through the same process and it is great to have so much support.

Finally, I would like to thank my parents, Robert and Paula Houston for their continued support throughout my educational career. Without their love, encouragement, and motivation, I would not be who I am today.
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF TABLES</td>
<td>3</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>4</td>
</tr>
<tr>
<td><strong>CHAPTER ONE</strong></td>
<td></td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>5</td>
</tr>
<tr>
<td>Research Questions and Hypothesis</td>
<td>8</td>
</tr>
<tr>
<td><strong>CHAPTER TWO</strong></td>
<td></td>
</tr>
<tr>
<td>REVIEW OF RELATED LITERATURE</td>
<td>10</td>
</tr>
<tr>
<td>Central Auditory Processing</td>
<td>10</td>
</tr>
<tr>
<td>Temporal Processing</td>
<td>12</td>
</tr>
<tr>
<td>Time Compressed Speech and Assessment</td>
<td>14</td>
</tr>
<tr>
<td><strong>CHAPTER THREE</strong></td>
<td></td>
</tr>
<tr>
<td>METHODS</td>
<td>17</td>
</tr>
<tr>
<td>Examiners</td>
<td>17</td>
</tr>
<tr>
<td>Subjects</td>
<td>18</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>19</td>
</tr>
<tr>
<td>Pre-Experimental Testing</td>
<td>20</td>
</tr>
<tr>
<td>Experimental Testing</td>
<td>20</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>22</td>
</tr>
<tr>
<td><strong>CHAPTER FOUR</strong></td>
<td></td>
</tr>
<tr>
<td>RESULTS</td>
<td>23</td>
</tr>
<tr>
<td>Descriptive Statistics</td>
<td>23</td>
</tr>
<tr>
<td>Statistical Analysis</td>
<td>25</td>
</tr>
<tr>
<td>Post Hoc Analysis</td>
<td>25</td>
</tr>
</tbody>
</table>
CHAPTER FIVE

DISCUSSION .......................................................................................................... 29

40% Time Compression vs. 60% Time Compression ........................................ 29
Age-by-Age .................................................................................................... 29
Age by Compression Interaction .................................................................... 29
Right Ear vs. Left Ear ..................................................................................... 30

CHAPTER SIX

CONCLUSIONS ...................................................................................................... 32

Limitations of the Study ................................................................................. 33
Recommendations for Further Research ........................................................ 34

REFERENCES ................................................................................................................ 35

APPENDICES

A. TCST Score Sheet ..................................................................................... 38
B. Geographical Locations of Examiners ....................................................... 41
C. Beta Site Examiners ................................................................................... 42
D. Questionnaire ............................................................................................. 43
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Males and Females in each age group.</td>
<td>18</td>
</tr>
<tr>
<td>Table 2</td>
<td>Descriptive statistics for each age group at 40% time compression for the right and left ear and 60% for the right and left ear.</td>
<td>23</td>
</tr>
<tr>
<td>Table 3</td>
<td>Descriptive statistics across ears for each age group at 40% time compression.</td>
<td>24</td>
</tr>
<tr>
<td>Table 4</td>
<td>Descriptive statistics across compression for each age Group at 60% time compression.</td>
<td>24</td>
</tr>
<tr>
<td>Table 5</td>
<td>Descriptive statistics for right vs. left ear across compression for each age group.</td>
<td>25</td>
</tr>
<tr>
<td>Table 6</td>
<td>Results of the statistical analysis for all 117 subjects.</td>
<td>26</td>
</tr>
<tr>
<td>Table 7</td>
<td>Post Hoc analysis utilizing the Tukey for compression X age.</td>
<td>27</td>
</tr>
<tr>
<td>Table 8</td>
<td>Post Hoc analysis utilizing the Tukey for the ear X age.</td>
<td>28</td>
</tr>
<tr>
<td>Table 9</td>
<td>Paired t-test analysis of the list effect.</td>
<td>31</td>
</tr>
</tbody>
</table>
## LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSCT</td>
<td>Time Compressed Sentence Test</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
</tr>
<tr>
<td>df</td>
<td>Degrees of Freedom</td>
</tr>
<tr>
<td>p</td>
<td>Tail Probability</td>
</tr>
</tbody>
</table>
CHAPTER ONE

INTRODUCTION

The Time Compressed Sentence Test (TCST) is designed to measure one aspect of audition called temporal resolution. The TCST evaluates temporal resolution by altering the auditory signal presented. The purpose of the TCST is to identify children between the ages of 6-11 years who have temporal processing disorders (disorders of auditory timing) and may benefit from early intervention. The TCST includes 4 lists of sentences, which are presented at 0, 40, and 60 percent time compression.

Jerger and Musiek (2000) suggest that tests of auditory processing disorders (APD) should control linguistic variables including little or no linguistic demand and specific linguistic parameters. These strategies will in turn allow for distinguishing an APD from poor performance due to a language disorder. A behavioral measure of an APD should consist of a duration pattern sequence test-a key measure of auditory temporal processing. The TCST is a duration pattern sequences test in that the duration of the sentences presented is altered. This aids in the diagnosis of a temporal processing disorder.

At the present time the only time compressed tests available utilize monosyllables. We believe that time compressed sentences are a more reasonable stimuli since the signal represents typical speech more normally. Two purposes of time compressed speech include diagnosis of an auditory processing disorder, and determining the site of lesion. Researchers have been interested in learning how neurological disorders affect auditory functioning to aid in determining improved methods for clinical
diagnosis and localization (Lynn, G.E. & Gilroy, J., 1977). Lynn and Gilroy also discussed the idea that patients with central auditory lesions do not exhibit typical abnormal auditory symptoms. Yet patients with neurological disorders do in fact exist and can only be diagnosed with appropriate tests with a specific design feature.

**Time Compressed Sentence Test:**

The TCST is made up of three subtests with 0, 40 and 60% time compression. Subtests two and three are presented to right and left ears separately. The subtests are described below:

**Subtest 1.**

Subtest 1 is a practice list and preliminary screening consisting of 10 sentences. These sentences are used to assure that the child is able to repeat a sentence of the length used. This portion of the test is presented at zero time compression at a comfortable listening level, or if that cannot be determined and the child’s hearing is normal, we recommend 55 dBHL.

**Subtest 2.**

Subtest 2, consists of ten sentences which are presented at 40% time compression. These sentences are presented to each ear separately. These sentences are utilized to determine the difference in the mean number of errors between the two types of compression.
Subtest 3.

Subtest 3, consists of ten sentences which are presented at 60% time compression. These sentences are presented to each ear separately. These sentences differ from the 40% time compressed sentences thus aiding in determining the difference in performance with an increase in time compression.

In this thesis I standardized TCST by administering the test to typically developing children between the ages of 6 and 11 years. The (TCST) score sheet can be found in (Appendix A). This test was designed to assess those children who are suspected as having an auditory processing disorder.
Research Questions and Hypothesis:

Five Null Hypothesis and Research Questions are to be investigated:

Null Hypothesis 1: There will be no difference in the mean number of errors at 40% or 60% time compression (ignoring age) except due to chance.

Research Hypothesis 1: There will be a difference in the mean number of errors at 40% or 60% time compression (ignoring age) more than chance.

Null Hypothesis 2: There will be no difference in the mean number of errors at age 6,7,8,9, and 10&11 combined (ignoring compression) except due to chance.

Research Hypothesis 2: There will be a difference in the mean number of errors at age 6,7,8,9 and 10&11 combined (ignoring compression) more than chance.

Null Hypothesis 3: There will be no interaction between time compression level and the age of listeners as shown by the joint error means except due to chance.

Research Hypothesis 3: There will be an interaction between time compression level and the age of listeners as shown by the joint error means more than chance.
Null Hypothesis 4: There will be no difference in the mean number of errors between the right and left ears for both 40% time compression and 60% time compression (ignoring age) except due to chance.

Research Hypothesis 4: There will be a difference in the mean number of errors between the right and left ear for both 40% time compression and 60% time compression (ignoring age) more than chance.

Null Hypothesis 5: There will be no difference in the mean number of errors for the right ear and the left ear at age 6,7,8,9,10&11 combined (ignoring time compression) except due to chance.

Research Hypothesis 5: There will be a difference in the mean number of errors for the right and the left ear at age 6,7,8,9,10&11 combined (ignoring compression) more than chance.
CHAPTER TWO
REVIEW OF RELATED LITERATURE

Central Auditory Processing.

Auditory processing is an important yet controversial aspect of the Audiology field. Currently, auditory processing is used interchangeably with other terminology including but not limited to central auditory ability, central auditory function, and auditory processing abilities (Roeser, 1995). Generally speaking, auditory processing is taking the received signal and locating, transforming, analyzing, clarifying, attending and/or storing it so that it becomes functionally useful (Katz, 1994).

However, due to the controversy and complexity of this disorder, consensus has been lacking as to the precise definition of the disorder and other related disorders and how they can be identified and ameliorated through intervention (ASHA, 1996).

Some children are thought to have hearing problems based on reports from parents and teachers. Anecdotal support for these reports include; uncertainty about what the client hears, difficulty listening in the presence of competing noise, difficulty following instructions, and trouble following speech that is too rapid. Some children will have a significant peripheral deficit, and thus intervention is imperative. Other children will have auditory thresholds that are within normal limits, thus posing the question as to what is causing this lack of performance in the classroom and at home. Jerger and Musiek (2000), propose that the latter mentioned group of children have a more complex disorder. This disorder is an auditory processing disorder, which is defined as a deficit in
processing auditory information despite normal hearing sensitivity (Jerger & Musiek 2000).

In order to establish a technical report with “statements of consensus” on best practice regarding the definition, diagnosis, and treatment of children and adults presumed to have this disorder or related disorders, the American Speech-Language and Hearing Association (ASHA) convened a task force in 1993 assessing these issues. According to the task force, “central auditory processes are the auditory system mechanisms and processes responsible for the following behavioral phenomena:”

- **Sound localization and lateralization.**
- **Auditory discrimination.**
- **Auditory pattern recognition.**
- **Temporal aspects of audition, including**
  - temporal resolution
  - temporal masking
  - temporal integration
  - temporal ordering
- **Auditory performance decrements with competing acoustic signals**
- **Auditory performance decrements with degraded acoustic signals**

The ASHA panel concluded that CAPD can result from a, “dysfunction of processes dedicated to audition and also may include other factors such as a general dysfunction across modalities i.e. attention deficit disorders” (ASHA 1996). In addition, the panel realizes that CAPD may coexist with other dysfunctions.
According to the ASHA statement, these mechanisms and processes presumably apply to verbal as well as nonverbal signals, which in turn may affect many areas of function, including speech and language. In addition, a central auditory processing disorder (CAPD) is an observed deficiency in one or more of the aforementioned behaviors (ASHA, 1996).

Another general definition of auditory processing is any breakdown in auditory abilities that results in diminished learning through hearing, when peripheral auditory sensitivity is normal. Individuals with normal auditory processing skills are able to understand speech under a wide range of listening conditions. Examples of these listening conditions include but are not limited to, tuning out background noise, understanding distorted speech, and adaptation to a wide variety of listening styles (Keith 2000). In diagnosing a central auditory processing disorder, the protocol includes but is not limited to, “a behavioral auditory measure of temporal processes including ordering, discrimination, resolution, and integration”. Sufficient evidence exists to support the theory that temporal processing is a key component and underlying factor of central auditory function (Chermak, Musiek, 1997).

**Temporal Processing.**

Over the past 20 years, Tallal and her colleagues have based their research on determining the etiology of early language impairment and the relationship between specifically language impaired (SLI) and dyslexia. Their objectives are based on the theory that neurological processes are the foundation for higher level cognitive functioning (Tallal et al 1997). As a result, if we are going to understand speech, language, and reading, we must have a grasp on the neurological processes upon which
these concepts depend. Many studies have concluded that language-learning impaired children show characteristics of deficits of higher order auditory processing, specifically rapid temporal integration of various acoustic stimuli an serial memory (Tallal et al. 1997). With that in perspective, these deficits occur with both non-speech and speech stimuli, with a significant impact on central auditory processing in the tens of millisecond (msec) time range.

Audition is not only the detection of sound but also the perception of how sounds are distributed in time. This concept is known as temporal processing which is thought to be the one of the underlying factors of central auditory function. The initial step in exploring temporal processing is to define precisely what is meant by the term. Temporal processing can be defined in many ways including determination of the sound source, “spatial percept,” determining the pitch of the sound, and the perceptual segregation of two acoustic events (Phillips, 1995).

Other examples of temporal processes in hearing exist and include masking, discrimination of duration, and the real time (i.e. time in msec.) that is required to recognize the signal, and variations in pitch that define prosody in speech (Phillips, 1995). Phillips also states that there are a number of ways in which the cortical auditory system is specialized to determine detection, representation, and analysis of brief signals in a brief time.

Throughout many years of research, Tallal and her colleagues (1996) concur that dysfunction in higher-level speech functioning, which is necessary for typical language and reading development, may be due in part to the disruption of processing basic information. In determining what is happening with language-learning impaired
children. Tallal (1996) suggests, “rather than deriving from a primarily linguistic or cognitive impairment, the phonological and language difficulties of LLI children may result from a more basic deficit in processing rapidly changing sensory inputs.”

Generally speaking, LLI children have difficulty discriminating between many speech syllables during a critical time frame during which many phonetic contrasts exist. In conclusion, Tallal and hear associates (1996) propose that the processing of a brief burst of acoustic information is relative to the development and maintenance of language.

**Time Compressed Speech and Assessment.**

There are many different strategies utilized to assess temporal aspects of acoustic signals. These techniques include but are not limited to the assessment of thresholds for brief tones, testing for temporal ordering utilizing a tone or click stimuli, and finally discrimination of time compressed speech (McCroskey & Keith, 1996).

Time compression is one way to assess auditory temporal acuity. Wilson et al (1994) utilized time compression to degrade the Northwestern University Auditory Test No. 6 (NU6) in the assessment of temporal dysfunction. The researchers utilized two procedures to alter the speech signal: 1) Time compression of the speech signal
2) Time compression of the speech signal plus reverberation. The rate of speech can be altered in many ways. For example, the speaker can alter the rate of speech, or the rate of playback can be changed. Clinically, time-compressed speech can be utilized to assess patients with neurological deficits (Wilson et al 1994). In contrasting patients with normal central neurological systems, responses to degraded speech signal are significantly poorer in patients with central neurological disorders.
Wilson et al. (1994) concur that as the compression ratio of the speech signal increases, there is a degradation of recognition performance. These findings are consistent with an early theory that recognition performance is most affected by compression ratios above 60 percent (Wilson et al 1994). The time compressed speech test recommended by Wilson, involves only monosyllables.

Time and frequency-altered speech has been studied extensively, and recently researchers are focusing on the clinical implications of time-altered speech. The use of time compressed speech has expanded in order to detect neurological deficits which may go unnoticed utilizing only pure tone and word discrimination as an assessment of audition (Beasley, D.S., & Freeman, B.A., 1977). Jerger concludes that due to the complexity and redundancy of the central nervous system a complex acoustic signal should be used to assess retrocochlear auditory dysfunction.

It has been difficult to develop tests of central auditory dysfunction due to the lack of available norms. Beasley et al performed a study on 60 children 4,6,and 8 years of age. The Word by Picture Identification (WIPI) Test and the PB-K 50 tests were time compressed by 0%, 30% and 60%. Results of this study suggest that as the time compression increases, intelligibility decreases (Beasley, D.S., & Freeman, B.A., 1977).

The effect of speaking rate has been studied for sentences (McCroskey & Thompson, 1973) and for words (Beasley, et al., 1976). Beasley's purpose was to stress the auditory system with accelerated speech and find the point of breakdown. McCroskey and Thompson accepted the view that every auditory system has its temporal limit and individuals who show verbal disabilities (auditory processing disorders) will reach that limit earlier.
A number of techniques for assessing different temporal aspects of acoustic signals are available. They include assessment of thresholds for brief tones, testing for temporal ordering, sequencing of tonal or click stimuli and discrimination of time compressed speech. All of these techniques find that disturbances in the temporal aspects of audition are related to cortical lesions. These findings are summarized in several references (Pinheiro and Musiek, 1985; Olsen, 1991; Baran and Musiek, 1991, Thompson and Abel, 1992). None of these techniques measure the gap detection threshold of the auditory system.

The purpose of this study is to gather normative data in order to standardize the Time Compressed Sentence Test (TCST) a new test used to identify one aspect of auditory processing disorders. Analysis of the results of data collection will provide normative data including means, standard deviation, and range of responses in normal subjects. With these data we will be able to establish cut-off scores for determining normal and abnormal performance.
CHAPTER THREE

METHODS

Examiners:

External

External examiners were asked to participate in the Time Compressed Sentence Test standardization study. These external examiners were asked to participate in this phase of the research by obtaining data on normal children. Each participant was asked to obtain normative data on 20 normally achieving children in each age group of 6 to 9 years and the combined age group of 10 & 11 years.

Robert W Keith, advisor to this master’s thesis, identified former students or colleagues who were known to conduct tests of auditory processing. Some examiners volunteered in response to comments made by Robert W Keith during an instructional course in auditory processing disorders given in several venues.

The external examiners are from different geographic areas of the United States thus allowing the Time Compressed Sentence Test standardization sample to be based on the general population. A total of 12 examiners in 7 states participated in gathering normative data. Two were in private practice, two were in clinical settings, three were in University settings, & four were educational audiologists. In (Appendix B), the geographical locations of the examiners and the number of subjects from each state are represented.

In return for their efforts, the external examiners received a free Time Compressed Sentence Test CD, and a copy of the normative data and procedures manual.
All examiners were provided with a Beta CD, score forms, and instructions for administering the test. They were also promised copies of all materials i.e. criteria for subject selection, exclusion criteria etc. Each Beta site examiner was responsible for obtaining IRB approval. The names and cites of examiners are included in (Appendix C). This investigator obtained IRB approval at the University of Cincinnati.

**SUBJECTS:**

**Standardization Study**

The subjects used in the standardization study consist of children between the ages of 6 and 11 years. Subjects were assigned to one of five groups by age from 6-0 to 6-11, 7-0 to 7-11, 8-0 to 8-11, 8-0 to 9-11, and 10-0 to 11-11. At the time of the testing, the audiologists administering the test were required to fill out a questionnaire (Appendix D) regarding information on each participating subject. This information helped to categorize each child’s diagnostic status (i.e. normal, or type of disorder), which will be necessary for the data analysis. Overall there were a total of 117 subjects; 58 were males and 59 were females. Table 1 represents the number of males and female subjects in from each age group. The 117 subjects included 76 who were Caucasian, 17 were Hispanic, 16 African American, 7 Multi Racial, and 1 Asian.

<table>
<thead>
<tr>
<th>AGE</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10&amp;11</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALES</td>
<td>9</td>
<td>10</td>
<td>14</td>
<td>12</td>
<td>13</td>
<td>58</td>
</tr>
<tr>
<td>FEMALES</td>
<td>8</td>
<td>11</td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>59</td>
</tr>
</tbody>
</table>

Table 1: Summary table of the number of males and females in each age group.

The children represented within these age groups met the following criteria:

a) Hearing within normal limits (0-15 dBHL) at frequencies 500, 1000, 2000 and 4000 Hz.
b) Normal tympanometry with a notch shaped tympanogram and middle ear pressure between 0 and -200 daPa

c) Normally achieving with subjects attending a regular classroom without the diagnosis of ADD, language disorder, learning disability, or auditory processing disorder.

c) Possess the cognitive ability to understand the instructions, which were administered prior to and during the testing, and the ability to repeat a sentence of 4 to 5 words.

e) Native English Speaker.

**INSTRUMENTATION:**

Equipment required for this standardization study consisted of a pure-tone audiometer, a tympanometer, and a CD player to administer the experimental test.

**RECORDING AND EDITING OF THE TCST:**

Sentences were recorded at 40 and 60% time compression. These parameters were chosen based on previous research indicating that typical children have little difficulty at the lower rate of time compression and greater difficulty at more rapid rates. The implication is that children with auditory processing deficits may respond differentially and have greater difficulty than typical children at these compression rates.

The sentences were recorded by a male speaker with a general American dialect in the studios of AUDiTec™ of St. Louis, and digitized direct to hard disk. The sentences were edited for equivalent level, employing a standard VU meter on Cakewalk Pro Audio 9 software installed on a Compaq computer. Time compression was achieved by employing a plug-in available in the Cakewalk Pro Audio 9 software package. To
obtain 45% compression one rendering was required. But to obtain 60% compression, two renderings of 50% and 10% were necessary since the software does not compress beyond 50%. Finally, interstimulus intervals were adjusted to 5 seconds.

**PRE-EXPERIMENTAL TESTING:**

Prior to experimental testing, children were administered a pure-tone hearing test, and tympanometry. A history was obtained to rule out a diagnosis of ADD, language disorder, learning disability, or auditory processing disorder. The children were also screened to determine that they possessed the cognitive ability to follow instructions and repeat a sentence of 4 to 5 words. After pre-experimental testing, if children met the criteria for inclusion as a subject, experimental testing was initiated.

**EXPERIMENTAL TESTING:**

Each audiologist administering the TCST received the following instructions:

**Step 1:**

After calibrating the audiometer, present the sentences monaurally at a comfortable listening level. These sentences were administered at 55dBHL. The first 10 sentences are for practice, to assure that the child is able to repeat a sentence of the length used here. Administer the practice sentences to the first ear tested. Then test one ear for lists one and two and then the opposite ear for lists three and four. Alternate the first ear tested between the right and left ear.

**Step 2:** Instruct the child as follows:

“For the next few minutes you are going to hear a group of sentences. Listen carefully and each time you hear a sentence repeat it exactly as you heard it. If
you are not sure take a guess and tell me what you think you heard. The first few sentences are for practice and sound normal. The next sentences will sound different. The speaker is talking very fast. Your job is to try and repeat all the words in the sentence.”

Step 3:

Administer and score the practice sentences:

- If the child has substantial difficulty, re-administer the practice sentences.
- If the child is unable to repeat the sentences that are not time compressed, terminate the test

Step 4:

After successful completion of the practice test, proceed to the time compressed sentences.

Step 5:

Mark the responses in the following way:

A). On the score sheet mark out words that were omitted and insert words that were added.

B). If there was no response to the sentence note “NR.”

Step 6:

Do not pause the test between sentences. If necessary, you can pause the test briefly between frequencies.
DATA ANALYSIS:

An error on the TCST was defined as follows:

a). Each sentence has a subject, verb, and an object, thus each sentence is worth a raw score of three. The subject missing one of the content words in the sentence constitutes an error. The number of errors per each subject per each subtest was obtained and recorded.

b). The rationale for this scoring is that the children are presented the sentences at three levels of time compression (0%, 40%, & 60%). The number of errors per subtest was used to determine the effects of time compression, and age.

Statistical Analysis.

A repeated measure ANOVA (1 Within X 1 Between) was used to determine the effects of 40% and 60% time compression, in terms of number of errors by each age group (6, 7, 8, 9, 10, & 11).

A repeated measure ANOVA (between subjects) was used to determine the effect of compression on the mean number of errors (ignoring age). A repeated measure ANOVA was also used to determine the effect of age on the mean number of errors (ignoring compression).

A repeated measure ANOVA (1Within X 1Between) subjects was utilized in establishing an ear effect in terms of both 40% and 60% compression, and also for an ear effect (ignoring compression) across groups.

A Post Hoc Analysis utilizing the Tukey Honestly Significant Difference test was conducted to determine the interaction of Compression X Age, and Ears X Age.
CHAPTER FOUR

RESULTS

The total number of normative data subjects included 117 subjects. Each subject’s data must have exhibited responses to the sentences. All of the data obtained from these subjects was included in the statistical analysis. Therefore, a total of 117 subjects provided the examiner with useable data.

Each subject was administered the Time Compressed Sentence Test (TCST). A number of errors per subtest were obtained from each subject in the age groups 6, 7, 8, 9, & 10-11 combined respectively. The practice test, which was not time compressed, was not included in the calculation.

Descriptive statistics were obtained to determine the mean number errors, and the standard deviation for the right and left ears at 40% time compression and 60% time compression for each age group. Results of this analysis can be found in Table 2.

Descriptive Statistics

<table>
<thead>
<tr>
<th>Age</th>
<th>40% Compression Right Ear</th>
<th>40% Compression Left Ear</th>
<th>60% Compression Right Ear</th>
<th>60% Compression Left Ear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
</tr>
<tr>
<td>6</td>
<td>2.1</td>
<td>2.5</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>7</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>8</td>
<td>1.3</td>
<td>1.1</td>
<td>1.3</td>
<td>1.9</td>
</tr>
<tr>
<td>9</td>
<td>1.2</td>
<td>1.2</td>
<td>0.7</td>
<td>1.1</td>
</tr>
<tr>
<td>10&amp;11</td>
<td>0.3</td>
<td>0.9</td>
<td>0.6</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Table 2: Summary Table of descriptive statistics for right and left ears at 40% time compression and 60% time compression. This data includes the mean number of errors, and the standard deviation for each age group.
The normative data sample size of subjects with usable data, the combined mean number of errors for subtest 1 and 3 (40% time compression), and the standard deviation for 40% time compression for each age group are represented in Table 3. The mean number of errors combined for subtest 2 and 4 (60% time compression), and the standard deviation for 60% time compression are represented in Table 4.

<table>
<thead>
<tr>
<th>Age</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1.824</td>
<td>2.096</td>
<td>34</td>
</tr>
<tr>
<td>7</td>
<td>1.286</td>
<td>1.235</td>
<td>42</td>
</tr>
<tr>
<td>8</td>
<td>1.345</td>
<td>1.551</td>
<td>58</td>
</tr>
<tr>
<td>9</td>
<td>.907</td>
<td>1.154</td>
<td>54</td>
</tr>
<tr>
<td>10&amp;11</td>
<td>.457</td>
<td>1.005</td>
<td>46</td>
</tr>
</tbody>
</table>

Table 3: Summary Table of the Descriptive Statistics of the TCST. The age group, the mean number of errors for each group, and the number of children represented in each age group across ears for subtests 1 and 3 (40% time compression).

<table>
<thead>
<tr>
<th>Age</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6.971</td>
<td>2.096</td>
<td>34</td>
</tr>
<tr>
<td>7</td>
<td>4.691</td>
<td>3.135</td>
<td>42</td>
</tr>
<tr>
<td>8</td>
<td>5.397</td>
<td>3.529</td>
<td>58</td>
</tr>
<tr>
<td>9</td>
<td>4.611</td>
<td>3.074</td>
<td>54</td>
</tr>
<tr>
<td>10&amp;11</td>
<td>3.087</td>
<td>2.199</td>
<td>46</td>
</tr>
</tbody>
</table>

Table 4: Summary Table of the Descriptive Statistics of the TCST. The age group, the mean number of errors for each age group, and the number of children in each age group across ears for subtests 2 and 4 (60% time compression).

Descriptive statistics were obtained for the right ear vs. the left ear across compression for each age group. The mean number of errors and standard deviation for each age group are illustrated in Table 5.
<table>
<thead>
<tr>
<th>Ear</th>
<th>Age</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>6</td>
<td>4.559</td>
<td>4.607</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>3.429</td>
<td>3.284</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>3.849</td>
<td>3.655</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>3.093</td>
<td>3.122</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>10 &amp; 11</td>
<td>1.522</td>
<td>1.871</td>
<td>46</td>
</tr>
<tr>
<td>Left</td>
<td>6</td>
<td>4.235</td>
<td>3.782</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>2.548</td>
<td>2.471</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>2.897</td>
<td>3.065</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>2.426</td>
<td>2.792</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>10 &amp; 11</td>
<td>2.022</td>
<td>2.399</td>
<td>46</td>
</tr>
</tbody>
</table>

Table 5: Summary table of Descriptive Statistics of right ear vs. left ear grouped across compression. The age group, the mean number of errors, and the number of subjects in each age group is represented in this table.

**Statistical Analysis:**

To determine whether there was a significant difference between 40% time compression and 60% time compression, a 1 Within X 1 Between Repeated Measures analysis of variance (ANOVA) was carried out. The tests given with 40% and 60% of time compression in the left and right ears comprised the four levels of the Within condition. The Between condition was a comparison of children who were grouped into five different Age categories including: 6, 7, 8, 9 and 10-11 year-olds. There was a significant compression effect as can be seen in row 2 of Table 6 (p < 0.001). A significant age effect was also found across the five groups of children (p < 0.001). The ANOVA was also used to test for a Compression X Age interaction. The interaction was found to be significant (p < 0.008).

A second ANOVA (1 Within X 1 Between) was used to determine if there was a significant difference between the right and left ear scores. There was a significant Ears
Main Effect as shown in Table 6 (p< 0.022). There was not a significant Ears X Age interaction (p< 0.123).

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Error df</th>
<th>F-Stat</th>
<th>p&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression</td>
<td>1</td>
<td>229</td>
<td>341.01</td>
<td>0.001</td>
</tr>
<tr>
<td>Age</td>
<td>4</td>
<td>229</td>
<td>9.429</td>
<td>0.001</td>
</tr>
<tr>
<td>Compression X Age</td>
<td>4</td>
<td>229</td>
<td>3.536</td>
<td>0.008</td>
</tr>
<tr>
<td>Ears</td>
<td>1</td>
<td>229</td>
<td>5.39</td>
<td>0.022</td>
</tr>
<tr>
<td>Ears X Age</td>
<td>4</td>
<td>229</td>
<td>1.839</td>
<td>0.123</td>
</tr>
</tbody>
</table>

**Table 6:** Results of the statistical analysis for the 117 normal hearing subjects. All of the effects were statistically significant at the $\alpha=0.05$ level except the Ears X Age interaction.

**Post Hoc Analysis.**

In light of the significant Compression main effect and the presence of a significant Age effect, a series of pairwise comparisons were obtained using the Tukey Honestly Significant Difference test. Comparisons were first obtained across age groups at the 40% and 60% compression levels. Those results are shown in Table 7. It was found that the oldest age group (10-11) performed significantly better than the three youngest age groups (6-8) at 40% compression and that the youngest age group (6 yr) performed significantly worse than the other four groups. All age groups performed more poorly at 60% compression than at 40% compression. However, the distribution of scores at 60% compression was similar to the distribution found at 40% compression. This time the oldest age group (10-11) performed significantly better than the 6 and 8 year-olds. The 6 year-olds performed more poorly than the 7, 9, 10-11 year-olds at 60% compression.
40% time Compression

<table>
<thead>
<tr>
<th>Age</th>
<th>N</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-11</td>
<td>46</td>
<td>.456</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>54</td>
<td>.9074</td>
<td>.9074</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>58</td>
<td>1.345</td>
<td>1.345</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>42</td>
<td>1.285</td>
<td>1.285</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>34</td>
<td></td>
<td>1.824</td>
<td></td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>.555</td>
<td>.585</td>
<td>.372</td>
</tr>
</tbody>
</table>

60% Time Compression

<table>
<thead>
<tr>
<th>Age</th>
<th>N</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-11</td>
<td>46</td>
<td>3.087</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>54</td>
<td>4.611</td>
<td>4.611</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>58</td>
<td>5.397</td>
<td>5.597</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>42</td>
<td>4.691</td>
<td>4.691</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>34</td>
<td></td>
<td>6.971</td>
<td></td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>.130</td>
<td>.780</td>
<td>.143</td>
</tr>
</tbody>
</table>

Table 7: Summary table of the Post Hoc Analysis utilizing the Tukey. All findings were significant when determining the Compression effect X Age ignoring ears. These findings were statistically significant at the \( \alpha = 0.005 \) level.

In addition, since there was a significant Ear main effect and the presence of a significant Age effect, a series of pairwise comparisons were obtained utilizing the Tukey Honestly Significant Difference Test. Comparisons were obtained across age groups for the right and left ears. Those results can be found in Table 8. It was found that the oldest age group (10-11) performed significantly better than the 6 and 8 year-olds in the Right ear. It is an interesting finding that the 8 year-olds are grouped with the 6 year olds, and this finding is most likely due to the fact that 24 out of the 29 8 year-olds received the harder of the two lists in the right ear. These comparisons were also obtained for the Left ear indicating that the youngest age group (6yr) performed more poorly than the older age groups (7-11).
### Table 8: Summary table of the Post Hoc Analysis utilizing the Tukey.

All findings were significant when determining the Ear effect X Age ignoring compression. These findings were statistically significant at the $\alpha=0.005$ level.

<table>
<thead>
<tr>
<th>Ear</th>
<th>Age</th>
<th>N</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>10&amp;11</td>
<td>46</td>
<td>1.522</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>54</td>
<td>3.093</td>
<td>3.093</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>42</td>
<td>3.429</td>
<td>3.429</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>58</td>
<td>3.845</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>34</td>
<td></td>
<td>4.559</td>
</tr>
<tr>
<td>Left</td>
<td>10&amp;11</td>
<td>46</td>
<td>2.022</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>54</td>
<td>2.426</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>42</td>
<td>2.548</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>58</td>
<td>2.897</td>
<td>2.897</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>34</td>
<td></td>
<td>4.235</td>
</tr>
</tbody>
</table>
CHAPTER FIVE

DISCUSSION

This study was designed to establish norms for the standardization phase of the Time Compressed Sentence Test (TCST). The experimental conditions involved testing various children utilizing the TCST.

40% Time Compression vs. 60% Time Compression.

When looking at the various components of 40% vs. 60% time compression, the analysis showed that there is a significant difference in subject performance between the two types of compression. This suggests, as in hypothesis 1, that there is a difference between types of compression. As a result, the Null hypothesis is rejected, and the Research hypothesis is accepted. This finding aids in supporting the TCST as an appropriate central auditory processing assessment to be included in the assessment battery.

Age by Age.

An analysis of the Time Compressed Sentence Test revealed again that as the age increases the mean number of errors declines. Thus suggesting, as in hypothesis 2, that there is a difference in the mean number of errors with an increase in age. As a result, the Null Hypothesis is rejected and the Research Hypothesis is accepted. This analysis suggests that different norms need to be provided for the different age groups when standardizing this test.

Age by Compression Interaction.

An analysis of the age by compression showed a significant difference in the mean number of errors as a function of Age X Compression, as hypothesized in
hypothesis 3. Therefore, the Null hypothesis is rejected and the Research hypothesis is accepted. Simply stating that as the child matures the number of errors decrease as the amount of compression increases. The older children performed better than the youngest children with an increase of 0% to 40% to 60% time compression.

**Right Ear vs. Left Ear.**

The analysis used to determine the Ear main effect suggests, as in hypothesis 4, shows that there is a significant difference between ear performances. As a result, the Null hypothesis is rejected and the Research hypothesis is accepted. However this significance is slight, and suggests that the Left ear performed better than the Right. Results from this analysis can be found in Table 9.

This finding poses the thought as to which ear will perform better on the TCST, regardless of compression. The List Effect analysis was obtained after the fact due to not having the expected right ear advantage. However, due to the List effect, the question arises, did the right ear receive the harder of the two lists thus doing poorer than the left ear? Then, there is a list effect, with certain lists harder. It turns out that the right ear received the harder list more often than the left ear, and so the mean data shows that the left ear performed better than the right ear. Of the 117 subjects, 81 of them received list one (the harder of the two 40% time compressed lists), and 81 of them also received list 2 (the harder of the two 60% time compressed lists). Thus this is not anatomical phenomenon; it is a design problem.
Table 9: Results of the statistical analysis of the 112 normal hearing subjects. The List effect was statistically significant at $\alpha=0.05$ level.

The final analysis used to establish a relationship between ear performance and compression level suggests that there was not a significant difference in the performance of the Right and Left ears as a function of compression. This finding concludes that the ear performance does not change as the compression level changes.
CHAPTER SIX

CONCLUSIONS

Results obtained on this study, lead to the conclusion that the Time Compressed Sentence Test (TCST), as a test used to identify disorders of auditory timing, may be an appropriate and influential element to be included in a test battery to assess central auditory processing disorders; namely, temporal processing disorders.

The underlying assumptions for this study were the understandings that (1) the acoustic signals in a spoken language have a basis in time; (2) the learning of these temporally bound acoustic cues requires a listening system that can detect the acoustic signal in a certain amount of time; and (3) individuals whose auditory systems have varying degrees of temporal processing disorders will exhibit varying kinds of verbal disabilities.

The Time Compressed Sentence Test looked at these assumptions for temporal processing and defined two levels of compression that may be utilized to assess a deficit in temporal functioning.

Temporal processing disorders have a significant impact on a child’s social, as well as academic lifestyle. These impacts include but are not limited to, phonological processing deficits, problems of auditory discrimination, receptive language and reading. Given the results of this study, incorporating the Time Compressed Sentence Test into a central auditory processing test battery appears to be a necessary component in the process of diagnosing children with a temporal processing disorder. As with any diagnosis, the earlier the disorder is detected, the earlier the remediation can start, and individualized interventions for each child can begin.
Limitations of this Study.

(1). A paired samples t-test was conducted to determine if there was a difference between lists 1 and 3 (40% time compression), and if there is a difference between lists 2 and 4 (60% time compression). The paired T-test showed a significant difference in both comparisons. Results from this analysis can be found in Table 9. List 1 is slightly harder than list 3. Both of these lists are presented with 40% time compression thus they should be comparable. This finding in fact, may be due to an order effect. Also list 2 showed a significant decrease in performance in comparison to list 4. Both of these lists are presented at 60% time compression thus they should be comparable in the total amount of errors.

(2). The difference in performance for Right vs. Left Ear. The Left ear performed better than the Right ear regardless of compression level. This effect could be due to the fact that since there was a list effect, the right ear may have received the more difficult of the to subtests at both 40% and 60% time compression. This problem could have been solved by randomizing the presentation of the lists.

(3). Of the multiple sites that the data was obtained, there was not a multiple site test conducted to determine if in fact there was a site effect. Did a group of subjects come from a certain site where the test was administered differently? A site effect should be determined to aid in appropriate standardization of this test.
**Recommendations for Future Research.**

This study could be completed again in order to obtain a larger and possibly more representative sample size. Although I don’t feel that much would change the aforementioned data since a large number of normal subjects were tested. In addition, this study could be completed again incorporating construct validity data and contrasting the two groups.

Another pertinent recommendation would be to randomize the order of the test presentation to aid in the elimination of the order effect. Eliminating the order effect, would in fact aid in determining the true means of each subtest thus improving the standardization of the Time Compressed Sentence Test.
REFERENCES


Appendix A
TIME COMPRESSED SENTENCE TEST©
Score Sheet

Subject name: _______________________    Age: ______  Date of Test: ____________

The ten practice sentences are recorded with zero time compression.

Ten Practice Sentences:

1. The policeman / chased / the thief.
2. Some farmers / keep / cows.
3. The postman / brings / the letters.
4. The teacher / told / a story.
5. The Girl / bought / a new dress.
6. The boy / has / a ball.
7. He / went outside / to play.
8. The dogs / are running / fast.
10. This / is / our house.

List 1 is 40% time compression.

a. Mother made a cake.
b. The boys played football.
   1. Mother / cut / the bread.
   2. The boy / fell / in the water.
   3. The dog / caught / a rabbit.
   4. Father / drives / a car.
   5. Horses / eat / grass.
   6. The girl / helped / her mother.
   7. The stone / broke / the window.
   8. The children / saw / the picture.
   9. The girl / threw / the ball.
  10. The man / kicked / the football

List 2 is 60% time compression.

a. The dog played with a ball.
b. The boy took off his coat.
   1. The woman / washed / the floor.
   2. The cat / chased / a mouse.
   3. The baby / hurt / his finger.
   4. Mother / sent for / the doctor.
   5. The duck / swam / on the water.
   6. The man / caught / a fish.
   7. The girl / had / black hair.
   8. The leaves / fell / from the trees.
   9. The butcher / cut / the meat.
  10. The boy / threw / a stone.
<table>
<thead>
<tr>
<th>List 3 is 40% time compression.</th>
<th>List 4 is 60% time compression.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The boy sailed a boat.</td>
<td>a. The man bought new shoes.</td>
</tr>
<tr>
<td>b. The woman sat in the park.</td>
<td>b. The cat climbed the tree.</td>
</tr>
<tr>
<td>1. The teacher / shut / the door.</td>
<td>1. The boy / bought / some candy.</td>
</tr>
<tr>
<td>2. The driver / stopped / the car.</td>
<td>2. The woman / opened / the door.</td>
</tr>
<tr>
<td>3. Mother / swept / the floor.</td>
<td>3. Father / smokes / a pipe.</td>
</tr>
<tr>
<td>4. The boys / played / baseball.</td>
<td>4. The dog / sat on / a chair.</td>
</tr>
<tr>
<td>5. Baby / bumped / his head.</td>
<td>5. Mother / pushed / the stroller.</td>
</tr>
<tr>
<td>6. The boy / found / a penny.</td>
<td>6. The girls / read / their books.</td>
</tr>
<tr>
<td>7. The man / posted / a letter.</td>
<td>7. The policeman / stopped / the car.</td>
</tr>
<tr>
<td>8. The bunny / ate / a carrot.</td>
<td>8. The bird / flew / away.</td>
</tr>
<tr>
<td>10. Shoes / are made / of leather.</td>
<td>10. The baby / threw / the ball.</td>
</tr>
</tbody>
</table>
Results:

<table>
<thead>
<tr>
<th>Practice</th>
<th>Number correct</th>
<th>Number of deductions</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>List 1</td>
<td>Number correct</td>
<td>Number of deductions</td>
<td>Total %</td>
</tr>
<tr>
<td>List 2</td>
<td>Number correct</td>
<td>Number of deductions</td>
<td>Total %</td>
</tr>
<tr>
<td>List 3</td>
<td>Number correct</td>
<td>Number of deductions</td>
<td>Total %</td>
</tr>
<tr>
<td>List 4</td>
<td>Number correct</td>
<td>Number of deductions</td>
<td>Total %</td>
</tr>
</tbody>
</table>

* “Three points are scored for each sentence repeated correctly, and one point deducted for each section of the sentence (subject, verb, or object) misinterpreted or not heard. The score is then converted into a percent.”

Comments:______________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
## APPENDIX B

<table>
<thead>
<tr>
<th>State</th>
<th>Colorado</th>
<th>Florida</th>
<th>Kansas</th>
<th>Ohio</th>
<th>Pennsylvania</th>
<th>South Dakota</th>
<th>Indiana</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>47</td>
<td>33</td>
<td>14</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

This Table represents the number of subjects obtained from these states.
APPENDIX C

Burns, Edith       Preston, Robin
   Boulder, CO       Tampa, FL
Eichert, Susan     Whitelaw, Gail
   Cincinnati, OH    Columbus, OH

Feehan, Pam
   Rapid City, SD
Garamella, Tammy
   Lakeland, FL
Garfinkle, Roz
   York, PA
Heacock, Marta
   Westminster, CO
Jonas, Catherine
   Cincinnati, OH
Krishnan, Lata
   West Lafayette, IN
Matta, M Eliz
   Manhattan, KS
Novak, Robert
   West Lafayette, IN
APPENDIX D

**Time Compressed Sentence Test®
Standardization Study
Information on Participating Subjects**

Please provide the following confidential information that is necessary to categorize the children who will participate.

Child's Date of Birth (mm/dd/yy): ___/___/___   Age: ________

Boy _____ or Girl _____

Does the child speak and understand English?   Yes _____  No _____

Is a language other than English spoken in their home?   Yes _____  No _____

If yes, what language? ____________________

What is the child’s race/ethnicity: (Please check one)

African American: _____ Asian: _____ Hispanic: _____

Native American: _____ White: _____ Multiracial: (Please specify) ___________

Has the child been previously diagnosed (at school or by a medical doctor) with any of the following? (Please check all that apply):

_____ Central Auditory Processing Disorder

What central audition tests were administered in order to categorize the child as Central Auditory Processing Disorder? (List)

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

_____ Developmentally Delayed   _____ Learning Disability   _____ Dyslexia
_____ Speech and Language Disorder (specify)
   _____ Articulation  _____ Fluency  _____ Language  _____ Voice
   _____ Other
(specify)_______________________________________________________

Comment:_______________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

_________________________________