THE INTERNATIONAL JOURNAL OF LISTENING, *21*(2), 140–155


# The Effects of Auditory Stimulation on Auditory Processing Disorder: A Summary of the Findings

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The study's purpose is to determine the efficacy of the Tomatis Method of auditory stimulation as a therapeutic intervention for Auditory Processing Disorders (APD). Forty-one subjects (18 females, 23 males; 4.3–19.8 years old) were evaluated for APD. Performance on standardized tests indicated weaknesses with auditory processing skills. Each subject participated in a 90-hour Tomatis Method protocol and, once completed, each subject was re-evaluated to measure improvement. All subjects demonstrated improvement with skills of immediate auditory memory, auditory sequencing, interpretation of directions, auditory discrimination, and auditory cohesion. Pre- and post-treatment comparison indicated statistically significant differences in the aforementioned skills. These findings suggest that the Tomatis Method of auditory stimulation can be effective as an intervention strategy for APD.

## OVERVIEW

The Tomatis Method of auditory stimulation is a therapeutic intervention used to improve characteristics and behaviors in children and adults with disorders of communication, learning and autism, and autism spectrum disorders (ASD). This noninvasive intervention and treatment method has been evaluated and studied in several research projects in Europe, Africa, and Canada in the 1980s and 1990s. Surprisingly, there has been no single study examining the effects of the Tomatis Method on auditory processing disorders.

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Children and adults with auditory processing disorder (APD) are a heterogeneous group of people who have difficulty using auditory information to communicate and learn. APD is a set of problems that occurs in different listening tasks. It is a deficit in the processing of auditory input that can be exacerbated in unfavorable acoustic environments and is associated with difficulty listening, speech understanding, language development, and learning (Jerger & Musiek, 2000).

An auditory processing disorder is the inability or decreased ability to attend to, discriminate among or between, recognize, or understand auditory information. Most language is learned by listening (or processing). To learn, a child must be able to attend to, listen to, and separate important speech from all of the other noises at school and home. When auditory skills are weak, the child may experience auditory overload. This makes learning more challenging and sometimes too difficult without special assistance. Most people with auditory processing problems have normal intelligence and normal hearing sensitivity.

The purpose of this retrospective study is to determine if the Tomatis Method can be used as a clinical intervention in affecting changes in the auditory processing skills in children who have been identified as having APD. This study will demonstrate the effects of the Tomatis Method, which produces improvements in skills of auditory perception and discrimination, immediate auditory memory, interpretation and following directions, auditory sequential memory, auditory cohesion and auditory latency.

## STUDY PURPOSE AND METHODS

The primary goal of this study is to determine the efficacy of the Tomatis Method of auditory stimulation in treating the auditory processing skill weaknesses in children who have been identified as having APD. Specific deficits may include: auditory perception, auditory discrimination, auditory association, auditory vigilance, auditory memory, auditory analysis, auditory synthesis, auditory conceptualization, auditory endurance, auditory latency, and auditory cohesion.

Forty one subjects were studied for a pre- and post- test retrospective case review.

The subjects ranged in age from 4.3 to 19.8 years. All subjects were presented with symptoms and characteristics of APD. All subjects were not receiving other therapies during the time of participation in the Tomatis Method of auditory stimulation.

### Rationale

Auditory processing disorder is a complex and controversial issue. The diagnosis of APD is typically given by way of testing by audiologists and speech-language

pathologists. Treatment and therapy programs are typically provided by speech-language pathologists and would be characterized by a variety of strategies that are not standardized or necessarily proven to be effective. Many of the effects of therapeutic interventions rely heavily on parent and teacher reports as well as standardized testing.

The Tomatis Method is an auditory stimulation intervention that has been effective in reducing symptoms of APD. The Tomatis Method is a noninvasive therapeutic intervention that has been widely used in Europe and Canada since the 1940s. It was introduced to the United States in the late 1980s.

The Tomatis Method is a 90-hour protocol of auditory stimulation involving both active and passive listening. Its focus is developmental in nature, corresponding with what is believed to be the earliest experiences of sound to the human ear (during fetal development). Beginning with the Passive Phase, the child listens to filtered sounds of Mozart music and Gregorian Chants which are believed to be physically relaxing and stimulating, similar to the earliest experiences of sound, those of prenatal and early life (DeCaspaar et al., 1994). As the Tomatis protocol for listening progresses, the child is gradually introduced to the Active Phase that is designed to stimulate processing through first listening to recorded discourse and eventually through audio-vocal exercises. The progression of the Tomatis Method parallels processing, language development, acquisition, and mastery with regard to sound perception, discrimination, and attention.

Research projects studying the effects on auditory processing and learning have originated from Europe and Canada. Gilmore (1999) studied the efficacy of the Tomatis Method for children with learning and communication disorders. His findings reported that the Tomatis Method resulted in positive changes in the following domains: auditory processing, cognitive, linguistic, personal and social adjustment, and psychomotor. He further reported that his findings were consistent with clinician's reports of beneficial effects. Additionally, investigators have also demonstrated that the Tomatis Method has proven to be effective in the areas of communication, learning, and social pragmatics (Rourke & Russel, 1992; Kershner et al., 1986; Mould, 1984; Gilmore, 1985).

Given that alternative interventions are being pursued and implemented by parents and professionals, the use of the Tomatis Method has become increasingly more popular.

## Hypothesis

The Tomatis Method is based on the evidence that the neurophysiological construction of the auditory system has important connections with entire body as well as the cortex and subcortical structures, which are stimulated when stable and normal auditory perceptions occurs. It has been hypothesized that the human auditory system has specific functional capabilities that include: to transmit

energy, (a cortical change to the brain), to establish equilibrium, to perceive sound, to attend to and discriminate sound, to localize sound, and to integrate auditory information for the development of laterality and language development. Typically, children with auditory processing disorder, depending on the severity of the deficit, will have difficulty perceiving and discriminating sound, attending to sound, and localizing sound, as well as other auditory skills that comprise the hierarchy of auditory processing skills (Bellis, 1996; EAA, 1996; DeConde & Gillet, 1993). The Tomatis Method serves as an auditory stimulation/re-education intervention to stimulate listening and processing as opposed to hearing. It reproduces the developmental steps of listening, language acquisition and use, and learning.

Finally, the Tomatis Method hypothesizes that auditory stimulation, particularly with high frequency sounds, is an important source of stimulation to the brain's ability to receive and process sound. Scientists have demonstrated that 80% of the 24,000 hair cells in the cochlea respond to sounds of 3000 Hz and above. The Tomatis Method offers stimulation up to 10,000 Hz.

## Study Method

**Subjects**: The pre-treatment and post-treatment testing results of 41 subjects between the ages of 4.3 and 19.8 were review for purposes of determining the effects of the Tomatis Method on auditory processing skill weaknesses. All children received 90 hours of auditory stimulation with the Tomatis Method and were not receiving any other therapy at the time (e.g., speech-language therapy, occupational therapy, tutoring, etc.).

1. **Assessment:** Each child received a complete battery of standardized measures prior to beginning the Tomatis Method protocol. Testing consisted of administration of the following batteries: Wide Range Achievement Test (WRAT), Lindamood Auditory Conceptualization Test (LACT), Phonemic Awareness Test, Token Test for Children, and Test of Auditory Perceptual Skills.
2. **Treatment procedures:** Each child underwent a traditional Tomatis Method Protocol, consisting of 90 hours of auditory stimulation. The protocol is divided into four blocks of time. The auditory stimulation is administered by passing high quality, specifically prepared auditory stimulation through equipment designed to modulate the acoustic signal. The acoustic signal modulation equipment attenuates low frequency sounds and amplifies higher frequencies that fall within the language area allowing the child to gradually focus listening on the language frequencies. During all blocks of the listening protocol the child listen

through headphones with an attached bone conduction oscillator, permitting the sounds to be perceived through bone conduction as well as the usual air conduction. The following describes the different blocks of listening:

**Block I:** The Passive Phase
Fifteen days of passive listening for two hours a day. The auditory stimulation consisted of nonfiltered sound (music) with gating up to 8000 Hz.
**Block II:** The Active Phase
Ten days of active listening for two hours a day. The child begins to tone, sing, read, and/or repeat words and phrases into a microphone. They listen to modulated voices. This phase ends with reading aloud thus completing the model of language acquisition and expression. Auditory stimuli is filtered up to 9000 Hz is used during this phase.
**Block III:** Stabilization Phase
Ten days of mixed active and passive listening for two hours daily. Children participate in both passive work as well as microphone work.
**Block IV:** Maintenance Phase
Ten days of mixed active and passive listening for two hours daily. Various levels of filtering are used from 2000 Hz to 9000 Hz.
**Breaks between blocks:**
Each child took a three-week break between each block.

## Post-Treatment Testing

Eight to twelve weeks following treatment, each child underwent the same testing battery that was administered prior to their participation in the Tomatis Method.

**Summary of Findings:**

## Auditory Discrimination

Auditory discrimination is the process used to discriminate among sounds of different frequency, duration or intensity (e.g., high/low, long/short, loud/soft). It is the ability to automatically notice, think about or manipulate the sounds in language (Torgesen, 1997). It refers generally to the awareness of words, syllables, or phonemes. A problem with auditory discrimination can affect following directions, listening understanding, reading, spelling, and writing skills. It can result in poor auditory memory and auditory fatigue. Figure 1 demonstrates improvement with auditory discrimination skills as a result of auditory stimulation using the Tomatis Method.

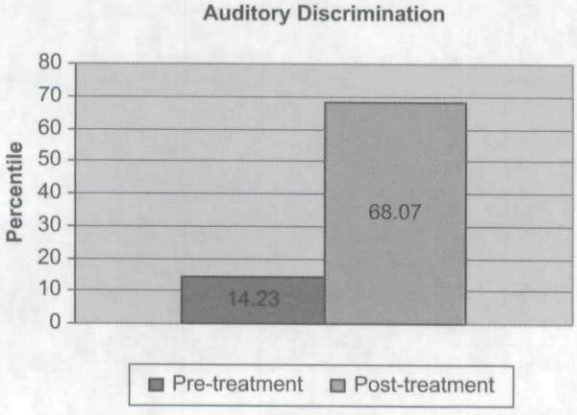


FIGURE 1 Improvement with Auditory Discrimination Skills.

These results indicate that prior to treatment overall auditory discrimination skills of the 41 children were placed at the 14.33 percentile. Following treatment, auditory discrimination skills improved to the 68.07 percentile reflecting an average improvement of 53.74%.

## Immediate Auditory Memory

Immediate auditory memory refers to the recall of the acoustic signal after it has been labeled, stored and recalled. This skill also requires that one be able to remember and recall various acoustic stimuli of different length and/or number. Auditory sequential memory is the ability to recall the order of a series of details. Figures 2 and 3 demonstrate improvement with auditory memory skills for digits forward, reversed, sentences, and words as a result of auditory stimulation using the Tomatis Method.

These results indicated that prior to treatment overall immediate memory skills for digits forward of the 41 children were placed at the 9.68 percentile. Following the treatment these skills improved to the 46$^{th}$ percentile reflecting an average improvement of 36.32%.

These results indicate that prior to treatment overall immediate memory skills for digits reversed of the 41 children were placed at the 19.10 percentile. Following the treatment these skills improved to the 37.37 percentile reflecting an average improvement of 18.27%.

The results in Figure 4 indicate that prior to treatment, overall immediate memory skills for auditory sequencing of the 41 children were placed at the 16.44

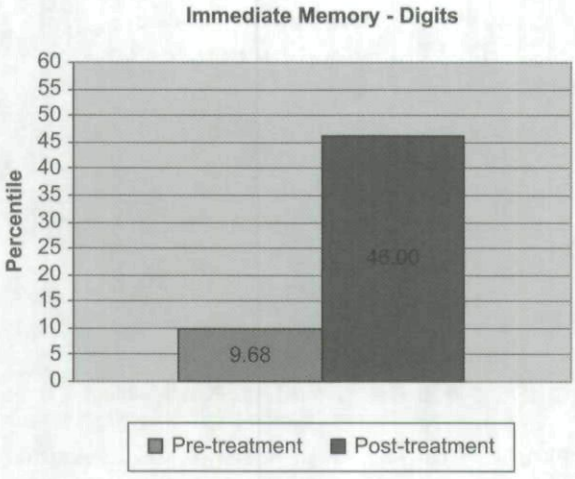


FIGURE 2 Immediate Memory-Digits.

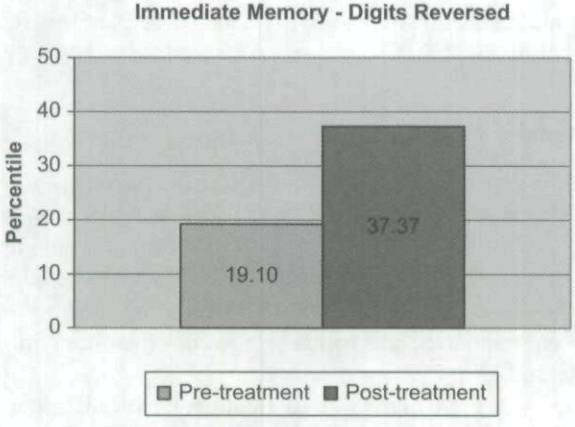


FIGURE 3 Immediate Memory-Digits Reversed.

percentile. Following treatment, these skills improved to the 53.41 percentile reflecting an average of 36.97%.

The results in Figure 5 indicate that prior to the treatment overall immediate memory skills for words of the 41 children were placed at the 12.20 percentile. Following the treatment, these skills improved to the 48.49 percentile reflecting an average improvement of 36.29%.

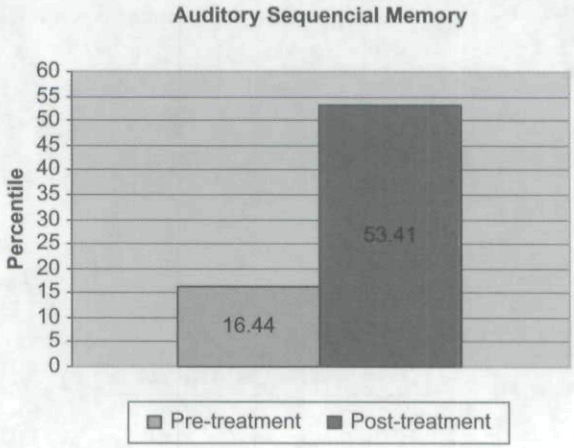


FIGURE 4 Auditory Sequential Memory.

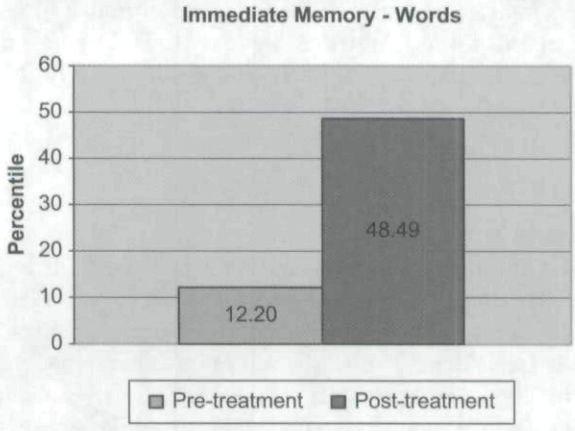


FIGURE 5 Immediate Memory-Words.

## Interpretation and Following Directions

These skills are inherently dependent upon skills of auditory discrimination, auditory association, and other auditory skills. Directions were presented according to the progression of the difficulty of the directions by chronological age and grade. These skills, while heavily loaded with auditory memory and sequencing, focus on one's ability to comprehend, understand, and interpret meaningful auditory information well enough to follow directions. Figure 6 demonstrates the

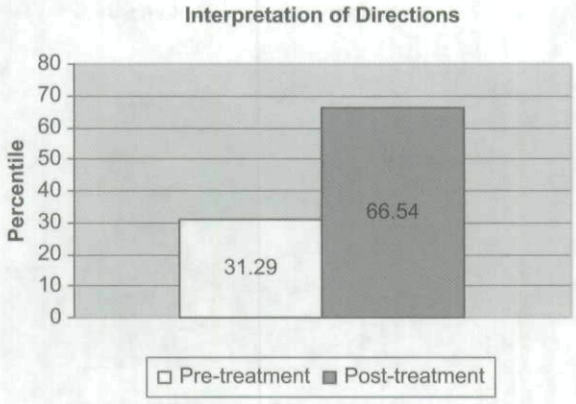


FIGURE 6 Interpretation of Directions.

improvement of the children to interpret and follow directions as a result of the Tomatis Method of auditory stimulation.

These results indicate that prior to the treatment overall ability of the 41 children to interpret and follow directions was at the 31.29 percentile. Following treatment, these skills improved to the 66.54 percentile reflecting an average improvement of 35.25%.

## Auditory Cohesion

Auditory cohesion is the ability to interpret, organize, and synthesize auditory information on a higher-order level of functioning. These skills are necessary for listening comprehension, organization, semantic and linguistic organization, understanding ambiguous information, and abstract reasoning and problem solving.

These results (see Figure 7) indicate that prior to the treatment overall auditory cohesion ability of the 41 children was placed at 23.15 percentile. Following the treatment these skills improved to the 56.63 percentile reflecting an improvement of 33.48%.

## Overall Auditory Processing

Figure 8 reflects the improvement of all auditory processing skills that include immediate auditory memory, auditory discrimination, interpretation, and following directions and auditory cohesion.

These results indicate that prior to the treatment, overall auditory processing skill ability of the 41 children was at the 8.41 percentile. Following the treatment these skills improved to the 58$^{th}$ percentile reflecting an improvement of 49.93%.

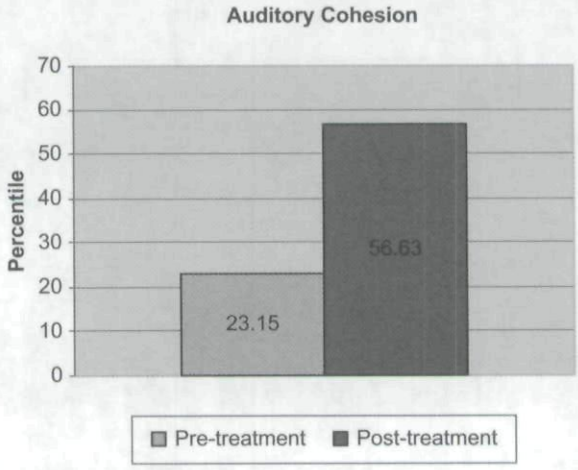


FIGURE 7 Auditory Cohesion.

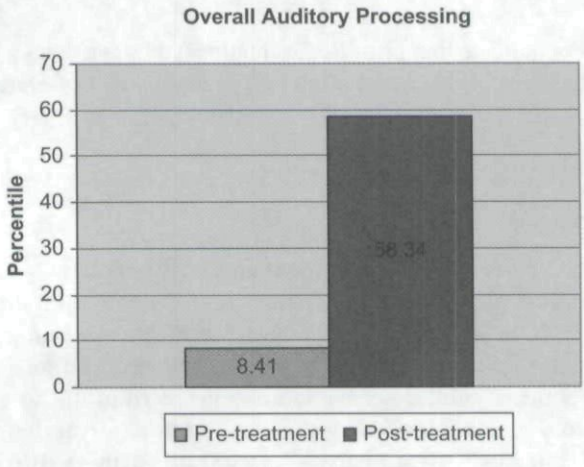


FIGURE 8 Overall Auditory Processing.

## Auditory Latency

Auditory latency refers to processing delays. This can be a lapse, hesitation, or frank delay in response time when presented with auditory stimuli requiring a response. Figure 9 reflects a reduction in auditory latency or processing delays as a result of auditory stimulation using the Tomatis Method.

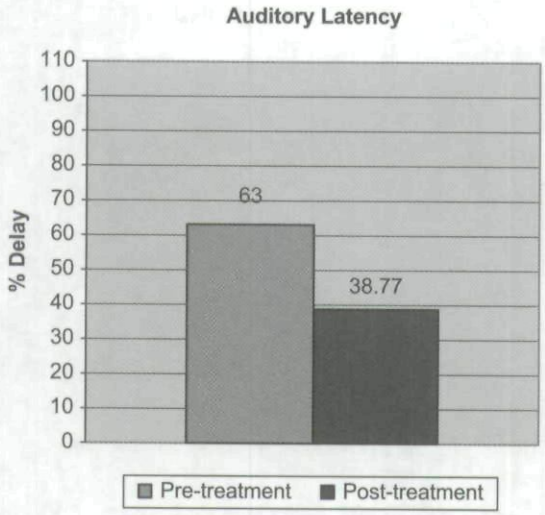


FIGURE 9 Reduction in Auditory Latency.

These results indicate that prior to the treatment average delays in processing were present 63% of the time. Following treatment delays were reduced by 24.23%.

## Statistical Analysis

A t-Test for comparison of pre-treatment and post-treatment was used on the results for the Test of Auditory Perceptual Skills (TAPS) and the Token Test for Children (TTC). Significant differences were shown when pre- and post-therapy results for both TAPS and TTC were compared. Before Tomatis intervention, TAPS mean subtest scaled scores ranged from 4.2 to 8.12, and the overall Auditory Quotient mean was 72.2. After intervention, the subtest scaled scores students' t-Test analysis showed all of these differences to be significant ($p < 0.00$). They ranged from 8.76 to 11.88, and the mean Auditory Quotient was 101.49. Similarly, TTC scores before Tomatis intervention showed marked differences, with pretreatment Age Scores of 485.68–494.82 and Grade Scores of 486.64–496.96, while posttreatment Age Scores ranged from 499.25–501.96 and Grade Scores ranged from 499.21–502.75. Students' t-Test showed all of those differences to be significant ($p < 0.00$ for most, and $p = 0.01$ and $p = 0.02$ for others). Descriptive statistics and t-Test comparisons are shown in Tables 1–4.

TABLE 1
Descriptive Statistics – TAPS

| | *Pre* | | *Post* | |
|---|---|---|---|---|
| *TAPS Subtest* | *Mean* | *SD* | *Mean* | *SD* |
| Number Memory F | 5.68 | 1.52 | 9.8 | 2.86 |
| Number Memory R | 7.46 | 2.46 | 8.76 | 1.77 |
| Sentence Memory | 6.59 | 1.96 | 10.37 | 3.05 |
| Word Memory | 6.15 | 1.49 | 9.83 | 2.48 |
| Following Directions | 8.12 | 2.12 | 11.76 | 3.14 |
| Word Discrimination | 4.2 | 4.28 | 11.88 | 3.04 |
| Auditory Processing | 7.22 | 2.52 | 10.83 | 3.3 |
| Overall Quotient | 72.2 | 11.5 | 101.49 | 14.88 |

TABLE 2
Descriptive Statistics – Token Test for Children

| | *Age* | | *SC* | | *Grade* | | *SC* | |
|---|---|---|---|---|---|---|---|---|
| | *Pre Mean* | *SD* | *Post Mean* | *SD* | *Pre Mean* | *SD* | *Post Mean* | *SD* |
| Part I | 494.82 | 11.82 | 500.46 | 2.13 | 496.96 | 11.07 | 502.75 | 2.56 |
| Part II | 492.43 | 9.33 | 501.96 | 1.5 | 492.07 | 10.53 | 502.32 | 3.08 |
| Part III | 486.75 | 11.02 | 499.25 | 5.62 | 486.93 | 8.64 | 499.21 | 4.93 |
| Part IV | 492.14 | 4.61 | 499.82 | 6.42 | 491.75 | 4.77 | 499.5 | 6.41 |
| Part V | 487.86 | 7.83 | 498.75 | 5.98 | 487.14 | 7.92 | 498.29 | 6.74 |
| Total | 485.68 | 7.63 | 499.57 | 4.98 | 485.64 | 7.18 | 499.5 | 4.74 |

TABLE 3
Paired t-Test Comparisons – TAPS

| | *Pre Mean* | *Post Mean* | *Diff. Mean* | *(Post-Pre) SD* | *t* | *P* |
|---|---|---|---|---|---|---|
| Number Memory F | 5.68 | 9.8 | 4.12 | 2.38 | 11.09 | .00 |
| Number Memory R | 7.46 | 8.76 | 1.29 | 2.58 | 3.21 | .00 |
| Sentence Memory | 6.59 | 10.37 | 3.78 | 2.73 | 8.85 | .00 |
| Word Memory | 6.15 | 9.83 | 3.689 | 2.57 | 9.16 | .00 |
| Following Directions | 8.12 | 11.76 | 3.63 | 2.91 | 7.99 | .00 |
| Word Discr. | 4.2 | 11.88 | 9.68 | 3.92 | 3.66 | .00 |
| Auditory Perception | 7.22 | 10.83 | 3.61 | 2.61 | 8.87 | .00 |
| Overall Quotient | **72.20** | **101.49** | **29.29** | **12.53** | **14.96** | **.00** |

TABLE 4
Paired t-Test Comparisons – Token Test for Children

| | *Pre Mean* | *Post Mean* | *Diff. Mean* | *(Post-Pre) SD* | *t* | *P* |
|---|---|---|---|---|---|---|
| Age SC. PART I | 494.82 | 500.46 | 11.54 | 5.64 | 2.59 | .02 |
| Part II | 492.43 | 501.96 | 9.54 | 9.31 | 5.42 | .00 |
| Part III | 486.75 | 499.25 | 12.5 | 12.47 | 5.3 | .00 |
| Part IV | 492.14 | 499.82 | 7.68 | 7.49 | 5.43 | .00 |
| Part V | 487.86 | 498.75 | 10.89 | 8.8 | 6.55 | .00 |
| Total | 485.68 | 499.57 | 13.89 | 6.92 | 10.62 | .00 |
| Grade SC Part I | 496.96 | 502.75 | 5.79 | 10.95 | 2.8 | .01 |
| Part II | 492.07 | 502.32 | 10.25 | 10.43 | 5.2 | .00 |
| Part III | 486.93 | 499.21 | 12.29 | 9.56 | 6.8 | .00 |
| Part IV | 491.75 | 499.5 | 7.75 | 7.14 | 5.74 | .00 |
| Part V | 487.14 | 498.29 | 11.14 | 9.92 | 5.94 | .00 |
| Total | 485.64 | 499.5 | 13.86 | 7.14 | 10.27 | .00 |

## DISCUSSION

Overall auditory processing skills improved following participation in a 90-hour Tomatis Method auditory stimulation protocol. Comparison of pre- and post-treatment evaluations indicates that skills of immediate auditory memory, auditory sequencing, interpretation and following directions, auditory discrimination, and auditory cohesion improved. Auditory processing skills are a hierarchy of skills that are basic to the listening, communication, and learning processes. Although sequential in development, these skills overlap and are essentially inseparable. Auditory processing skill weaknesses result in difficulty in the ability to use auditory information to listen, communicate, and learn.

The findings of this study indicate that measurable improvement was attained following the Tomatis Method. Skills of auditory discrimination demonstrated the area of greatest improvement, with the average improvement 53.74%. Auditory discrimination is the second skill on the auditory processing hierarchy of skills. Problems with auditory discrimination can affect all other skills on the auditory processing hierarchy. It is logical to suggest that as auditory discrimination skills improve, other skills will improve. Problems with auditory discrimination can affect auditory memory, auditory comprehension, auditory cohesion and result in processing delays. Analysis of the information obtained from this study indicates that as a result of improved auditory discrimination all other auditory processing skills improved.

Skills of immediate auditory memory as measured by digits forward and reversed sentences and single words demonstrated improvement following the

Tomatis Method. Auditory memory skills are affected by skills of auditory discrimination, auditory latency, and familiarity with the language that is being processed and auditory endurance. When referring to the auditory processing skills hierarchy (Bellis, 1996), immediate memory skill acquisition requires prior acquisition of auditory discrimination, localization, auditory figure-ground, auditory association, and auditory closure.

The ability to interpret and follow directions demonstrated improvement following the Tomatis Method of auditory stimulation. As with other auditory skills, this skill requires prior acquisition of auditory discrimination, auditory association, auditory closure, and immediate auditory memory. For the most part, no auditory skill functions independently of the others. However, when examining the pre- and post-treatment assessment results, the findings strongly suggest that the ability to interpret and follow instructions is measurably improved.

Auditory cohesion skills demonstrated improvement. This higher order skill improvement is reflective of improvement of auditory skills that are further down on the auditory skills hierarchy.

The Tomatis Method of auditory stimulation is a controversial method of auditory skills training. This study seeks to provide an initial attempt to demonstrate the relationship between the Tomatis Method and improvement of auditory processing skills. The results of these findings suggest that the Tomatis Method can be an effective auditory stimulation intervention in improving auditory processing skills in some children. Certainly, more rigid clinical research studies are necessary. Until that occurs, clinicians and professionals would benefit from further study of this methodology and its application to auditory processing disorder and other behavior and/or communication disorders.

## NOTES

For additional information, the author refers readers to the following web sites: www.theswaincenter.com, www.thelisteningcenter.net, www.thelisteningclinic.com, and www.tomatis.com.

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