A Review of Research done on Tomatis Auditory Stimulation

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Abstract

A total of 35 studies were published on the impact of the Tomatis Method of auditory stimulation. The largest number of publications deals with treating learning disabilities, showing that a variety of learning disabilities are effectively treated by the Tomatis Method. Several small scale research projects on autism have been reported, showing that about 60% of the autistic children benefit from the Tomatis intervention. Several studies show that the Tomatis intervention accelerates the learning of foreign languages. One of these shows that the Tomatis intervention reduces the time to obtain a correct pronunciation by half. Two small scale study documents the positive impact of Tomatis Training on the voice. Other studies show that Tomatis Training facilitates child birth and reduces the time of labor. Other studies show positive effects on stuttering, retardation and on a range of psychological disorders.

Introduction

This paper reviews the research done on the impact of the Tomatis Method of auditory stimulation. For an in-depth overview of the Tomatis Method, please see Pierre Sollier's: *"Listening for Wellness"* (Sollier, 2005).

The Tomatis Method of auditory stimulation utilizes music that has been electronically modulated by a device of Tomatis' design, called the Electronic Ear. The resulting sound is presented through headphones and vibrators. It has to be emphasized that the Tomatis Electronic Ear has evolved over the years. In the early 70's bone conduction was introduced to more effectively stimulate the auditory pathways. Later-on, the extended precession was introduced. In the late 90's, new gating systems were introduced allowing to change both the slope and the pivot point of the gating system. All these improvements helped to increase the success rate of the Tomatis Method.

The treatment modalities have also changed over the years, most notably using channel reversal when called for. Also, in the case of autism, the number of hours of listening to a recording of the mother's voice has increased significantly, improving the success rate to 80% (Vervoort, 2006).

The current theory is that Tomatis Method stimulates the myelination of the auditory pathways (Sacarin, 2009) which improves the speed of processing of the auditory signals (Kandel, 2000). In addition, the auditory stimulation results in a better integration between the different sensorial systems and in a more harmonious balance between the para- and sympathetic nerve system (Tomatis, 1983).

In many cases, the Tomatis treatment is accompanied by other forms of therapy. In the case of treating learning disabilities, sensory integration exercises have been shown to be useful adjuncts.

It has also to be emphasized that the results depend also on the skill of the Tomatis practitioner. The concept of "the machine does it all" is definitely not valid for the Tomatis Method. Careful observation of the client, adjusting the settings on the Electronic Ear accordingly and psychological counseling (of the client and if we are dealing with a child, also of the parents) are integral parts of the Tomatis Method.

As the patents covering the Electronic Ears have lapsed, several forms auditory stimulation are being marketed, many of which make reference to the research done on the Tomatis Method. While some of these Methods might or might not have beneficial effects, the research discussed below cannot be used to support their claims. To determine whether the auditory program meets the Tomatis criteria, please consider the following:

- Is the program administered by a trained Tomatis practitioner who has obtained at least 4 weeks of full time training?
- Is the progress monitored by administering regular Listening Tests, so as to adjust the program and the settings on the Electronic Ear?
- What is the duration of the therapy? For optimal results, the length of the program needs in most cases to be between 60 and 75 hours, much longer in case of autism.
- Does the program include reading texts into a microphone connected to the Electronic Ear, an essential part of the Tomatis protocol?
- Does the program include listening to a recording of the Mothers Voice (if available) via the Electronic Ear, again an essential part of the Tomatis Method.

This review covers research done in the following areas:

- Auditory Processing Disorders
- Learning disabilities and Behavior Problems
- Attention Deficit Disorders
- Autism
- Learning Foreign Languages
- Voice
- Child Birth
- Stuttering
- Psychological Disorders

Auditory Processing Disorders

The current hypothesis is that auditory Processing Disorders are the root cause of many learning and behavior problems. Tomatis Auditory Stimulation is believed to stimulate the myelination of the auditory pathways and so improve the speed of processing of the auditory signals (Sacarin, 2009). To check this theory, **Ross-Swain** (The Swain Center, Santa Rosa, California) reviewed the pre / post treatment testing results of 41 randomly selected clients that had Auditory Processing Problems (Ross-Swain, 2007).

The subjects (18 females, 23 males) ranged in age from 4.3 years to 19.8 years (mean age of 12.1). All subjects received 90 hours of Tomatis auditory stimulation, and were not receiving any other therapy at the time. The effect of the treatment was measured using the TAPS (Test of Auditory Perceptual Skills) and the TCC (Token Test for Children). The post study was done eight to twelve weeks following the treatment.

The TAPS measures a variety of auditory responses. "Auditory Discrimination" is the process used to discriminate among sounds of different frequencies, duration or intensity. A problem with auditory discrimination can affect reading, spelling and writing skills. "Auditory Memory" refers to the recall of an acoustic signal. A problem in this respect may affect memorization skills. "Auditory Processing" (also referred to as 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, abstract reasoning and problem solving. "Interpreting and Following Directions" is a skill that depends on the auditory skills discussed above. It is one's ability to comprehend, understand and interpret auditory information well enough to follow direction.

The TAPS results are given in Table 1. The last column shows the pre / post percentile ratings. Ratings between 37% and 68% denote an average performance. Scores falling below 37% is below average and scores above 68% are considered to be above average. Prior to the treatment, all subjects had below average scores. Upon completion of the Tomatis auditory stimulation, the scores were in the average range and thus, on average, the clients no longer had auditory processing problems. In addition, a significant reduction in auditory latency was also noted (63% to 39%).

TAPS subtests	**Pre / Post**
	%
Auditory Processing Overall	8.4 / 58.3
Auditory Discrimination	14.2 / 68.1
Auditory Memory, digits	9.7 / 46.0
Auditory Memory, digits reversed	19.1 / 37.4
Auditory Memory, words	12.2 / 48.5
Auditory Memory, sentences	16.4 / 53.4
Auditory Processing	23.2 / 56.6
Following Directions	31.3 / 66.5

Table 1: Ross-Swain study: Pre/Post Percentile Ratings

The Token Test of Children, which measures a child's ability to follow spoken directions, showed

significant increases in both Age and Grade Scores. The average Age Score increased from 486 to 500 and the average Grade Score from 486 to 499. This shows that Tomatis therapy helps children to better comprehend, remember and execute directions.

Learning (dis) abilities and Behavior Problems

The Tomatis Method has been found to be effective in the treatment of learning difficulties and behavior problems. A total of 10 studies were conducted. All except one showed positive effects of the Tomatis Method of auditory stimulation.

When analyzing the data, mainly percent changes in the pre/post scores are reported, so as to correct for differences in the pretest scores between the test and control group. The data which are significant at a 95% or higher confidence level are labeled with an "s".

Rourke *et al* (University of Windsor, Ontario, Canada) studied 25 learning disabled children from nine to fourteen years of age, following them over a period of one year (Rourke, 1982). Sixteen followed the Tomatis program and nine were assigned to the control group. The subjects were not randomly assigned but were balanced for initial IQ. Most of the subjects were enrolled in schools for children with learning disabilities or received supplementary special education or tutoring. The report did not mention the number of hours of auditory stimulation nor the length of the program.

All subjects were assessed on a battery of standardized test, some administered at 3 months intervals, others just at the beginning of the research and after 1 year. The test battery included the Wechsler Intelligence Scale for Children (WISC, Wechsler, 1949), the Personality Inventory for Children (PIC, Wirt, 1977, which assesses the opinion of the parents on the child's behavior attitudes and family relationships), the Wide Range Achievement Test (WRAT, Jastak & Jastak, 1965), the Verbal Fluency Test (Strong, undated), the Oral Reading Test (Gates & McKillop, 1962) and the Grooved Pegboard Test (GPT, Klove, 1963, a measure of speed and accuracy of hand-eye coordination).

Table 2 summarizes the key results, all of which were either directionally or significantly in favor of the Tomatis intervention (negative changes in the PIC and GPT scales denote improvements).

	Tom / Ctrl
N	16 / 9
WISC, Full Scale IQ	+5 / 0, s
WISC, Verbal IQ	+ 2 / -2
WISC, Performance IQ	+ 8 / +2, s
PIC, Adjustment Scale	-16 / -2, s
WRAT Reading Std. Score	+ 6 / +2, s
WRAT Arithmetic Std. Score	+2 / -3
Verbal Fluency	+27 / +11
Oral Reading	+35 / +21
GPT, Dominant Hand Score	-18 / -7, s

Table 2 : Rourke Study, % Change

There were no instances where the performance of the control group advanced at a significantly greater speed, or to a significantly higher level than the treatment group.

Wilson *et al* (North Shore University Hospital, Cornell University, N.Y.) studied 26 language-impaired preschool children over a period of nine months (Wilson, 1982). Eighteen received Tomatis auditory stimulation plus the Wilson remedial program and eight were assigned to the control group, which only received the Wilson program. Previous research had shown that the Wilson Program was effective in helping language impaired children. The report did not mention the number of hours of auditory stimulation nor the length of the program.

The test battery included the WIG, a test in which parents and teachers rate the subjects in terms of a wide spectrum of distinct behavioral parameters. This test was specifically designed for this study. In additions it included a non specified test measuring auditory closure and sound mimicry.

Table 3 summarizes the key results. They show that the children in the treatment group exceeded the performance of those in the control group, either significantly or directionally, in terms of communication, auditory closure and sound mimicry:

	Tom / Ctrl
N	18 / 8
WIG Communication Scores	
Parent's rating	22 / 12
Teacher's rating	34 / 27
Language Domain	
Sound Mimicry	86 / -9, s
Auditory Closure	38 / 3

Table 3 : Wilson Study, % Change

Based on observations of parents and teachers, the children in both groups significantly improved in communication skills. The difference between Tomatis and Control group approached statistical significance. Detailed analysis showed that the children treated with the Tomatis Program demonstrated significantly greater improvement in their ability to express thoughts and feelings.

Mould (Brickwall House, East Sussex, England) did two studies, both involving severely dyslexic boys (Mould, 1985). On average, their reading ages were between four and five years below their chronological ages. Written language skills (spelling) were even further behind. The boys lived in a publicly funded school in England, reducing the mitigating influences of home and social environment during the two-year evaluation period.

The first study started in the 1982 school year and involved 23 boys, aged 10 to 15 years. Twelve of them were withdrawn from class in order to receive 100 hours of Tomatis therapy over a period of 6 months. The control group of eleven subjects did not receive any treatment. The second study started in the 1983 school year and involved 24 boys. Half of them were withdrawn from class to receive 100 hours of Tomatis therapy. The control group did not receive any treatment. In this study the students were evaluated on additional parameters.

All subjects were evaluated every six months over a period of two years. However, for some of the measures in the second study, no data after 24 months were reported and thus were substituted for measurements after 18 months. The 24 month data are probably included in the final report (Gilmor & Mould, 1994), a report the author of this paper was unable to obtain. The test battery included the Neale Reading Test (which provides measures of reading rate, accuracy and comprehension), the Wide Range Achievement Test (WRAT), the British Picture Vocabulary Scale (BPVS), the Fluency Test and the Myklebust Pupil Rating Scale (which assesses overall learning disabilities).

Table 4 gives the % improvements in the various skill areas upon completion of the observation period. The results show that the subjects who received the Tomatis intervention had improved significantly more that the Control group. Significant differences were noted in terms of reading and spelling skills.

	Tomatis / Control	
	1982	1983
N	12 / 11	12 / 12
Neale Reading (accuracy)	27 / NA	21 / 11
Neale Reading (comprehension)	NA	19 / 7
WRAT Reading (raw scores)	60 / 16, s	43 / 22
WRAT Spelling (raw scores)	53 / 18, s	53 / 23
Receptive Vocabulary (BPVS)	NA	19 / 4, s
Verbal Fluency (raw scores)	NA	52 / 39, s
Pupil Rating Scale	23 / 0, s	NA

Table 4 : Brickwall Studies, % change

Of importance to note is that the data showed that the improvements continued to build even after the 6 months of Tomatis intervention had been completed. The continued build of the Tomatis therapy is also called the "Extended Tomatis Effect". An example of the build of the Tomatis Effect over time is given in Figure 1:

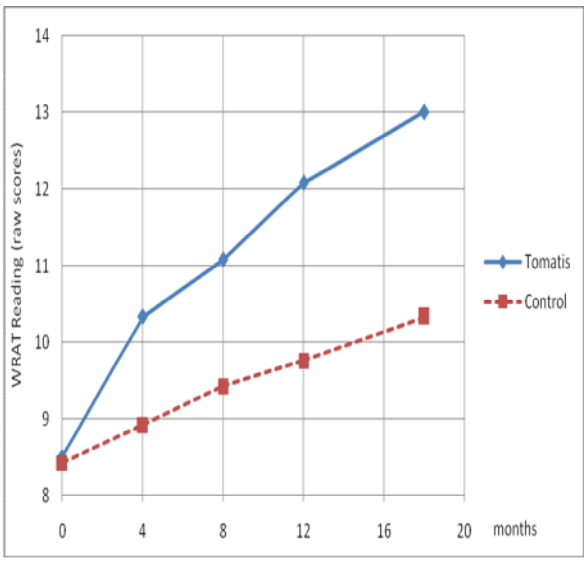

Fig. 1: Extended Tomatis Effect

Kershner *et al* (University of Toronto, Canada) followed the progress of 32 children with learning disabilities (Kershner, 1986/1). At the beginning of the test they were between the ages of 8 and 14 years. They attended a private school aimed at children with learning disabilities. The average class size was 8 students and the curriculum was based on the Orton-Gillingham approach.

Half of the children received Tomatis training; the other half received a Placebo intervention which used an audio-vocal feedback device which transmitted amplified but unfiltered auditory feedback through standard headphones. The Tomatis group received six hours of training per week on a withdrawal-from-class basis. They received in total 100 hours of Tomatis training. The Placebo group was withdrawn from class twice weekly, for 40 minutes per session. No explanation was given why the Placebo group was withdrawn from class less frequently. Although it was not explicitly stated, in all likelihood the intervention lasted for 6 months or less. A third group of 10 students was taken as a control group and only assessed on the standard school tests. However, as the standard deviations on these tests were extremely large (on average 72% of the measurement), this group was not taken into consideration in the analysis of the results.

The subjects were assessed prior to the research period and after one year. The progress of 26 out of the 32 subjects was continued for another year (Kershner, 1986/2). The test battery included the Wide Range Achievement Test (WRAT, Jastak & Jastak, 1978), the Test of Written Language (TOWL, Hamill & Larsen, 1983) and the Test of Verbal Fluency (Reitan, 1983).

The key results of the two studies are summarized in Table 5. Kershner *et al.* concluded that this study did not show a statistically significant advantage for the Tomatis Method. While the Tomatis group advanced significantly, so did the Control group. Of importance to note is that the measures are Standard Scores, and that thus the numbers have been corrected for age. Any positive number thus denotes that on average the subjects in this group have progressed faster than would have been expected by maturation alone, which is an achievement for children who had significant delays to start with.

	Tomatis / Control	
	Year 1	**Year 2**
N	16	13
WRAT Reading	+8 / +4	+2 / -1
WRAT Spelling	+3 / +1	+6 / 0
WRAT Arithmetic	+8 / +3	+7 / +8
TOWL Lang. Quo.	+5 / +1	+17 / + 8
Verbal Fluency	+14 / +6	+23 / +13

Table 5: Kershner study: % change in Standard Scores

While the improvements in language measurements may not have reached statistical significance, they still seem important to highlight. In all but one respect, the Tomatis group advanced more than the Control group, especially in terms of Verbal Fluency and TOWL Language Quotient. Also in year 2 the subjects in the Tomatis group reached the norm level in terms of Verbal Fluency, meaning that they were at par with children of their age group.

The lack of statistical significance could be due to several reasons. First of all, the groups lacked homogeneity, as evidenced the large standard deviations. The average standard deviation of the above measures was 14% of the observed variable. This means that the improvement has to be very large to become statistically significant. At a 95% confidence level, the improvement has to be 39%. This assumes zero impact of the Control, which is unlikely given the specialized nature of the school.

Secondly, it seems that the test design of this study was flawed in that the control group was reportedly "contaminated" by receiving three interventions which the test group did not receive (Gilmor, 1999). This would have unduly favored the control group.

Of interest to note is the evolution of the key measures over time. In figure x the average of the normalized standard scores of the five key measures is graphed in function of time. While the intervention took place during the first six months, its impact continued till the end of year 2. Not only were the improvements maintained but continued to grow beyond what would have been expected by maturation alone (Extended Tomatis Effect).

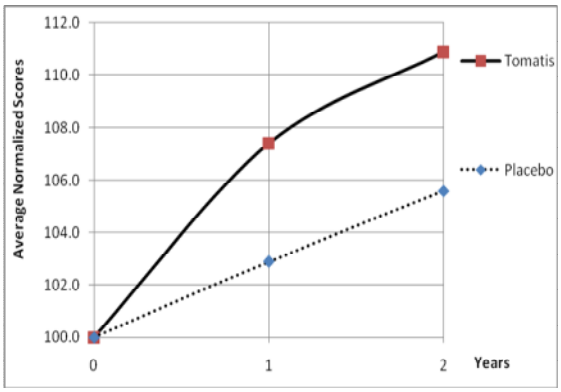

Fig. 2: Kershner Study, Average of the five key measures

Gilmor (The Listening Centre, Toronto, Canada) followed the progress of 57 children with learning difficulties, who came to his clinic for treatment (Gilmor, 1982). They were between six to fourteen years old. The length of the Tomatis therapy varied from four to six months. The study is based on pre/post readings and did not include a control group.

The children were assessed using standardized measures of aptitude, achievement and adjustment. The average time between the pre and post assessment was about one year. Not all children were assessed on all tests. The test battery included the Wechsler Intelligence Scale for Children – Revised (WISC-R), the Wide Range Achievement Test (WRAT), the Monroe Sherman Reading Diagnostic Test (Monroe), and the Personality Inventory for Children (PIC).

They results are given in Table 6. All differences are statistically significant at a 99% or higher confidence level.

	Post - Pre
WISC-R, Std. Score Units (N = 40)	
- Full Scale IQ	6.1
- Verbal IQ	4.0
- Perceptual-Organizational IQ	6.9
WRAT, Grade Score Units (N = 57)	
- Reading (Word Recognition)	0.88
- Writing (Spelling)	0.78
- Arithmetic	0.77
Monroe, Grade Score Units	
- Reading Comprehension (N = 25)	1.36
- Word Discrimination (N = 24)	0.89
PIC, T Score (N = 45)	
- General Adjustment, Comp. Index	6.0

Table 6: Gilmor Study (1982)

On average, the subjects improved by about 1 grade score over a one year period, which is the rate at which children without learning difficulties advance. As without treatment children with learning difficulties would have advanced at a lower rate, the Tomatis intervention seems to have had a positive impact.

In addition to the above standardized tests, the following tests were used on a trial basis: the Gales-McKillop Oral Reading Test, a Verbal Fluency Test, the Trail Making Test and the Purdue Pegboard Test. In all cases, statistically significant improvements were detected.

Reference was made to a similar study involving 102 children (Gilmor, 1984/1), but the author of this review paper did not have access to this report. That study was part of the Meta Analysis reported by Gilmor (see below).

Gilmor published a meta-analysis of the five studies mentioned above (Gilmor, 1999). It involved 225 learning-disabled children which had about 100 hours of auditory stimulation. Many of the previous studies had relatively small base sizes, and thus true effects may have been obscured by random variations. By performing a meta-analysis on the pooled results, a more reliable result could be obtained. The analysis showed that the Tomatis Method significantly improved skills in the following areas: Linguistic, Psychomotor, Personal and Social Adjustment, and Cognitive. The mean effect size ranged between 0.30 and 0.41, which means that a child performing at the 50% percentile prior to the treatment could be expected to perform at the 62nd to 65th percentile after the treatment (see table 7).

Domain	**Mean Effect Size (N = 225)**
Linguistic	0.41
Psycho Motor	0.32
Personal and Social Adjustment	0.31
Cognitive	0.30
Auditory	0.04

Table 7: The Gilmor meta-analysis

The low effect size for the auditory domain derives from the strong negative effect (-0.55) found in the Kershner study, contradicting positive effects found in other studies (Rourke: +0.47 and Wilson: +0.23.)

Roy and Neysmith-Roy (University of Ottawa, Canada) studied five dyslexic boys during a period of fourteen months (Roy, 1980 and Neysmith-Roy, 1980). Roy found that Tomatis training, even without remedial tutoring, improved the academic skills of the boys. However, in only one of the five boys the IQ increased significantly (as measured by the WISC-R Full Scale IQ). Neysmith-Roy found that four of the five boys showed positive changes in the cognitive control functioning and spontaneous speech, in line with their age / grade level and their intellectual potential (as measured by the Santostefano Cognitive Control Test).

Gilmor also reported the results of the Tomatis Listening Therapy on over 400 children and adolescents who came to his clinic for treatment (Gilmor, 1984/2). All of them had well-documented histories of learning problems, as well as a pattern of underachievement on psycho-educational tests. The results of the treatment were graded by the parents, 95% of whom were of the opinion that the program had helped their children. The parents saw improvements in the following areas (see table 8):

Skill or Ability	%
Communication	89
Attention Span	86
Frustration Level	80
Reading Comprehension	85
Quality of Speech	74
Memory	73
Spelling Aptitude	69
Maturity	84

Table 8: Gilmor 1984 Study: % of parents seeing improvements

In a follow-up six months after the program, 83% of those children in the study had maintained the improvements and/or had continued to make further gains. An additional 14% of the children had maintained some of the gains; 3% had maintained none of the improvements.

Spaggiari, a Tomatis practitioner in Reggio Emilia (Italy), evaluated the impact of Tomatis Training on 27 people with language, speech and learning difficulties (Spaggiari, 1995). The success rate of the intervention was rated on a 4 point scale (1 = no impact, 4 = very large impact). In 78% of the cases, the treatment was successful (as defined by a 3 or 4 rating). The failure rate (1 rating) was 0%, whereas the remaining 22% showed a moderate improvement.

Nicoloff (EARobic Center, Sydney, Australia) reported two case studies of children with Developmental Dyspraxia (Nicoloff, 2004). They received 94 and 155 hours of Tomatis Therapy, respectively. Both children improved significantly in the areas of speech, communication and motor skills.

Gilles (University of Ottawa, Canada) investigated the relationship between ear laterality and reading performance (Gilles, 1978). They studied ten dyslexic children under different conditions of auditory feedback. When feedback was mainly given to the right ear instead to both ears, children with reading problems read a little faster (34.7 versus 33 words per minute, or 5%). This finding may lend support to the notion that dyslexic children have problems in auditory lateralization.

Attention Deficit Disorders

Davis (The Davis Center, Rockaway, N.J.) evaluated the impact of 60 hours of Tomatis training on eleven ADD / ADHD children (Davis, 2005). All parents saw some level of improvement as a result of the Tomatis intervention (see table 9).

Ability or Behavior	%
Interpersonal Growth	82
Listening and Speech	91
Academic Achievement	91
Attention	100
Behavior	91
Intrapersonal Growth	82
Movement, Sports, Rhythm	64
Musical and Vocal skills	55
Relaxation	73
Creativity	64
Reading, Writing, Spelling	55
Well-Being	36

Table 9: Davis Study: % of children who according to the parents had improved

Autism

Autism is a complex, multi-faceted disorder for which so far no cure has been found. The Tomatis Method of auditory stimulation is not purported to be a cure either, but rather an intervention to help some children with autism to function better. Dr. Alfred Tomatis estimated that the Tomatis Method appreciably improves the quality of life for about

60% of autistic children (Neysmith-Roy, 2001). Of those who do benefit, about half respond rather quickly to the Tomatis Treatment, whereas the others improve more gradually. So far, no explanation has been found to why some autistic children do not respond to Tomatis auditory stimulation.

The benefits range from slight to very important and in some cases a complete recovery has been reported (Neysmith-Roy, 2001 and Ruben, 2004). Clinical evidence also shows that more intense use of the mother's voice and longer sessions (administered during the sleep) seem to improve the success rate to 80% in younger autistic children (Vervoort, 2006). The research on the impact of Tomatis Training on Autism is still in its infancy, and more research is needed.

Schiedeck (University of Salzburg) studied the impact of Tomatis therapy on Motor Skills, Visual Perception and Pronunciation (Schiedeck, 2000) on children and adolescents with mild autism The sample consisted of 20 subjects and all were verbal to varying degrees and had low IQ's (between 50 and 80). Half of the subjects received 46 hours of Tomatis Therapy while the other half did not receive any intervention. The test battery included the LOS KF 18, which assesses motor development (Eggert, 1974), two subtests of the FEW, which determines the visual perception ability (Frostig, 1987), and the DLBT, which assesses whether the sounds are pronounced correctly (Fried, 1997). The results are given in Table 10.

	Tomatis	**Control**
	Pre / Post	**Pre / Post**
Motor Skills	27 / 54	28 / 29
Visual Perception	34 / 58	39 / 40
Pronunciation	48 / 61	47 / 48

Table 10: Schiedeck study,
normalized data (max = 100)

The Motor Skills and Visual Improvements in the Tomatis group are statistically significant (95% confidence level). The improvement in Pronunciation / Sound Formation is not statistically significant. However, three of the ten subjects in the Tomatis group scored at or near 100% in the pretest and could thus as per definition not improve (ceiling effect). In the Control group, two subjects scored at or near 100% on the pretest. After correcting for the ceiling effect, the pre/post difference in the Tomatis group is significant ($p = 0.37$). The data corrected for the ceiling effect, calculated by the author of this review paper, are given below (see table 11).

	Tomatis (n = 7)	**Control** (n = 8)
	Pre / Post	**Pre / Post**
Pronunciation	26 / 44	33 / 34

Table 11: Schiedeck study,
corrected for ceiling effect

Of note is that while the subjects in the Tomatis group improved significantly, they were still performing significantly below the target performance (100%). That could have been expected as the Tomatis intervention was limited to only 46 hours, while 90 or more hours are recommended when treating subjects with autism.

Interestingly, the Schiedeck data show a strong correlation between the three measures used in this research. The correlation coefficients of the pre intervention measurements of the test and control group combined are given in table 12 (calculated by the author of this review paper).

	N = 20
Motor Skills / Pronunciation	0.76
Motor Skills / Visual Perception	0.84
Pronunciation / Visual Perception	0.91

Table 12: Schiedeck study,
Correlation Coefficients at T1

According to Tomatis, the ear, via the vestibules, controls every muscle in the body, including the eye and the larynx, and thus these high correlation coefficients were to be expected.

Neysmith-Roy (University of Regina, Canada) studied the impact of the Tomatis intervention on **s**ix severely autistic boys (Neysmith-Roy, 2001). They were assessed on the CARS scale (Child Autism Rating Scale) before and after the treatment. The CARS is composed of 15 subscales each measuring a specific behavior. For each of these scales the subject is rated on a continuum from one to four – one being normal behavior, two being mildly abnormal behavior, a three rating equals moderately abnormal behavior and a four rating corresponds to severely abnormal behavior.

A CARS score of 15 to 30 is typical of a non-autistic individual. A score of 31 to 36 is indicative of moderate autistic behavior, whereas a score of 37 to 60 indicates severely autistic behavior. A one full point change in one of the subscales is considered a notable change.

The subjects were also videotaped prior to and upon completion of the program; these were scored by two independent judges, who were blinded to the test conditions.

The length of the treatment and the number of block of Tomatis training varied, depending on the results seen. The results are given in Table 13. As shown, all subjects were severely autistic at the beginning of the program (CARS > 36).

	CARS
Subject	**Pre / Post**
A	44 / 26
B	48 / 49
C	47 / 34
D	44 / 35
E	47 / 47
F	53 / 47

Table 13: Neysmith-Roy Study

Three of the boys demonstrated positive behavior changes by the end of the treatment (subjects A, C and D). One boy (subject A) was no longer considered autistic by the end of the treatment (CARS score of 26). At the completion of the program, one might consider him "language delayed" but without the autistic behavior. He had received eight blocks of Tomatis treatment (180 hours) spread out over a period of 21 months.

Two boys (subjects C and D) showed only mild symptoms of autism by the end of the treatment. Subject C made "notable progress" on 7 of the 15 subscales, and subject D improved by one point or more on five subscales. Three boys remained within the severely autistic range.

Of particular interest were the changes that occurred in the pre-linguistic areas of five of the six boys. These included Adaptation to Change, Listening Response, Non verbal Communication, Emotional Response and Activity Level. The author suggests that the Tomatis method may be helpful in making pre-linguistic behaviors manageable and thus help prepare the child to learn basic skills necessary for the development of language and learning.

Vervoort *et a*l (The Mozart Brain Lab, Belgium) studied the impact of Tomatis Auditory Stimulation on the brain of severely autistic children. He reported improvements in EEG based Brain Maps and Auditory Evoked Potentials of four subjects with severe autism who successfully completed the Tomatis program (Vervoort, 2007).

Corbett *et al* (University of California, Davis) ran a double-blind, placebo controlled cross-over study evaluating the impact of 90 hours of Tomatis Training on eleven autistic boys. The Placebo mimicked the Tomatis intervention, except that the "music" was not modulated through the Electronic Ear. The Tomatis treatment did not include listening to a recording of the mother's voice, which is likely to have diminished the impact of the intervention.

The impact was assessed on a battery of tests including the EOWPVT (Expressive One-Word Picture Vocabulary Test, Brownell, 2000), the PPVT (Peabody Picture Vocabulary Test, Dunn & Dunn, 1997), the BASC (Behavior Assessment System for Children, Reynolds *et al*, 1999), the VABS (Vineland Adaptive Behavior Scales, Sparrow *et al*, 1984) and the Short Sensory Profile (Dunn, 1999).

The results were analyzed in two ways. In one publication the results were evaluated quantitatively (Corbett *et al*, 2007) and in another qualitatively (Gerritsen, 2009). The quantitative analysis did not show a statistically significant difference between the Placebo and Tomatis treatment. This is not surprising given that the Corbett study had significant shortcomings, invalidating the conclusions reached (Gerritsen, 2008). In neither the design nor in the analysis did the authors take into account that 40% of autistic children do not benefit from a standard Tomatis program of auditory stimulation. This reduced the effective sample size to only six subjects, too few to detect statistically significant differences. Also, the authors failed to recognize that a cross-over design is not the appropriate tool to study treatments that have a carry-over effect, making it all but impossible analyze the data quantitatively. In addition, the "Placebo" was contaminated by the Extended Tomatis Effect.

When evaluated qualitatively, looking at the results on a child by child basis, the analysis showed that six out of eleven autistic children benefited from the Tomatis Training. The results of the Placebo and the Responders are given in Table 14.

	Group 0 Placebo first, Tomatis second			**Group 1** Tomatis first, Control second (Includes Extended Tomatis Effect)			
Subject #	Placebo	6	8	3	5	10	12
PPVT	32/40	60/65	13/30	3/4	0/2	3/11	61/53
EOWPVT	25/29	32/54	6/6	12/20	0/0	1/9	46/48
VABS (raw scores)							
Communication	64/64	73/86	29/32	43/61	26/22	25/40	72/86
Daily Living Skills	65/56	25/88	24/46	35/57	33/29	33/49	75/76
Motor Skills	59/64	NA	57/60	42/62	43/41	51/56	NA
Socialization	59/55	43/71	34/40	32/62	27/21	43/53	76/77
BASC, Parents' rating, the normal range is 40 - 60							
Attention Problems	65/62	66/53	80/65	61/73	55/54	55/61	61/51
Atypicality	63/63	62/45	71/56	71/79	119/94	71/79	75/53
Hyperactivity	60/59	61/54	64/57	63/50	77/60	47/60	73/54
Withdrawal	65/65	63/63	74/76	70/59	75/74	78/57	60/54
Social Skills	32/29	35/42	16/20	28/33	11/15	32/43	32/33
Sensory Profile	120/117	112/167	94/97	139/154	111/122	135/126	125/150
Legend:		= significant at a 95% conf. level; NA = Not Applicable / Available					

Table 14: Corbett Study, pre / post scores among responders.

The first conclusion is that the Placebo treatment seems to have had little or no impact on the VABS and BASC scores. Hence, the improvements obtained upon completion of the Tomatis auditory stimulation are thus not a Placebo effect.

Secondly, as with any clinical treatment intervention, the benefits from the Tomatis Therapy varied from child to child. In this study, one subject went from being non-verbal to developing verbal skills (subject 10), another subject went from being non-verbal to being able to repeat words (subject 5), and others increased their vocabulary. Some subjects were reported to have fewer atypical behaviors, other subjects were observed to have diminished hyperactivity with improved ability to attend to structured tasks while yet other subjects demonstrated measurable improvement with Daily Living Skills. In other subjects, improved motor skills were observed and noted, which usually facilitates language development. Of note is that some of the children approached the BASC norm level (50), which indicates that they started to behave like “normal” children in this respect.

Thirdly, the tests used only reveal part of the impact of the intervention as the test battery focused on some specific areas. For example, subject 5, who was non-verbal at the start of the research, started to repeat words, something that the test battery failed to identify. Subjects 3 and 8 achieved toilet training, a characteristic also not measured by the test battery. According to the

parents and the research assistants, subjects 7 and 11, did in fact benefit from the auditory intervention.

Spaggiari, an Italian psychiatrist and Tomatis practitioner in Reggio Emilia (Italy), evaluated the impact of Tomatis Training on 13 autistic children (Spaggiari, 1995). The success rate of the intervention was rated on a 4 point scale (1 = no impact, 4 = very large impact). In 54 % of the cases, the treatment was successful (as defined by a 3 or 4 rating). The failure rate (1 rating) was 8 %, whereas the remaining 38 % showed some improvement.

Tatum (Optimal Health & Learning Center, Florida, USA) reported a case study of a 14 year old girl with autism and no speech, who became verbal upon receiving Tomatis Therapy combined with Speech Therapy (Tatum, 2004). She received a total of 125 hours of Tomatis Therapy plus 96 hours of Tomatis Therapy combined with Speech Therapy, spread out over a period of 1½ years. Upon completion of the intervention, the subject had functional use of 34 words and had made many social improvements. Prior to the Tomatis intervention, the subject had had speech therapy since she was 4 years without becoming verbal.

Nel (University of Potchefstroom, South Africa) reported a case study of a 14 year old boy with Asperger Syndrome (Nel, 2005). The impact of the 75 hours of Tomatis Therapy was measured using the Profile of Moods States (POMS) testing instrument (McNair, 2005). The data indicated improvements in Interpersonal Communication and Psychological Well-being.

Learning Foreign Languages

Each language uses a different set of frequencies. As our ears are used to the frequencies of our mother tongue, and are "deaf" to the frequencies of foreign languages, it is difficult to learn a new language. One of the objectives of the Tomatis Method is to open the ear to the full range of frequencies, thereby making it easier to acquire a new language. Once the Tomatis intervention has been completed, one will be able to correctly hear what is said in the new language. Also, as there is a cybernetic loop between the ear and the mouth, it will also be easier to pronounce the new language correctly.

The Kaunzner research, which focused on the pronunciation, concludes that Tomatis training reduces the time to obtain a correct pronunciation by half, as compared to a classical Language Laboratory setting (Kaunzner, 2001). Murase also reported that Tomatis training improved the pronunciation of Japanese high school children learning English (Murase, 2004). Eurocopter data shows that Tomatis Training reduces the time to reach fluency from 700 to 520 hours, a reduction of 26% (Eurocopter, 1995). One study was inconclusive because of the extremely small sample size and insufficient amount of Tomatis Training (Lemmer, 2001)

Kaunzner (University of Bologna, Italy) studied the impact of Tomatis training on 164 people studying German (De Jong, 2000 and Kaunzner, 2001). They were randomly assigned to three groups. The Tomatis Group received Sound Perception Training, a pronunciation course developed for the project, with the sound processed through a variation of a Tomatis Electronic Ear. The Control Group used the same didactical material, but in a classical language laboratory setting while the Zero Group did not get any specific pronunciation training, but merely proceeded with their regular courses in German.

With respect to the receptive and (re) productive abilities, the Tomatis Group outperformed both the Control and the Zero Group. Within the same time period they gained more than twice the ability as the Control and Zero Groups (see table 15).

	N	Increase
Tomatis	69	+ 0.432
Control	49	+ 0.141
Zero	17	+0.122

Table 15: Kaunzner Study: Increase in Ability Score

These results held regardless of the mother tongue of the participants (Italian, Spanish and Dutch).

Murase conducted a pilot study to evaluate the impact of Tomatis training on Japanese students learning English (Murase, 2004). Forty students received 45 hours of Tomatis training, spread over a period of 10 weeks, in addition to classical English Language Training. Native American teachers, evaluated three aspects of English speaking competence from sonograms, taken before and after the Tomatis intervention. On a 5

point scale, the Tomatis training significantly improved the combined fluency / pronunciation / intonation scale (see table 16).

	Pre	Post
Fluency	3.25	3.50
Pronunciation	2.98	3.57
Intonation	2.98	3.82
Average	3.08	3.80
Standard Deviation	0.78	0.57

Table 16: Murase Study: Ability ratings on a 5 point scale. N = 40

The Listening Test, administered prior to and upon completion of the Tomatis intervention, showed a significant increase in auditory acuity, especially in the 2,000 to 4,000 Hz frequency range.

The progress was also measured versus a control group (N = 120) who only followed the classical English Language Training. A standardized test which assessed the Vocabulary, Reading and Listening skills was administered two weeks after the start of the Tomatis intervention, and again 9 months later. The students in the Tomatis Group advanced from the 8th to the 5th rank. Those in the control group advanced from the 11th to the 10th rank.

Eurocopter (France) is one of the largest helicopter producers in the world. Since 1989, they have used the Tomatis Method to train its employee to learn foreign languages. Between 1989 and 1995, 580 people took the Tomatis Language Training, and their progress was carefully monitored (Eurocopter, 1995). In Eurocopter's experience, Tomatis Training reduced the time to become fluent from 700 hours to 520 hours, a reduction of 180 hours (26%).

Voice

Tomatis auditory stimulation improves the hearing, especially in the higher frequency range. As per the second law of Tomatis, the voice will thus become richer in the higher harmonics, which improves speech intelligibility and voice quality. In addition, by either shifting to or reinforcing right ear dominance, the voice is controlled more rapidly and with greater accuracy. As a result of the enhanced auditory feedback, Tomatis Training also improves the playing of musical instruments.

Tomatis dedicated an entire book on the connection of the Ear and the Voice (Tomatis, 2005), with many examples of famous actors and singers whose voices improved considerably upon Tomatis Training. Two small scale studies document the positive impact of Tomatis Training on the voice. A third study was inconclusive as due to technical reasons the voice recordings could not be analyzed (Du Plessis, 2001).

Weiss (University of Ottawa, Canada) studied the impact of Tomatis auditory training on the voice of three francophone theater students (Weiss, 1985). The subjects received 60 hours of Tomatis auditory training, with emphasis on the active phase, spread over a period of 7 months. The voice of the subjects was evaluated before and after the intervention. The evaluation tools included the LTAS (Long Term Linear Average Spectrum) which provides an objective measure of the voice quality (B&K Real Time Frequency Analyzer 2033). The second test used was the I.D.S , which measures the relative Spectral Density in different spectral frequency bands (Leipp, 1977).

The LTAS results show that in all three cases, the loudness increased significantly, by 20 to 40 dB. In addition, the intervention resulted in a shift from the fundamental region (500 Hz and below) towards the higher frequency bands. The LTAS of one of the subjects is shown in Figure 3.

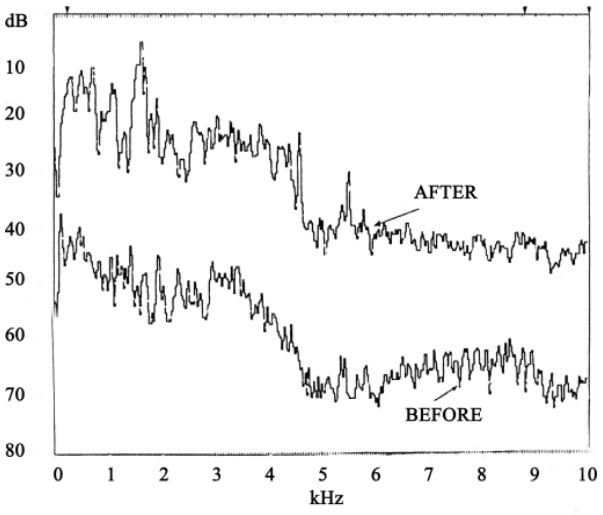

Fig. 3: Long Term Linear Average Spectrum, Before and After Tomatis Intervention

The I.D.S. data also show a shift in the relative energy from the fundamental region towards the frequency bands in which the higher harmonics are

situated. The relative Spectral Density data, calculated by the author of this review paper, based on Tables 1 and 2 of the original publication, are shown in Table 17:

	Female		Male
Hz / Subject	**H.D**	**H.S.**	**F.D**
50 - 400	33.8 / 27.8	32.7 / 27.5	45.5 / 43.0
400 - 800	21.6 / 23.8	28.5 / 26.7	21.4 / 24.2
800 - 1,800	20.7 / 26.2	20.9 / 25.5	16.7 / 18.9
> 1,800	23.9 / 22.2	17.9 / 20.3	16.4 / 13.9

Table 17: Weiss Study
Pre / Post Energy Levels (%)

The conclusion is that Tomatis Training increases the dynamic range of the voice, and shifts the relative energy towards the higher frequencies and thus improves speech intelligibility and voice quality.

Hesse (Mozarteum University in Salzburg) evaluated the quality of the singing voice of seven male music students, three of whom were studying to become professional singers. They received 40 hours of Tomatis therapy (Hesse, 2002). The results were evaluated by a battery of tests, including voice analysis, and the judgment of independent observers. The study concluded that the Tomatis intervention improved the vocal qualities of the participants. The most pronounced effects were those in timbre, sound complexity, tonality and vibrato.

Harmonics: Due to technical difficulties, the analysis of the number of harmonics present in the voice could only be performed on four test subjects. The tests showed that the intensity of the higher harmonics in the voice of two out of the four subjects had increased.
Intonation: Three of the subjects, who at the start of the research had large percentage deviations from the perfect octave in the lower range ([ba:]), significantly improved their performance. The other subjects had relatively lower percentage deviations to start with. The deviations of the perfect octave in the high range ([bi:]) were also relatively low to start with.
Vibrato: Six of the seven subjects experienced improvement in the quality of their vibrato in the lower ranges, while in the high ranges this occurred only for two subjects.

Of note is that the students received only 40 hours of Tomatis treatment, which is less than the recommended 70 hours. In addition, the intervention did not include the active phase, which is a key and critical step in any Tomatis program, in particular for singers.

Child Birth

Tomatis used to offer auditory stimulation free of charge to the parents of children who were being treated in his clinic. The purpose was to help them to relax and understand what their children were experiencing. Some of the mothers were pregnant at the time and reported that the auditory stimulation facilitated child birth. In hindsight this stands to reason as auditory stimulation reduces anxieties (see psychological disorders).

Klopfenstein, head of the Department of Gynecology of the General Hospital in Vesoul (France) conducted a study with 170 expectant women, chosen at random (Klopfenstein, 1988). Relative to the control group, the dilation time was reduced from 3 ½ hours to 2 hours and 22 minutes. The Hamilton test, a self-administered test measuring anxiety, showed a decrease in anxiety.

D'Orthy (Hospital Foch, Suresnes, near Paris) compared the time of labor of all babies born at the hospital during 1991 (D'Orthy, 1991). Fifty-three of them received a shortened version of the Tomatis program (twice weekly during the eight month of gestation) in addition to the traditional preparation technique. The control group (N = 683) received only the traditional preparation technique. Compared to the control group, the Tomatis intervention reduced the average labor time from 8 hours and 12 minutes to 7 hours and 19 minutes, a reduction of 53 minutes which is statistically significant. The percentage of women who gave birth to their babies in less than three hours was 17% in the Tomatis group and 6% in the control group.

The Hamilton test also showed a decrease in anxiety among the Tomatis mothers (from 5.7 to 4.0), whereas in the control group anxiety increase slightly (from 4.4 to 4.7). The APGAR test, rating the degree of adaptation of the baby to the new environment, showed that the Tomatis babies recovered better and faster. The Tomatis babies also weighed 4% more (3.410 versus 3.280 kg), since most Tomatis mothers gave birth after a

slightly longer gestation period than the control group (279.0 days versus 276.4 days).

Retardation

De Bruto at the University of Potchefstroom (South Africa) studied thirty inmates of the Witrand Care and Rehabilitation Center (De Bruto, 1983). They were aged 4 to 14 years and previously diagnosed as severely developmentally delayed, but with the ability to sit and walk. They were randomly assigned to three groups. One group received auditory stimulation (Tomatis) and a sensory motor stimulation program (Group A). The second group received music stimulation (without the Tomatis effect) plus the same sensory stimulation program (Group B) while the last group did not receive any treatment (Group C).

Psychological tests included the Bailey Scales of Infant Development. The results indicated that both experimental groups manifested an increase in mental age, but the increase in the Tomatis stimulation group (group A) was significantly higher than in group B. No change was found in the control group C.

Stuttering

Tomatis observed that stutterers showed a decreased acuity in the perception of the frequencies corresponding to the speech area (1,000 – 2,000 Hz). By improving the acuity to these frequencies, it seems that stuttering can be reduced. Tomatis also recognized the psychological component of the stuttering problem, making that auditory stimulation alone is unlikely to completely and permanently resolve the stuttering problem.

Two studies by **Van Jaarsveld** (University of Potchefstroom, South Africa) show that Tomatis training can reduce the severity of stuttering. For practical reasons, neither study contained a control group.

The first study tested the long-term impact of Tomatis training on 43 stutterers (Van Jaarsveld, 1973, 1974). According to people close to the test subjects, 82.5 % of the participants experienced significant symptom relief. Only 54% maintained their improvement for one year or more. Of note is that the program was cut short, and thus this study does not measure the full impact of Tomatis auditory stimulation.

The second study (Van Jaarsveld, 1976 and 1988) tested 30 young adult stutterers with a severe stuttering problem. The results are given in Table 18. All differences are statistically significant (99% confidence level). That test showed that the severity of the stuttering decreased.

	Pre	Post
Lanyon Stuttering Severity Scale	72	42
Johnson Disfluency Index: Reading	16	6
Johnson Disfluency Index: Speech	27	12
Rate of Reading (wpm)	99	118
Rate of Speaking (wpm)	88	111
Attitude Toward Stuttering	2.5	1.7

Table 18: Van Jaarsveld Study:
Impact of Tomatis on the severity of stuttering

Psychological Disorders

One of the characteristics of Tomatis auditory stimulation is that it opens the ear, especially to high frequency sounds. Such sounds have an energizing effect, giving people the energy they need to deal with the psychological problems they face.

Several studies show a positive impact of Tomatis auditory stimulation on anxiety disorders. Du Plessis and Van Jaarsveld reported reductions in anxiety as a result of Tomatis auditory stimulation. Spaggiari reported a success rate of 72% in treating anxieties, both psychosomatic anxieties as well as anxieties with panic attacks. The success rate on other psychological disorders is about 50%. One study with weight preoccupied students was inconclusive as the intervention was scaled back to only 20 hours of Tomatis Therapy (Du Plessis, 2004).

Peché (University of Potchefstroom, South Africa) ran a pilot study to determine the effect of Tomatis treatment on 10 anxious female students (Van Jaarsveld, 1988). The results were positive and lead to more in-depth research by Du Plessis.

Du Plessis (University of Potchefstroom, South Africa) studied the impact of Tomatis auditory stimulation on 20 anxious university students (Van Jaarsveld, 1988). Half of them received 30 hours

of Tomatis training and regular therapeutic interviews. The other half served as the control group. At retesting, the anxiety level of the Tomatis group had decreased significantly, with no change in the control group. In addition, the scores on the "Purpose in Life" test had increased significantly in the Tomatis group yet had decreased in the control group. Retesting after 14.3 months later showed that the Tomatis group had maintained its reduced level of anxiety, and that the level of self-actualization had increased significantly. No change was detected in the control group.

Du Plessis also studied 29 anxious primary school students (Du Plessis, 1988). They received either 52 hours of Tomatis auditory stimulation, a psychotherapy program or no treatment at all. The groups were carefully balanced with respect to anxiety level, personality, cognitive and family functioning, and listening aptitude. The test battery included two tests to assess anxiety: the CAS test (Children's Anxiety Scale, Gillis, 1980) and the STAIC test (State-Trait Anxiety Inventory for Children, Spielberger *et al*, 1973). The results are shown in Table 19. The shaded cells denoted statistically significant differences (95% confidence level).

	Pre / Post Anxiety Scores		
	Tomatis	**Psycho therapy**	**Control**
N	10	9	10
CAS	9.6 / 7.6	11.0 / 11.3	8.4 / 7.7
STAIC Trait	42.8 / 32.9	41.2 / 37.1	37.2 / 37.6
STAIC State	32.8 / 27.6	30.7 / 28.1	31.3 / 30.0

Table 19: Du Plessis (1988) Study. Differences in the shades cells are statistically significant.

On both tests, the Tomatis group showed significant reductions in anxiety. For the psycho-therapy group, the results were mixed. While no reduction in anxiety was measured on the CAS scale, one of the STAIC parameters did show a reduction in anxiety, although a smaller reduction than achieved in the Tomatis group. No change in anxiety was found in the control group.

Spaggiari, an Italian psychiatrist and Tomatis practitioner in Reggio Emilia (Italy), evaluated the impact of Tomatis Training on 409 people with psychological disorders (Spaggiari, 1995). The success rate of the intervention was rated on a 4 point scale (1 = no impact, 4 = very large impact). In 57% of the cases the treatment was deemed successful (3 or 4 rating). This has to be contrasted with a 78% success rate he obtained in treating learning difficulties. 10 % of the clients did not seem to benefit from the Tomatis Treatment.

The lowest success rate was with obsessive-compulsive disorders (2.2 overall rate and a failure rate of 29%). A similar score was found for Anorexia, but in this case the base size was very low. The highest success rate was scored in treating Anxiety Disorders (72%), where the success rate approached the level of success in treating learning difficulties (78%). Details are given in table 20 (calculations done by the reviewer).

Disorder	**Sa,mple Size**	**Ave Rating**	**Failure %**	**Success %**
Anorexia	7	2.4	29	43
Psychosomatic Anxieties	71	3	6	72
Anxieties with Panic Attacks	45	2.7	2	73
Obsessive Compulsive Behavior	31	2.2	29	42
Bipolar / Manic Depressions / Cyclotomia	97	2.6	5	58
Severe Depressions	30	2.6	7	53
Schizophrenia (with or without paranoia	68	2.4	16	47
Personality Disorders (paranoia, schizotype and borderline)	39	2.4	8	46
Neurological and Cerebral Disorders	21	2.5	10	52
Total	409	2.5	10	57

Table 20: Spaggiari , Success Rate of Tomatis Therapy on psychological disorders
Failure = 1 rating; Success = 3 or 4 rating

Botes (University of Potchefstroom, South Africa) studied in-depth three clients with neurotic depression (dysthymic disorder), showing positive effects of the Tomatis treatment (Van Jaarsveld, 1988).

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