

**A Newly Designed Computer-Based Auditory Training  
Program for Rehabilitation of  
Egyptian Children with Autism**

**THESIS**

Submitted for the partial fulfillment of The M.D. Degree in *Phoniatrics*

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**2013**

## ACKNOWLEDGEMENT

*First of all I'm always grateful to Allah, for helping me and giving me support to proceed and complete this work.*

*I would like to express my deep gratitude to **Prof. Dr. Hossam Mohamed El-Dessouky**, Professor of Phoniatrics and Head of Phoniatric Unit, Faculty of Medicine, Cairo University, for his kind supervision, encouragement and generous support throughout this work. I am indebted to his precious expertise throughout this work.*

*I'm deeply grateful to **Prof. Dr. Nagwa Abdel-Meguid Mohammad**, Professor of Human Genetics, National Research Center, who influenced me a lot. She gave me the idea of this work and supported me till I's able to complete it. I am grateful to her continuous encouragement, support, meticulous supervision, guidance and valuable advice for the fulfillment of this work.*

*My sincere thanks to **Prof. Dr. Dalia Mostafa Osman**, Professor of Phoniatrics, Faculty of Medicine, Cairo University, for her active and enthusiastic participation. She did not save any time or effort to help in accomplishing this study. I really appreciate her constant help and without her this work wouldn't have been done.*

*I would like to express my deepest thanks to **Dr. Martha S. Burns**, Ph.D. Speech and Language Pathology, Adjunct Associate Professor Northwestern University, for all her help, support and co-operation all through this work.*

*I'm really indebted to all the team of Autism clinic at National Research Center for all their help and cooperation for fulfillment of this work.*

*Finally I'd like to thank my lovely mother, the great person who has always supported, encouraged and helped me to finish this work.*

## **ABSTRACT**

Autism is a neurodevelopmental disorder characterized by severe impairment of socialization, communication and patterns of repetitive behaviors. Individuals with autism exhibit abnormal auditory processing that affects their ability to comprehend social cues and to learn language. There is evidence of the efficacy of directed auditory training for improving auditory processing in a population of children with autism by impacting biological processes. A computerized audiovisual-based training program (Let's Learn) focusing on enhancing auditory skills in Egyptian children with autism was designed, the program can be used in conjunction with traditional lines of therapy in order to help children with autism develop their language and communication skills in a functional manner. After the application of Let's Learn on 20 autistic children for 10 weeks together with the ordinary rehabilitation program for autism, the progress achieved with therapy was compared to another 20 autistic children who had received ordinary rehabilitation program only. This comparison showed significant improvement in: eye contact, attention, response latency and activity level which are essential prerequisites for improvement of joint attention and language acquisition in those children.

The application of Let's Learn for a sufficient duration is thus expected to have positive impact on language acquisition and development of communication skills in these children.

**Key Words:** Computer-based, Auditory Training, Rehabilitation, Autism

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## **LIST OF ABBREVIATIONS**

ASD: Autism Spectrum Disorders  
AD: Autistic Disorder  
ACC: Anterior Cingulate Cortex  
AMMT: Auditory Motor Mapping Treatment  
AIT: Auditory Integration Training  
ADIR: Autism Diagnostic Interview-Revised  
AC: Auditory Comprehension  
ABLLS: Assessment of Basic Language and Learning Skills  
BCKDK: Branched Chain Ketoacid Dehydrogenase Kinase  
BCKDH: Branched Chain Ketoacid Dehydrogenase  
BA: Broca's Area  
CNV: Copy Number Variation  
CI: Cochlear Implants  
DSM IV: Diagnostic and Statistical Manual of Mental Disorders IV  
DSM V: Diagnostic and Statistical Manual of Mental Disorders V  
EGR2: Early Growth Response 2  
EC: Expressive Communication  
FG: Fusiform Gyrus  
fMRI: Functional Magnetic Resonance Imaging  
F0: Fundamental Frequency  
FFW: Fast ForWord Language  
FFW-L: Fast ForWord Language  
GABA: Gamma-Amino Butyric Acid  
HFA: High-Functioning Autism  
HOXA1: Homeobox A1  
HTS: High-Throughput Screening  
IQ: Intelligence Quotient

IFG: Inferior Frontal Gyrus  
LFA: Low-Functioning Autism  
MET: Met Proto-OncogeneGene  
MBD5: Methyl-CpG Binding Domain Protein 5  
MNS: Mirror Neuron System  
MEG: Magnoenetcephalography  
NLGNs: Neuroligins  
NLGN4X: Neurologin 4,X-Linked  
NRXN1: Neurexin 1  
NRC: National Research Center  
PDD-NOS: Pervasive Developmental Disorder—Not Otherwise Specified  
PTEN: Phosphatase and Tensin Homolog Gene  
PTEN: Phosphatase and Tensin Homolog  
PECS: Picture Exchange Communication System  
PET: Positron Emission Tomography  
PLS-4: Preschool Language Test 4<sup>th</sup> Scale  
RELN: Reelin Gene  
ROIs: Regions Of Interest  
ROBO1: Roundabout, Axon Guidance Receptor, Homolog 1  
RCBF: Regional Cerebral Blood Flow  
STG: Superior Temporal Gyrus  
SH3: SHANK3  
SNP: Single Nucleotide Polymorphism  
SB-IV: Stanford-Binet Intelligence Scale, Fourth Edition  
STAR: Strategies for Teaching Based on Autism Research  
TPH2: Tryptophan Hydroxylase 2  
TSC1: Tuberous Sclerosis Protein 1  
TSC2: Tuberous Sclerosis 2  
TD: Typically-Developing

TOJ: Temporal Order Judgment

VEN: Von Economo Neurons

VB-MAPP: Verbal Behavior Milestones Assessment and Placement Program.

WNT2: Wingless-Type MMTV Integration Site Family Member 2

5HT: 5-Hydroxytryptamine

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## INTRODUCTION

Autism is one of the autism spectrum disorders (ASDs) (*American Psychiatric Association, 2000*). It is a complex neuro-developmental disorder, which has a symptomatic diagnosis in patients, characterized by disorders in language/communication, delayed onset of verbal and non-verbal communication, unusual patterns of restricted, repetitive behaviors, social interactions, imaginative and symbolic play, with an onset prior to the age of 3 years (*Rapin and Tuchman, 2008*).

Autism is characterized by social deficits, impaired communication, and restricted and repetitive behavior patterns (*Casanova et al., 2006*). Cognitive impairment is evident in some autistic children. The majority of them are in the moderate range of retardation, however, they show certain cognitive patterns. For example, visuospatial skills show superior results during psychometric evaluation, whereas verbal skills are severely disrupted (*Heaton, 2003*).

Autism is widely regarded as one of the most severe childhood behavioral disorders. The exact causes for autism are largely unknown, but it has been speculated that immune and inflammatory responses, may be involved (*Tager-Flusberg and Caronna, 2007*). Currently there are at least two major hypotheses regarding the causes of autism, either neurobiological genetic or behavioral. The neurobiological hypothesis attributes the cause of autism to a presumed but as yet unidentified neurobiological disorder (*Paul, 2008*).

Communication deficits are one of the core symptoms of Autism Spectrum Disorders (ASD). People with ASD can be slow to begin talking, or may not learn to talk at all; others may learn to produce words and sentences but have difficulty using them effectively to accomplish social interactive goals. Most parents of autistic children first begin to be concerned about their child's development because of early

delays or regressions in the development of speech (*Paul and Sutherland, 2005*).

Moreover, the impairment of receptive language and comprehension in autistic children is evident. They may obey simple orders if given in an immediate present context or with the aid of gestures. Receptive language seems to be more impaired than expressive language at the youngest developmental cognitive level. Then, the converse is applied in a more advanced cognitive and chronological level (*Volden et al., 2011*).

Furthermore, autistic children suffer from expressive language deficits. They seem unable to combine words into meaningful sentences. They have difficulty in producing and interpreting syntactic constructions such as questions, pronominal references, passive and past tenses. They manifest reversal of pronouns for a longer time than normal children (*Filipek, 2005*). Some of them have areas of special abilities such as numerical skills, music, art and visuospatial skills. They show good block design, picture arrangement and concrete discrimination. However, tasks requiring formal discrimination or verbal associated tests are areas of weaknesses. They show superior performance in detecting embedded figures and typical performance in global and configural processing. Some children with ASD have difficulties processing speech in background noise. Due to this effect, emerging evidence suggests that the neural encoding of speech sounds may be impaired in these children (*Groen et al., 2009*).

Some children with ASD exhibit auditory brainstem processing deficits specific to speech stimuli (*Russo et al., 2009*). Such as deficits in neural synchrony (timing) and phase locking (periodicity encoding; transcription of pitch contour), as well as degradation of the morphology of the responses in quiet and background noise, despite normal click-evoked brainstem responses. Reduced amplitude, delayed timing, and overall degraded morphology of cortical responses to speech syllables have also been reported in children with ASD relative to typically-developing children

*(Whitehouse and Bishop, 2008).*

The lack of successful therapy, genetic heterogeneity and increasing incidence making autism one of the most challenging neurodevelopmental disorders. There is efficacy of directed auditory training for improving auditory processing in language impairment and ASD, thus, the computer based auditory program may benefit some children with autism by impacting biological processes (*Russo et al., 2009*).

## **AIM OF THE WORK**

The aim of this work was to design and apply a computerized auditory-based training program focusing on enhancing auditory skills in Egyptian children with autism. The use of this program, in conjunction with traditional lines of therapy, can help children with autism develop their language and communication skills.

# CHAPTER ONE

## AUTISM

### AETIOLOGY OF AUTISM:

Autism spectrum disorders (ASDs) are a set of developmental disabilities diagnosed in childhood that have significant impact throughout the child and adolescent's development. Several characteristic behavioral symptoms may be manifest, including impaired social interaction, language and communication difficulties, and repetitive movements and stereotyped behaviors (*Rice, 2007*). There is consensus about the disorders that comprise this spectrum, with autistic disorder, Asperger's disorder, and pervasive developmental disorder—not otherwise specified (PDD-NOS) as the most typical examples (*Willemsen-Swinkels and Buitelaar, 2002*).

Classical 'autistic disorder' (AD) is frequently accompanied by mental retardation, as indicated by an intelligence quotient (IQ) of <70 (*Hoekstra et al., 2010*). By contrast, presence of the core ASD symptoms accompanied by an average (or above) IQ is typically classified as Asperger syndrome or high-functioning autism (*World Health Organization, 2007*). The term pervasive development disorder (PDD) is often used as a broader diagnostic descriptor, to encompass not only all ASDs, but also PDD-not-otherwise-specified (PDD-NOS or atypical autism), Rett disorder and childhood disintegrative disorder (*Santangelo and Tsatsanis, 2005*).

Autistic disorder is the most severe end of a group of neurodevelopmental disorders referred to as Autism Spectrum Disorders (ASDs), which share the common feature of dysfunctional reciprocal social interaction. Pervasive developmental disorder - not otherwise specified and autistic disorder are the most