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

THESIS

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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

CONTENTS

LIST OF ABBREVITONS

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 4thScale

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 heterogenecity 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