

## Can language acquisition be facilitated in cochlear implanted children? Comparison of cognitive and behavioral psychologists' viewpoints

Leila Monshizadeh, Roshanak Vameghi, Fariba Yadegari, Firoozeh Sajedi, Seyed Basir Hashemi

Leila Monshizadeh, Roshanak Vameghi, Firoozeh Sajedi, Pediatric Neurorehabilitation Research Center, University of Social Welfare and Rehabilitation Sciences, Tehran 1985713834, Iran

Fariba Yadegari, Department of Speech Therapy, University of Social Welfare and Rehabilitation Sciences, Tehran 1985713834, Iran

Seyed Basir Hashemi, Department of Otolaryngology, Shiraz University of Medical Sciences, Shiraz 7134814336, Iran

**Author contributions:** Monshizadeh L proposed the main concept and idea of the research, performed the research and wrote the paper; Vameghi R made critical contribution to the concept and design of the research and performed critical revision related to content of the manuscript; Yadegary F, Sajedi F and Hashemi SB contributed equally in the concept and design of the study.

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**Correspondence to:** Roshanak Vameghi, MD, Professor of Pediatrics, Pediatric Neurorehabilitation Research Center, University of Social Welfare and Rehabilitation Sciences, Velenjak Ave., Daneshjoo Blvd, Koodakyar St., Tehran 1985713834, Iran. [r\\_vameghi@yahoo.com](mailto:r_vameghi@yahoo.com)  
Telephone: +98-21-22180099

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### Abstract

#### AIM

To study how language acquisition can be facilitated for cochlear implanted children based on cognitive and behavioral psychology viewpoints?

#### METHODS

To accomplish this objective, literature related to behaviorist and cognitive psychology prospects about language acquisition were studied and some relevant books as well as Medline, Cochrane Library, Google scholar, ISI web of knowledge and Scopus databases were searched. Among 25 articles that were selected, only 11 met the inclusion criteria and were included in the study. Based on the inclusion criteria, review articles, expert opinion studies, non-experimental and experimental studies that clearly focused on behavioral and cognitive factors affecting language acquisition in children were selected. Finally, the selected articles were appraised according to guidelines of appraisal of medical studies.

#### RESULTS

Due to the importance of the cochlear implanted child's language performance, the comparison of behaviorist and cognitive psychology points of view in child language acquisition was done. Since each theoretical basis, has its own positive effects on language, and since the two are not in opposition to one another, it can

be said that a set of behavioral and cognitive factors might facilitate the process of language acquisition in children. Behavioral psychologists believe that repetition, as well as immediate reinforcement of child's language behavior help him easily acquire the language during a language intervention program, while cognitive psychologists emphasize on the relationship between information processing, memory improvement through repetitively using words along with "associated" pictures and objects, motor development and language acquisition.

## CONCLUSION

It is recommended to use a combined approach based on both theoretical frameworks while planning a language intervention program.

**Key words:** Language; Cochlear implantation; Behavior; Child; Cognition

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**Core tip:** Cognitive and behavioral theoretical frameworks are not in opposition to one another, at least when translated to practice. So, an intelligent practitioner in the field of speech therapy may make practical benefit of both theories simultaneously in a combined approach, by planning to promote the child's cognitive and motor development and his ability for information processing, accompanied by appropriate reinforcement for his correctly imitated or spontaneous responses. This of course needs experimental research for verification of enhanced effectiveness.

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## INTRODUCTION

Communication is an important way by which information and idea is transferred between people. Getting in touch with others through language is the well-known method of communication all over the world<sup>[1]</sup>. Although language is the best means of communication, it cannot be totally acquired in hearing impaired children. Hearing impaired children usually suffer from different kinds of language disorders which include disabilities in comprehension, speech processing and writing. They usually experience one or more of the phonological, syntactic, semantic and pragmatic types of disorders that cause them to be highly in need of systematic rehabilitation programs for language acquisition<sup>[2]</sup>.

Before cochlear implants innovation about 35 years

ago, children with profound hearing impairment could only rely on hearing aids for receiving the slightest degrees of auditory stimuli. However, nowadays cochlear implants have effectively replaced older means of speech and language acquisition in children who suffer from sensorineural hearing loss. Based on the evolution from use of hearing aids to cochlear implantation, it is also expectable to see significant changes in language treatment procedures of hearing impaired children. Also, these days' researches on cochlear implants are taking new path and direction. More and more research is focusing on pre-linguistically cochlear implanted children, that is, those who have noticeably gained benefit in language acquisition post-cochlear implantation<sup>[3]</sup>. Due to the importance of the cochlear implanted child's language performance, the authors have turned their efforts to respond to a rather basic question: How can language acquisition programs be facilitated and their effects maximized for cochlear implanted children. Different studies up to now have indicated that the cochlear implanted child's success in language acquisition is significantly related to certain factors including the age at which deafness occurred, length of hearing loss and the age at which the child underwent cochlear implantation<sup>[4,5]</sup>. However, if the above-mentioned demographic variables were kept controlled, would the outcome of cochlear implantation be influenced by any other variables? In other words, is there any other remaining factor affecting language acquisition and performance in this group of children? The authors speculate that language acquisition is highly correlated with some cognitive and behavioral factors which have been mostly ignored over the years, especially regarding hearing impaired children, and specifically in the case of those who have underwent cochlear implantation.

Evidently, hearing impaired children encounter significant delay and disorders of speech and language development<sup>[6,7]</sup>. Such children have much difficulty in communication and social adjustment. These problems will still be prevalent among hearing impaired children after cochlear implantation. It is now well-known that cochlear implantation with no language intervention following it cannot be much helpful to the acquisition of language by the child<sup>[8-10]</sup>.

There are different language treatment protocols all over the world, most of which have indicated the importance of timely language intervention for language disordered children or those at risk of it. However, they differ in terms of the theories, concepts and principles underpinning their intervention strategies. Each of these different treatment protocols may have proven effective for different target groups but to our knowledge, no study has proposed the best treatment strategy for hearing impaired children who have undergone cochlear implantation. With the growing number of these children and the usually limited period of golden time remaining for their language training, it seems quite necessary and urgent that we figure out the best strategies fitting

**Table 1** Levels of evidence in medical research

Level of evidence	Study design
Level I	Systematic review (with homogeneity) of RCTs RCT with statistically significant difference or narrow confidence intervals
Level II	Low quality RCT ( <i>e.g.</i> , < 80% follow-up) Cohort study or other Prospective comparative study
Level III	Systematic review of cohort studies Case-control study or other Retrospective comparative study
Level IV	Systematic review of case-control studies Case series
Level V	Poor quality case-control studies Expert opinion Narrative reviews

Adopted from URL: <http://www.cebm.net>. RCT: Randomized control trial.

their specific state of health.

As a small step towards this goal, in this article we plan to explain behavioral psychologists' and cognitive psychologists' theories and viewpoints, mainly based on expert-opinion type literature relevant to language acquisition and to compare and discuss them in order to find clues for facilitating language acquisition in cochlear implanted children.

## MATERIALS AND METHODS

In order to study literature related to behaviorist and cognitive psychology prospects about language acquisition, some relevant books as well as Medline, Cochrane Library, Google scholar, ISI web of knowledge and Scopus databases were searched. While screening titles and abstracts, the authors excluded any duplicates, case reports and articles written in languages other than English. Studies accessed only in abstract form were also excluded.

At first 25 articles were selected, but only 11 met the inclusion criteria and were included in the study. The inclusion criteria consisted of review articles, expert opinion studies, non-experimental and experimental studies that clearly focused on behavioral and cognitive factors affecting language acquisition in children.

After collecting relevant articles, they were appraised according to guidelines of appraisal of medical studies (Table 1)<sup>[11]</sup>.

## RESULTS

The 11 studies that met the inclusion criteria are described below in Table 2.

### **Behavioral psychologists' point of view regarding language acquisition**

A number of single subject studies which have specifically focused on the language responses of language impaired children have demonstrated diverse language behaviors in this group of children<sup>[12,20]</sup>.

Behavioral psychologists usually emphasize on a noticeable relationship between child's encouragement and language acquisition. They believe that as well as any other behavior, language acquisition might happen through operant conditioning. In addition, they suggest that immediate reinforcement of child's language behavior causes him to acquire the language as fast as he can. So, learning language has a positive relationship with visual and auditory reinforcements that the child receives when making improvements. Based on this theory, language acquisition is not dependent on complex mental development but the most critical variable in language acquisition is functional feedback<sup>[12]</sup>. Hence, teaching a new behavior with step by step reinforcements is the effective way of acquiring that behavior.

Also, in behavioral psychology, repetition and modeling a word or a verb are recommended to facilitate language acquisition. Therefore, the clinician is asked to model an appropriate response to help the child imitate it.

The behavioral theory is the basis of most conventional language treatment programs for various language disordered children, including those with hearing impairment who have undergone cochlear implantation<sup>[18]</sup>. Actually, the first step in auditory verbal training of cochlear implanted children is to help them be aware of the verbal and non-verbal sounds by conditional responses. The normal process in such programs is that first, every correctly imitated response is encouraged. After 4-5 times of encouragement, the reinforcements are reduced to once for every 2-3 correct responses in a fixed rate. Finally, the child cannot predict the exact time of receiving prizes because of the variant rate of reinforcements. By this method the number of child's correct responses will increase dramatically<sup>[8,18]</sup>.

### **Cognitive psychologist's point of view in language acquisition**

Cognitive psychologists emphasize that the complexity of language structures in a child indicates his level of cognitive development and *vice versa*<sup>[8,15]</sup>. Although it seems that young language learners acquire language simply by exposure to their mother's tongue in a natural trend<sup>[9]</sup>, the process is actually more complex than it appears. In fact, a young child's language acquisition is based on a series of perceptual and cognitive skills. Language in humans is acquired in unique ways that require information processing. As a result, early sensory deprivation, especially hearing loss will cause impairments in language acquisition that may last a life time<sup>[5]</sup>.

Information processing generally refers to a complex set of mental processes that include perception, cognition and thought. It is concerned with many functions that are themselves based on cognition, such as object recognition, perceptual learning, memory development, and language processing skills like speech perception and production. In fact, different aspects of information processing such as sensation, perception, memory, thought, language processing and problem-solving are

**Table 2 Study characteristics and outcomes**

Ref.	Yr	Study design	Evidence level	Sample	Result
Hegde <i>et al</i> <sup>[12]</sup>	1979	Case-control	III	Normal children Language disorder children	Behaviorist Language learning is limited to what is trained especially in language disordered children Reinstatement and generalization are very rare
Elger <i>et al</i> <sup>[13]</sup>	1997	Low quality RCT	II	Temporal lob impaired patients	Cognitive based There is a relationship between temporal lobe structures for memory and language acquisition
Kutas <i>et al</i> <sup>[14]</sup>	2000	Systematic review of case-control studies	III	Normal children	Cognitive based The organization of semantic memory has an effect on word processing
Pisoni <sup>[15]</sup>	2000	Expert opinion	V	Cochlear implanted children	Cognitive based Promotion of cognitive development, information processing and language acquisition are the most important results of early cochlear implantation
Bloom <sup>[8]</sup>	2000	Narrative review	V	Normal children	Cognitive based Acquiring language is the result of cognitive abilities that include the abilities to acquire concepts and understanding of the mental status of other people
Iverson <i>et al</i> <sup>[16]</sup>	2004	Low quality RCT	II	Normal children	Cognitive based There is an age related increase in frequency of vocal motor coordination in children A temporal pattern similar to that is seen in adult gestures and speech coordination
Clark <sup>[9]</sup>	2004	Narrative review	V	Normal children	Cognitive based Conceptual and linguistic representations for talking about experience provide the starting point for language from the age of 12 mo
Pulvermüller <sup>[17]</sup>	2005	Expert opinion	V	Normal children	Cognitive based Motor development prompts cognitive development The neuronal connection between systems for action and language perception is seen
Yu <i>et al</i> <sup>[18]</sup>	2007	Single subject studies	V	Normal children	Cognitive based and behaviorist Child's social cognitive capacities like joint attention, prosody and intention reading help him acquire the meaning of words. In other word, a combination of cognitive and behavioral development play important role in language development
Behrens <i>et al</i> <sup>[19]</sup>	2011	Systematic review of case-control studies	III	Normal children Language disorder children	Cognitive based and behaviorist There is a relationship between motor and language development
Hegde <i>et al</i> <sup>[20]</sup>	2013	Prospective study	II	Learning disabled children	Behaviorist Reinforcement, imitation and modeling facilitate language acquisition Reinstatement and generalization are very rare

RCT: Randomized control trial.

all part of a spectrum and are all related to cognitive processing and cannot be considered independently and separately<sup>[15]</sup>. Appreciation of one requires understanding and consideration of the others<sup>[21]</sup>. Also, the more complex aspects of information processing that appear at older age are hierarchically dependent on the more simple aspects that have occurred earlier<sup>[13,15,22]</sup>.

The information processing approach helps better understand the cognitive and language development in language impaired children<sup>[15]</sup>.

Based on the cognitive psychologists' point of view, one of the preconditions of language acquisition is memory and memory improvement. In fact, it is said that separation of the process that supports language perception from that which supports memory is im-

possible. When a word is produced, the meaning is derived from a life-long storage of knowledge, experience and memory in the brain. Evidence has shown that this storage of knowledge is organized in different dimensions and can be used flexibly<sup>[14]</sup>.

For young children to understand the meaning of a new word among the various word-referent pairs in their environment, it is commonly presumed that this needs the repeated accompanying of auditory stimuli in the form of a word with a simultaneous extra-linguistic stimulus such as seeing and experiencing an object or an action<sup>[18]</sup>. This mechanism of word learning is called "associationism" and usually starts with the most familiar objects and actions in a child's environment<sup>[5,8,9]</sup>. "Association" improves memory and helps the child keep



visual and auditory stimulations in his mind.

As with any other young language learner, perception and production of intelligible speech in a cochlear implanted child needs to have a structured system for symbolizing and coding sounds in the brain<sup>[9,21-23]</sup>. According to cognitive psychologists' point of view, this is actually what happens among cochlear implanted children during the process of language acquisition<sup>[18]</sup>. So, cognitive psychologists suggest that one of the best methods of language treatment in cochlear implanted children is to strengthen memory *via* repetitively using words along with "associated" pictures and objects<sup>[24]</sup>.

In addition, one other precondition for language acquisition that is often overlooked and thus requires additional attention is the child's motor development. The impact of this developmental domain on the child's language acquisition is an issue that requires further attention.

In human beings, movement and thought have always been correlated. Nowadays, research has shown that movement in human life occurs with other intentions than movement itself<sup>[19]</sup>. The main reason that causes the psychologists to believe in interrelationship between motor and language development is derived from the idea that infant's motor development encourages him to explore his surrounding as much as he can<sup>[16]</sup>. The children's locomotion ability enable them to achieve new experiences by investigation of the environment and object manipulation. These new experiences provide an opportunity to develop communication skills. According to these finding, psychologists and other scientists need to explore the link between motor development and language acquisition furthermore<sup>[17,19]</sup>.

Locomotion and object-manipulation are two important components of motor movement that facilitate language acquisition in children, especially those with language impairment. This finding has resulted from research on monkeys' brains which have shown connections between their motor cortex and that part of their cortex which is similar to the human language cortex. So, it can be assumed that faster information processing is the consequence of correlating language and action<sup>[17,19]</sup>.

## DISCUSSION

The review of literature regarding theoretical frameworks of behaviorists' and cognitive psychologists' prospects in language acquisition, indicates some key points which might facilitate language acquisition in language impaired children, especially those with hearing loss who have undergone cochlear implantation.

In behavioral methods of language training, expansion and generalization of the trained element is reached by repetition of the items that are being taught. Accordingly, a gradual increase of training trails will similarly cause enhancement of generalization. However, it should be noted that generalization occurs with different number of newly trained items in the case of a pronoun for example, than in the case of a verb. So, training in each modality is not influenced by training in

other modalities<sup>[20]</sup>.

Furthermore, according to behavioral theories the parents' response to a child by smiling, hugging or imitation of what they have heard when the child makes a sound or produces a word or a phrase, are the best means of communication and encouragement for language acquisition. Such environmental reinforcements are the basic of behavioral treatment protocols in language impaired children<sup>[12,20]</sup>.

On the other hand, according to cognitive theories there are a number of cognitive factors that are necessary to be taken into consideration, while planning a language training program<sup>[8,9,13-17,19]</sup>.

The two main cognitive principles of language acquisition are memory development and motor movement training. As a result, cognitive psychologists believe that it is necessary to focus on a child's cognitive improvement and his understanding of the association between words and meaning while planning a language intervention program. Also, including motor movement training in a language intervention program may facilitate language acquisition in a child by promoting investigation of his surroundings<sup>[16,17]</sup>. Since movement allows the child to find and focus attention on new objects of interest, he is more likely to learn new words associated with the new objects.

Given that the two theoretical frameworks are not in opposition to one another, at least when translated to practice, the authors speculate that a practitioner in the field of speech therapy can intelligently make benefit of both theories simultaneously and in a combined approach. For example, in order to help cochlear implanted children develop language, based on their cognitive as well as their behavioral development, it can be proposed that a combination of visual and auditory stimuli accompanied by memory exercises using pictures, objects and asking the child to repeat and imitate the words that are being heard, be utilized<sup>[13-15]</sup>. This of course should be followed by positive response and reinforcement from the therapist and the family. Also, making use of language exercises that somehow include actions related to different parts of the body in semantic terms, can be eventually added to the training process to facilitate the process of language acquisition through previously mentioned mechanisms activated by movement. Once the child's attention is directed towards a newly discovered object, the caregiver can then provide input. This input may be words referring to certain characteristics of the new object, along with positive reinforcements (e.g., "Yes dear, that's a cup!").

Finally, the authors suggest that this combined approach for children, especially those with hearing impairment who have undergone cochlear implantation, be put to trial by researchers and compared with training interventions based on each of the theoretical frameworks independently.

In conclusion, given that the two theoretical frameworks are not in opposition to one another, at least when translated to practice, the authors speculate that a practitioner in the field of speech therapy can

intelligently make benefit of both theories simultaneously and in a combined approach by planning to promote the child's cognitive and motor development and his ability for information processing, accompanied by appropriate reinforcement for his correctly imitated or spontaneous responses. This of course needs experimental research for verification of enhanced effectiveness.

## COMMENTS

### Background

Hearing impaired children usually suffer from one or more of the phonological, syntactic, semantic and pragmatic types of disorders that cause them to be highly in need of systematic rehabilitation programs for language acquisition. Although cochlear implantation is now considered to be one of the most effective interventions for children with sensori-neural deafness in terms of language acquisition, cochlear implantation with no language intervention following it cannot be much helpful to the acquisition of language by the child. There are different language treatment protocols all over the world. However, no study has proposed the best treatment strategy for hearing impaired children who have undergone cochlear implantation.

### Research frontiers

Due to the importance of the cochlear implanted child's language performance, one of the current research hotspots in the field of cochlear implantation, is to figure out the best strategies for language acquisition in this group of children.

### Innovations and breakthroughs

There are different language treatment protocols all over the world, most of which have indicated the importance of timely language intervention for language disordered children or those at risk of it. Each of these different treatment protocols may have proven effective for different target groups but to our knowledge, no study has proposed the best treatment strategy for hearing impaired children who have undergone cochlear implantation. According to this study, in a language intervention program for cochlear implanted children, the two theoretical frameworks can be used in a combined approach by planning to promote the child's cognitive and motor development and his ability for information processing, accompanied by appropriate reinforcement for his correctly imitated or spontaneous responses.

### Applications

Since the two theoretical frameworks are not in opposition to one another at least when translated to practice, the authors suggest that practitioners in the field of speech therapy intelligently make benefit of both theories simultaneously by planning to promote the child's cognitive and motor development and his ability for information processing, as well as by providing appropriate reinforcement for his correct responses.

### Terminology

A cochlear implant is an electronic device which functions similar to how the inner ear functions and is used to transfer sound signals to the brain in patients who suffer from hearing loss because of damaged inner ear. Rehabilitation is a word most commonly used to facilitate language acquisition following cochlear implantation.

### Peer-review

The authors are writing down a well written narrative review related to behaviorist and cognitive psychology prospects about language acquisition for cochlear-implanted children.

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