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Deafness & Education International

ISSN: 1464-3154 (Print) 1557-069X (Online) Journal homepage: http://www.tandfonline.com/loi/ydei20

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To cite this article: Ester Goldblat & Ofir Y. Pinto (2017): Academic outcomes of adolescents and young adults with hearing loss who received auditory-verbal therapy, Deafness & Education International, DOI: 10.1080/14643154.2017.1393604

To link to this article: http://dx.doi.org/10.1080/14643154.2017.1393604

Published online: 24 Oct 2017.

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DEAFNESS & EDUCATION INTERNATIONAL, 2017
https://doi.org/10.1080/14643154.2017.1393604

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Academic outcomes of adolescents and young adults with hearing loss who received auditory-verbal therapy

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ABSTRACT

Auditory-verbal therapy (AVT) is an instructional approach for children with hearing loss (HL) that emphasizes auditory learning. Studies relating to the effectiveness of AVT usually relate to speech and language outcomes of young children receiving AVT. Little is known about outcomes of these children later on, such as academic achievements. The purpose of the present study was to fill this void by examining academic achievements of AVT graduates (study group) in comparison to individuals with HL who did not receive AVT (control group). Parents of 52 adolescents and young adults participated in a telephone survey. Information was merged with administrative data of the National Insurance Institute of Israel. Results indicate positive correlations between receiving AVT and academic variables. Significant differences were found between the study and control groups in all grades. AVT had a positive contribution to Hebrew and literature grades. These results suggest that AVT graduates outperform adolescents and young people with HL who were not rehabilitated via this rehabilitative approach.

ARTICLE HISTORY
Received 16 May 2017
Accepted 4 October 2017

KEYWORDS
Auditory-verbal therapy; academic achievements; rehabilitation and intervention approaches

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Introduction

Hearing loss (HL) present at birth or occurring in childhood often represents a significant barrier to spoken language development (Eriks-Brophy *et al.* 2006). Thus, one of the main goals of rehabilitation programs for children with HL is the proper acquisition of oral language.

A variety of communication options and instructional approaches are available to children with HL (Jackson and Schatschneide 2014), ranging from auditory-verbal to manual-based approaches (Fitzpatrick *et al.* 2008). Auditory-verbal therapy (AVT) is an instructional approach for children with HL that emphasizes auditory learning. AVT focuses on teaching oral spoken language, emphasizing the development of spoken language through early identification of HL, optimal amplification, and intensive therapy in which parents are viewed as the primary language models for their children (Estabrooks 1994). In an AVT instructional approach, children are discouraged from relying on visual processing strategies and instead are encouraged to maximize their listening skills. Natural situations and environments are used for learning to listen and talk (Jackson and Schatschneide 2014).

Research reveals that AVT is effective for children with HL for developing speech and language in the early years of life. A number of studies demonstrated that children with HL receiving AVT had improved speech perception skills over time and that their rate of progress for speech and language skills was similar to that of children with typical hearing (Dornan *et al.* 2007, 2009a, Hogan *et al.* 2008, Sahli and Belgin 2011, Fulcher *et al.* 2014). In addition to speech and language acquisition, in a study assessing oral narrative comprehension abilities no statistically significant differences were found between children with and without HL. Four out of five children with HL in this study were enrolled in AVT (Zupan and Dempsey 2013).

AVT was found efficient for language development among school-aged children as well. In a study evaluating speech and language, speech perception in noise and reading among seven children aged 5–17 years with sensorineural HL, significant improvements were found in all domains after 20 sessions of AVT (Fairgray *et al.*, 2010).

Although research shows that AVT is effective for children with HL for developing speech and language, there is a debate in the literature whether AVT is a viable option for these children. Dornan *et al.* (2009b) argued that there were few rigorously controlled studies providing high levels of evidence for speech and language outcomes obtained by children with HL educated in AVT programs. In a systematic review (Brennan-Jones *et al.* 2014), aimed at assessing the effectiveness of AVT in developing receptive and expressive spoken language in children with HL, the authors revealed the lack of well controlled studies. Thus, there is no consensus as to the efficacy of AVT, especially in comparison to other rehabilitative

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approaches. To the best of our knowledge only one study attempted at comparing the relative impact of early intervention approaches on speech perception and language skills of children with HL, including AVT (Dettman *et al.* 2013). In this study, speech perception and vocabulary among children using cochlear implants from different intervention approaches were evaluated. The study represented data from children in AVT programs, auditory-oral (AO) programs, and bilingual-bicultural (BB) programs. All children had equivalent demographics. The results indicated superior scores of children from AVT programs in speech perception of words. Children from AVT programs and AO programs demonstrated equivalent scores on reception of sentences, superior to children from BB programs. Children from AVT programs had the highest scores on the vocabulary measure compared to the two other groups. Thus, these findings shed a light on the efficacy of AVT compared to other approaches for rehabilitation of children with HL.

Language abilities have been considered one of the main skills contributing to literacy development (Moeller *et al.* 2007, Lederberg *et al.*, 2013). Thus, research aims to explore the relationship between written language abilities and rehabilitation of children with HL. For example, Yasamsal *et al.* (2013) evaluated written skills of children with HL aged 6–11 years. All participants had at least one year of AVT. They were compared to 35 age-matched normal hearing children. Results revealed participants who were implanted with CI under the age of four had written abilities similar to their hearing peers' abilities.

Does AVT at the early years of life affect lives of these children as they mature? Outcomes of AVT in adolescents and young adults was examined in a study evaluating communication, academic and social skills among participants who received AVT at early childhood. Standardizes assessments of communication, reading, spelling, and mathematical competence, as well as self-perception, were administered. The results showed that participants with HL performed at average and above average on measures of communication, academic achievement and self-perception compared with hearing pears (Eriks-Brophy *et al.* 2012). It is important to note that participants in this study were not compared to young adults with HL who were enrolled in other rehabilitative approaches. Thus, the outcomes showed in this study may not be due solely to AVT. The question whether AVT has a life lasting effect is still puzzling.

The purpose of the present study was to examine the relationship between AVT and outcomes of adolescents and young adults rehabilitated through this approach. Specifically it examined whether academic outcomes of AVT graduates were different from that of adolescents and young adults with HL who were not enrolled in AVT during childhood. Two hypotheses were tested: 1) AVT graduates will have better grades compared with young adults with HL who didn't receive AVT. 2) AVT graduates will have a higher rate of entitlement to a matriculation certificate compared with young adults with HL who didn't receive AVT.

Method

Instrument

Telephone survey was performed to parents of adolescents and young adults with HL. Participants' characteristics and outcomes were assessed by a questionnaire developed for the purpose of the present study. Parents were asked to choose a proper answer to each question in the questionnaire from a closed set of answers, or answer short open questions.

The questionnaire contained multiple choice questions, relating to the following domains: HL characteristics (such as severity of HL, age at detection of HL, and use of HA/CI, i.e. 'What is the HL severity of your child? Moderate / severe / profound'), mode of communication (i.e. 'What is your mode of communication with your child? Total communication / oral language / sign language'), education (such as educational placement and grades, i.e. 'What is your child's grade in literature? A / B / C / D / F'), rehabilitation (i.e. 'Was your child enrolled in a rehabilitation day-care center? Yes / no'), and educational level of parents (i.e. 'What is the educational level of the mother in your family? Elementary / partial high-school / full high-school / vocational training, / bachelor, master or doctoral degree / high religious qualification / other'). A few questions were open questions, such as 'at what age was your child's HL detected?'. Additional administrative data of participants was derived from national records of The National Insurance Institute of Israel (NII), as will be detailed in the description of participants.

Participants

Potential participants were retrieved from the data base of the NII. All children in Israel with HL reaching the criterion for disabled child allowance (SRT of 45 dB or worst in the better ear for children under the age of three, and mean hearing threshold of 45 dB or worst in the better ear for children older than three) are eligible to a monthly universal allowance, independent of income ,which is around 620$. In addition, children can enter rehabilitation day-care settings only if they are eligible to disabled child allowance. Thus, due to the economic incentive for parents and to the allowance criteria, it is logical to assume that all children with a moderate HL or worst in Israel are known to the NII. This assumption is supported by another study conducted in Israel (Raz *et al.* 2015) confirming the completeness of NII database for

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Autism Spectrum Disorders (ASD) by demonstrating that 97% of children with ASD diagnosis in HMOs appeared in the NII database. The findings of this study can also be applied to the population of children with HL in Israel, meaning that most children with moderate HL or worst in Israel are known to the NII.

Administrative data was derived from records of the NII. Administrative data for each participant included gender, date of birth, residence, income of parents, severity of HL, and age at HL detection. Questions relating to severity of HL and age at HL detection were also included in the questionnaire. Details of 57 AVT graduates aged 15–29 were received from AV Israel. AV Israel is a non-profit organization, whose principal objective is to promote listening and speaking as a way of life for children who are deaf or hard of hearing. AV Israel provides training of children with AVT, provides a support system for parents, and facilitates networking among professional and lay communities (http://www.etni.org.il/old_hearing/eng/avisrael.htm). All AVT graduates received AVT for at least three years in early childhood. Confidentiality waiver forms were available for all AVT graduates. Each member of the AVT group was matched with two potential 'twins' with HL based on several criteria (along the lines of the Statistic Method, as explained by Caliendo and Kopeining (2005)): year of birth, gender, residence, and income of parents.

Answering the telephone survey was considered consent of participation. For the AVT group, out of 57 potential participants 13 could not be reached by telephone. Thus only 44 AVT participants' parents answered the telephone survey. For the control group, out of 144 potential participants 51 could not be reached by telephone. Another six refused to participate. Thus only 87 control group participants' parents answered the telephone survey. The final sample included 40 AVT participants and 40 matched controls. If more than one control was available for a certain AVT participant, the most suitable control was chosen as the final control match. Out of these, the current study will relate to 52 participants who were born up to the year 1998. These participants were at least 18 years old, enabling data on their final educational outcomes.

Table 1. Participants' demographics in each study group.

Variable	AVT	Controls
Gender		
Male	13	13
Female	13	13
Severity of HL		
Moderate	1	1
Severe	1	5
Profound	21	17
Else	3	3
Additional special needs	5	5
Use of assistive device		
Hearing aid (HA)	6	9
Cochlear implant (CI)	20	15
No assistive device	0	2
Mode of communication at home		
Sign language	0	5
Oral language	26	13
Sign language + oral language (total communication)	0	7
Educational level of mother		
Non academic	8	15
Academic	18	11
Educational level of father		
Non academic	10	16
Academic	16	10

Mean age of participants was 18–29 years (M = 22.42, Sd = 2.65). Participants who were rehabilitated by AVT formed the study group (N = 26). Participants who were not rehabilitated by AVT formed the control group (N = 26). Table 1 presents a description of the participants' demographics in terms of severity of HL, additional special needs, use of assistive devices and services, mode of communication, and educational level of parents. Data are presented only for those participants for whom the data was available.

As shown in Table 1, participants were equally divided on the basis of gender. Most participants had profound HL and used CI. It is important to note that age at implantation was available for only 26 participants out of 35 participants who used a CI, mainly from the study group of AVT graduates. Thus it was not possible to compare age at implantation between the two groups of participants. Nevertheless, reference to age at implantation will be detailed in a separate section. Additional data demonstrate that most participants used oral language, and that more parents in the AVT group had academic degrees compared to the control group. An equal number of participants from each group had additional special needs.

Results

Pearson correlations were performed in order to find relations between AVT and study variables. Table 2 presents correlations between AVT and the following variables: gender, severity of HL, use of CI, participation in verbal talk (labelled 'verbal talk'), and mode of communication at home.

As shown in Table 2, AVT had positive correlations with participation in verbal talk and use of oral language at home. AVT had negative correlations with use of sign-language and total communication.

Table 3 presents correlations between AVT and the following variables: mainstream education, math grade, Hebrew grade, literature grade, English grade, matriculation, and educational level of parents (academic or non-academic).

As shown in Table 3, positive correlations were found between AVT and all the educational and academic variables, except mothers' level of education. It is interesting to note that fathers' level of education was positively correlated with all academic outcomes of participants, while mothers' level of education was positively correlated only with math and English grades of participants.

Table 2. Correlations between AVT and study variables.

	AVT	Gender	Severity of HL	Use of CI	Verbal talk	Oral language	Sign language	Total comm.
AVT	1	−.00	.05	.18	.26*	.53***	−.31*	−.04**
Gender		1	.55***	−.52***	.02	−.32***	−.18	−.27*
Severity of HL			1	.07	−.21	−.02	.17	−.12
Use of CI				1	−.25	−.19	.09	.15
Verbal talk					1	.53***	−.61***	.27
Oral language						1	−.59***	−.72***
Sign language							1	−.13
Total comm.								1

***$p < .001$; **$p < .01$; *$p < .05$.

Table 3. Correlations between AVT and educational and academic variables.

	AVT	Mainstream education	Math grade	Hebrew grade	Literature grade	English grade	Matriculation	Education of mother	Education of father
AVT	1	.44***	.30*	.34**	.31*	.33*	.31*	.23	.27*
Mainstream education		1	.12	.25	.15	.20	.12	.11	.05
Math grade			1	.92***	.94***	.96***	.66***	.28*	.48***
Hebrew grade				1	.96***	.93***	.63***	.17	.35**
Literature grade					1	.95***	.57***	.24	.42**
English grade						1	.59***	.29*	.49***
Matriculation							1	.24	.42**
Education of mother								1	.74***
Education of father									1

***$p < .001$; **$p < .01$; *$p < .05$.

In order to compare dependent and independent variables between the control and study groups, a *t*-test was performed. Table 4 presents averages and standard deviations for the following independent variables: severity of HL, age at HL detection, use of CI, and parents' educational level. Mean for severity of HL represents the weighted average of this variable. Means for use of CI, and mother and father academic levels, represent rates of all participants.

As shown in Table 4, there were no significant differences between the study group and control group in severity of HL, age at HL detection, use of CI, and mother academic level. There was a significant difference between the two groups in father academic level.

Table 5 presents averages and standard deviations of outcome variables and differences between the two groups for the following dependent variables: participation in verbal talk, mode of communication at home, academic grades, and matriculation. Means for verbal talk, and all academic grades, represent weighted averages. Means for oral language, sign language, and total communication, represent rates of all participants.

As shown in Table 5, significant differences were found between the study group and control group in all variables.

In order to evaluate the contribution of study variables to academic achievement, order logistic regressions were performed. Ordered logistic regression handles ordinal dependent variables such as answers to a survey (McCullagh 1980). Table 6 presents estimates, standard errors, and significance levels of the different parameters entered into the regression tests.

As shown in Table 6, only father academic level had a significant positive contribution to all academic achievement. Use of CI had a significant negative contribution to achievements in Hebrew, literature and English. AVT had a significant positive contribution to achievements in Hebrew and literature.

Table 4. Averages and standard deviations of independent variables (severity of HL, use of CI, and parents' level of education) and differences between the control and study groups.

	AVT ($n = 26$)		Controls ($n = 26$)		Difference
	M	*Sd*	*M*	*Sd*	*t*
Severity of HL	2.52	1.05	2.41	1.01	.39
Age at HL detection	1.92	2.40	1.95	1.37	−.06
Use of CI	.76	.44	.59	.50	1.28
Mother academic level	.64	.49	.41	.50	1.69
Father academic level	.60	.50	.33	.48	1.96*

*$p < .05$.

Table 5. Averages and standard deviations of outcome variables and differences between the control and study groups.

	AVT ($n = 26$)		Controls ($n = 26$)		Difference
	M	*Sd*	*M*	*Sd*	*t*
Verbal talk	4	1.22	3.26	1.51	1.93*
Oral communication	1	0	.55	.51	4.39***
Sign language	0	0	.18	.39	−.23*
Total communication	0	0	.26	.45	−2.9**
Math grade	2.76	2.65	1.33	1.96	2.22*
Hebrew grade	2.60	2.63	0.96	1.91	2.58**
Literature grade	2.64	2.74	1.11	1.93	2.34**
English grade	2.64	2.66	1.11	.35	2.43**
Matriculation	.60	.50	.29	.46	2.27**

***$p < .001$; **$p < .01$; *$p < .05$.

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Table 6. Estimates, standard errors, and significance levels of the different parameters.

Response variable	Math grade		Hebrew grade		Literature grade		English grade	
Parameter	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Intercept 5	−2.65***	0.68	−2.12***	0.65	−2.06**	0.64	−2.63***	0.68
Intercept 4	−2.32***	0.65	−1.96***	0.63	−1.89**	0.63	−2.29***	0.66
Intercept 3	−1.30*	0.59	−1.53**	0.61	−1.21*	0.59	−1.70**	0.62
Intercept 2	−0.87	0.57	−1.04	0.58	−0.79	0.58	−1.09	0.59
Intercept 1	−0.57	0.56	−0.43	0.56	−0.50	0.57	−0.47	0.56
AVT	0.84	0.58	1.41*	0.62	1.20*	0.62	1.08	0.60
Use of CI	−1.00	0.61	−1.60**	0.65	−1.48*	0.64	−1.38*	0.63
Father academic level	1.98***	0.60	1.47**	0.60	1.56**	0.61	2.10***	0.61
Adj. R-Square	28%		28%		27%		32%	
Number of Observations	52		52		52		52	

***$p < .001$; **$p < .01$; *$p < .05$.

To illustrate the regression results, we displayed the marginal effects of the explained variables for the all-variables-included models in Table 6. Since we used order logistic regressions, the marginal effects were calculated for specific values of the dependent variables. Since our regressions were based on ordered logistic regression with 5 optional results, the marginal effects were calculated when the dependent variables were equal to 5 (Grade A). Table 7 presents marginal effects of explained variables.

As shown in Table 7, AVT had a positive contribution of approximately 22% and 18% respectively to achievements in Hebrew and literature. Father education had a positive contribution to achievements in mathematics, English, Hebrew and literature of 27% 30%, 24%, and 26% respectively. Use of CI had a negative contribution to achievements in Hebrew and literature of approximately 8%, and a negative contribution to achievements in English of 5%.

Robustness check for age at implantation

An alternative explanation for the differences on academic achievements between the study and control groups could be the age at implantation of cochlear device. Since early amplification is a principle of AVT, it is a crucial issue to distinguish between the influence of AVT on academic achievements and the influence of the age at implantation on them, in order to robust our findings.

Only 35 out of 52 participants in the present study used CI. Our data contained information on age at implantation for only 26 out of 35 participants with CI. First we preformed Pearson correlation between participating in AVT and age at implantation. As expected, the coefficient was negative but unexpectedly it wasn't significant ($r = -0.38$, $p > 0.05$). In addition, a *t*-test was performed in order to evaluate the difference in age at implantation between AVT graduates and control group. Although average age at implantation of AVT graduates was lower compared with average age at implantation of control group ($M = 4.55$, $Sd = 4.5$ and $M = 9.50$, $Sd = 7.71$ respectively), once again our results revealed an insignificant difference ($t = -1.99$, $p > 0.05$). Although our results did not indicate a significant difference between AVT graduates and the control group in implantation age, we do point a meaningful difference.

In order to evaluate the relationship between age at implantation and academic achievements, we examined the correlation between implantation age and academic grades. Table 8 presents correlations between implantation age and the following variables: math grade, Hebrew grade, literature grade, and English grade.

As shown in Table 8, no significant correlations were found between age at implantation and academic grades.

In order to examine the marginal effects of age at implantation on academic grades we preformed ordered logistic regressions. Table 9 presents estimates, standard errors, and significance levels of the different parameters entered into the regression tests (AVT, age at implantation, and father academic level).

As shown in Table 9, no significant contribution was found for age at implantation on any academic grade.

Even though our results did not reveal significant differences between AVT graduates and controls for age at implantation, some correlation between those elements could exist. If variables for AVT and age at implantation are correlated, a multi-collinearity phenomenon could exist. In order to overcome such a hypothetical phenomenon, ordered logistic

Table 7. Marginal effects of explained variables.

	Math grade	Hebrew grade	Literature grade	English grade
AVT	7.5%	22.2%*	18.4%*	10.8%
Use of CI	−4.1%	−8.4%**	−8.5%*	−4.9%*
Father academic level	27.3%***	23.6%**	26.4%**	30.3%***

***$p < .001$; **$p < .01$; *$p < .05$.

Table 8. Correlation between age at implantation and academic grades.

	Math grade	Hebrew grade	Literature grade	English grade
Age at implantation	0.01	0.04	0.02	0.04

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Table 9. Estimates, standard errors, and significance levels of AVT, age at implantation, and father academic level.

Response variable	Math grade		Hebrew grade		Literature grade		English grade	
Parameter	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Intercept 5	7.33***	2.29	−8.03***	2.36	−6.92***	2.21	−8.92***	2.56
Intercept 4	6.96***	2.25	−7.61***	2.30	−6.55***	2.17	−8.13***	2.46
Intercept 3	6.02***	2.12	−6.53***	2.16	−5.85***	2.08	−7.40***	2.37
Intercept 2	−5.12**	2.00	−5.61**	2.03	−4.94**	1.96	−6.21***	2.17
Intercept 1			−5.33**	1.99			−5.85**	2.12
AVT	2.99	1.57	3.09*	1.56	2.75	1.54	3.47*	1.63
Age at Implantation	0.17	0.12	0.19	0.12	0.16	0.12	0.21	0.13
Father academic level	3.28***	1.08	3.43***	1.10	3.13***	1.07	3.86***	1.17
Adj. R-Square	53%		54%		49%		58%	
Number of Observations	26		26		26		26	

***$p < .001$; **$p < .01$; *$p < .05$.

regressions were performed, only for AVT graduates with cochlear devices, which their age at implantation was known. Table 10 presents estimates, standard errors, and significance levels of the different parameters entered into the regression tests (age at implantation and father academic level).

As shown in Table 10, no significant contributions were found for age at implantation on academic grades of AVT graduates.

According to our analysis, it seems that age at implantation in the present study has no effect on academic achievements, and the contributions of AVT to academic outcomes found in the present study are robust.

Discussion

The purpose of the present study was to examine the academic outcomes of adolescents and young adults with hearing loss in relation with early AVT. Specifically it examined whether academic outcomes of AVT graduates were different from that of adolescents and young adults with HL who were not enrolled in AVT during childhood. Previous studies on the efficacy of AVT mainly related to communication outcomes of children with HL receiving AVT (Dornan *et al.* 2007, 2009a, Sahli and Belgin 2011, Zupan and Dempsey 2013). Only a few studies related to academic abilities among children enrolled in AVT programs, such as reading (Fairgray *et al.*, 2010) and writing skills (Yasamsal *et al.*, 2013). Studies relating to academic outcomes did not compared outcomes of AVT participants to outcomes of children with HL who did not receive AVT. To the best of our knowledge, only one study examined outcomes of AVT among adolescents and young adults (Eriks-Brophy *et al.* 2012), but without providing comparison to individuals with HL who were not enrolled in AVT.

The results of the present study show a positive contribution of AVT to Hebrew and literature grades. In addition, positive correlations were found between AVT, academic grades, and matriculation. These findings are consistent with previous research showing that AVT graduates performed at average and above average on measures of academic achievement (Eriks-Brophy *et al.* 2012).

Significant differences were found between AVT graduates and young adults with HL who were not enrolled in AVT in academic grades, matriculation and communication variables. This finding is unique to the present study since to the best of our knowledge no previous study compared academic outcomes of AVT graduates to academic outcomes of young people with HL who were not enrolled in AVT. Our findings might highlight a possible superiority of AVT received at the early years of life as contributing to academic achievements of young people with HL later on.

It is important to note that in the present study a positive correlation was found between AVT and fathers' level of education. A significant difference was found between the control and study groups in this specific variable, meaning that fathers of AVT participants had higher levels of education compared with

Table 10. Estimates, standard errors, and significance levels of age at implantation, and father academic level for AVT participants.

Response variable	Math grade		Hebrew grade		Literature grade		English grade	
Parameter	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Intercept 5	−4.27***	1.37	−4.99***	1.47	−4.13***	1.37	−5.79***	1.68
Intercept 4	−3.91***	1.34	−4.61***	1.44	−3.77***	1.34	−5.04***	1.63
Intercept 3	−2.88*	1.24	−3.46**	1.33	−2.99*	1.26	−4.25**	1.57
Intercept 2	−2.06	1.10	−2.61*	1.20	−2.15	1.14	−2.96*	1.34
Intercept 1			−2.15*	1.12			−2.22*	1.14
Age at Implantation	0.01	0.10	0.02	0.10	0.00	0.10	0.02	0.10
Father academic level	4.03***	1.35	4.32***	1.40	3.90***	1.35	5.13***	1.62
Adj. R-Square	55%		58%		52%		63%	
Number of Observations	20		20		20		20	

***$p < .001$; **$p < .01$; *$p < .05$.

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fathers of controls. These findings are in accordance with findings of a research conducted in Israel showing that educational level of parents is the most important factor in predicting rates of eligibility for a matriculation certificate among the general population (Dahan *et al.* 2003). Thus, we can't rule out the possibility that the educational level of fathers could be an intervening variable affecting academic outcomes of AVT graduates, due to the correlation between fathers' education and participation in AVT.

In the present study not all participants used CI, and information on age at implantation was available for 75% of participants with CI, thus creating multi-collinearity between age at implantation and other study variables. Despite these restrictions, we attempted at comparing age at implantation between the study and control groups. Although average age at implantation of AVT graduates was lower compared with average age at implantation of control group, these differences were not significant. In addition, no significant correlations were found between age at implantation and academic grades, and no significant contribution was found for age at implantation on any academic grade. Research has provided evidence on the effectiveness of early intervention, mainly age at fitting of hearing aids and age at cochlear implantation, for improving outcomes of young children with HL at a population level (Ching 2015). Studies show advantages of implantation at an early age in academic achievements as well (Stacey *et al.* 2006, Van der Kant *et al.* 2010). Nevertheless, early diagnosis followed by immediate audiologic management is one of the main principles of practice to which AVT adhere (Rhoades 2006). Thus, it is almost impossible to separate AVT and early implantation, meaning that early implantation is a component of AVT, and can't stand as a separate variable. Perhaps for this reason correlations in the presents study between age at implantation and academic outcomes were not significant, and age at implantation did not significantly contribute to academic outcomes.

In the present study we did not have information on rehabilitation interventions that participants in the control group received during the first years of life other than AVT. Thus, we were not able to compare outcomes of different rehabilitation approaches. In a future study it is recommended to compare outcomes of young people with HL on the basis of affiliation to a certain rehabilitation approach.

The results suggest that AVT graduates outperform young adults with HL who were not rehabilitated via this rehabilitative approach. The present study adds evidence to justify the approach of AVT.

Disclosure statement

No potential conflict of interest was reported by the authors.

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