Hearing loss during the critical period for language acquisition restricts spoken language input. This input limitation, in turn, may hamper syntactic development. This study examined the comprehension, production, and repetition of Wh-questions in deaf or hard-of-hearing (DHH) children. The participants were 11 orally trained Hebrew-speaking children aged 9.1–12.4 with moderate-to-profound hearing loss from birth, who consistently used hearing aids or cochlear implants and who had difficulties understanding relative clauses. Experiment 1 tested the comprehension of Wh-questions using a picture selection task, comparing subject with object questions and who - with which -questions; Experiment 2 tested the production of subject and object who-questions using an elicitation task; and Experiment 3 tested the repetition of Wh-questions and other structures derived by Wh-movement. All the DHH participants showed difficulty in the comprehension, production, and repetition of object questions, and their performance was significantly below that of hearing children. In contrast, they repeated embedded sentences without movement well, indicating that their deficit is in syntactic movement rather than embedding or the CP node in the syntactic tree. The results provide additional evidence that DHH children have difficulties with Wh-movement and emphasize that Wh-questions, which are crucial for communication, can be severely impaired in these children.

Many children whose hearing is impaired receive limited language input during the sensitive period for language acquisition. In the current study, we explore the effects this input limitation has on the syntactic abilities of these children. We focus on the comprehension and production of Wh-questions, which are a very crucial ability in communication, and their relation to the ability of orally trained deaf and hard-of-hearing (DHH) children to understand and produce other structures that involve the same syntactic construction, Wh-movement.

Limited exposure to language input during the sensitive period for language acquisition can have far-reaching consequences for the syntax of individuals with hearing loss (de Villiers, de Villiers, & Hoban, 1994; Delage & Tuller, 2007; Friedmann & Szterman, 2006; Geers & Moog, 1978; Haddad-Hanna & Friedmann, 2009). Studies that assessed the syntactic abilities of English-, Palestinian Arabic-, and Hebrew-speaking DHH children found a specific difficulty in the comprehension and production of structures that are derived by syntactic movement. Difficulties were found in the comprehension and production of object relative clauses (English: Berent, 1988; de Villiers, 1988; Quigley, Smith, & Wilbur, 1974; Hebrew: Friedmann & Szterman, 2006; Friedmann, Szterman, & Haddad-Hanna, 2010; Szterman & Friedmann, 2003, 2007; and Arabic: Friedmann et al., 2010; Haddad-Hanna & Friedmann, 2009), in the comprehension and production of passive sentences (in English: Power & Quigley, 1973; Turner & Rommetveit, 1967), and in the comprehension of topicalization structures (Hebrew: Friedmann & Szterman, 2006; Arabic: Haddad-Hanna & Friedmann, 2009). (examples and explanations for the syntactic properties of these structures are given in the next section).

Friedmann and Szterman (2006) suggested that the source of the difficulty in relative clauses and topicalization sentences is their being derived by Wh-movement of the object, movement of the object from its original position, after the verb, to another position...
in the sentence-to the clause-initial position (to the CP domain). If indeed the difficulties stem from Wh-movement impairment, we would also expect difficulty in the comprehension and production of Wh-questions, which are also derived by Wh-movement. Hence, the current study assessed the comprehension and production of Wh-questions in Hebrew-speaking DHH children. Such study can shed light as to whether or not Wh-movement is indeed problematic in hearing loss and also suggest insights with respect to the ability of DHH children to understand and form questions, which are a crucial communication tool.

The Comprehension and Production of Questions in DHH Individuals

Three previous studies assessed Wh-questions in individuals with hearing loss (Berent, 1996; Quigley, Wilbur, & Montanelli, 1974; Williamson, 1985, cited in de Villiers, 1988); the two that tested comprehension of Wh-questions were only in the written modality. These studies report difficulty in the comprehension of Wh-questions by DHH English speakers. Quigley, Smith, et al. (1974) tested questions in 420 DHH English speakers aged 10–19 years. The study tested the comprehension of yes/no questions, Wh-questions, and tag questions using written tasks: answering questions, grammaticality judgment, and rewriting sentences. The results of Quigley, Smith, et al.’s study indicated difficulty in question comprehension and in judging the grammaticality of questions. There was a steady increase with age in the comprehension of all three question types; however, the DHH children did not show mastery of Wh-questions even in the older ages tested and were only able to reach normal performance on yes/no questions, but still in a much later age than hearing children. Although Quigley, Smith, et al.’s study was very broad, it did not examine the ability of the DHH children to interpret semantically reversible Wh-questions and assign the thematic roles to the noun phrases (NPs) in the question.

Williamson (1985, cited in de Villiers, 1988) tested Wh-word selection and the use of auxiliaries in the oral production of questions in English-speaking DHH individuals aged 6–14 years. Williamson found that the DHH children produced Wh-questions with the Wh-word in the initial position, but many of their productions were ungrammatical, mainly because of frequent omissions of the auxiliary. de Villiers et al. (1994) suggested that this pattern arises from the children positioning the Wh-question in a topic position in the beginning of the sentence rather than via grammatical Wh-movement into CP. Another study that examined Wh-questions was conducted by Berent (1996). Berent tested written production and grammaticality judgment of questions in English-speaking DHH college students and found that despite years of exposure to English language input, Wh-questions were still not mastered by the DHH students. Subject questions were produced and judged better than object questions.

Thus, these studies indicate a difficulty with Wh-questions, which is consistent with the difficulties DHH children have in relative clauses and topicalized structures. No study until now tested the ability of children to process orally presented Wh-questions and to undergo the related assignment of thematic roles to moved elements in the sentence, and no study tested the comprehension of semantically reversible Wh-questions. To test these research questions and to further characterize the syntactic deficit in orally trained DHH individuals, this study will examine the ability to comprehend and produce Wh-questions, which, like relative clauses and topicalization structures, are also derived by Wh-movement. The comprehension of object questions will be compared with the comprehension of subject questions, and which-questions will be compared with who-questions. Studies about typical language acquisition (Friedmann, Belletti, & Rizzi, 2009), syntactic specific language impairment (SLI; Friedmann & Novogrodsky, in press), and agrammatic aphasia (Hickok & Avrutin, 1996) found that which-questions are more difficult to comprehend than who-questions. It is therefore important to examine whether this difference exists also in individuals with hearing loss—to widen the knowledge about the types of structures that are hard to comprehend and to expand the knowledge that will lead to a precise characterization of their syntactic deficit.

The assessment of Wh-questions in children with hearing loss is expected to shed light on whether these
children indeed have a difficulty in Wh-movement. Naturally, such assessment also has implications for the characterization of these children’s ability to understand everyday conversations: Wh-questions are very common in the spoken language and have a crucial pragmatic value in daily conversation, as well as in classroom and academic situations. A detailed exploration of their ability to understand and produce questions will be important for the diagnosis of individuals with hearing loss and for the development of appropriate treatment. In a wider context, it will provide information as to how syntax develops under conditions of restricted input.

**Subject and Object Wh-Questions**

Wh-questions that begin with *which* and *who* are derived by a movement of the Wh-phrase to the beginning of the clause. Wh-questions are classified according to the position from which the Wh-phrase has moved: subject questions are derived by movement of the Wh-phrase from the subject position (1–2), and object questions are derived by movement of the Wh-phrase from the object position (3–4).

(1) Subject *which* question: [which cow] _ kicked the giraffe?  
(2) Subject *who* question: [who] _ kicked the giraffe?  
(3) Object *which* question: [which giraffe] did the cow kick _?  
(4) Object *who* question: [whom] did the cow kick _?

In the sentence *The cow kicked the giraffe*, the verb *kick* assigns two thematic roles to the NPs in the sentence: a role of an agent and a role of a theme. In English and Hebrew, the agent, in this case *the cow*, typically appears in subject position, before the verb, and the theme, in these sentences *the giraffe*, typically appears in the object position following the verb. This order, agent–verb–theme, characterizes simple active sentences and is termed the *canonical order*. In object questions (Examples 3 and 4), however, the NP that serves as the theme precedes, rather than follows, the verb and the agent. The phenomenon of dislocation of an element from its original position to another position in the sentence is called *syntactic movement*. An element that moved to a new position leaves in its initial position a *trace* (marked in Sentences 1–4 with an underline). The verb assigns the thematic role to the trace of the moved element, and the thematic role is transferred from the trace to the moved constituent via a chain that connects the trace and the moved element in its new position (the movement and the chain are marked by an arrow in Examples 1–4). In order to interpret such a sentence with movement, and to comprehend the thematic roles in these sentences, the hearer needs to identify the position of the trace, assign the correct thematic role to the trace, and transfer the thematic role to the moved element in its new position. Subject questions (1 and 2) include movement as well (Clements, McCloskey, Maling, & Zaenen, 1983; Friedmann, 2002), but this movement does not change the canonical order of the arguments and it remains agent–verb–theme. The assignment of the thematic role via a chain in subject questions does not cross the other argument of the verb. Hence, the difference between subject questions and object questions can be stated in two related ways: Whereas subject questions are canonical in that the agent precedes the theme, object questions include the noncanonical order theme–agent. Furthermore, whereas the movement in object questions crosses the other argument of the verb (in Sentences 3 and 4, *the giraffe crosses the cow*), the movement in subject question does not cross another argument. Crossing of an argument was found to be a crucial factor in comprehension and production in children who have difficulties with object relatives and object questions, both typically developing children acquiring language (Friedmann et al., 2009; Friedmann & Costa, 2010) and children with syntactic SLI (Friedmann & Novogrodsky, 2004, 2007, in press).

This difference in crossing between subject and object questions is related to the difference between *who*- and *which*-questions. Whereas object *which*-questions (like Example 3) include movement of a full NP (*the giraffe*) across another full NP (*the cow*), in *who*-questions the moved element is not a full NP but rather a phrase without a lexical restriction, *who*. Young typically developing children and children with syntactic SLI who show significant difficulties in the comprehension of structures that involve movement of a full NP across another one do not experience similar problems in *who*-questions, even when they
involve crossing (Friedmann et al., 2009; Friedmann & Novogrodsky, in press). Namely, whereas children with syntactic SLI and typically developing children have difficulties understanding object which-questions, they understand well object who-questions. It is therefore important to include these comparisons also in a study of Wh-questions in DHH individuals. Hence, in this study we explore the comprehension and production of questions in DHH children, comparing subject and object questions, and who- and which-questions, trying to trace the source of the syntactic difficulty in DHH children.2

Our previous studies found that orally trained DHH children who were not exposed to language input in an early age have a difficulty in the comprehension of relative clauses. Because relative clauses include both embedding and Wh-movement, two possible accounts are imaginable for the deficit in relative clauses: a deficit in embedding and a deficit in Wh-movement. Given that Wh-questions include Wh-movement but not embedding, this structure can help decide between the possible accounts for the difficulty in relative clauses. If we find that these children also encounter difficulties in the comprehension of Wh-questions, this will support the hypothesis according to which syntactic movement, and not embedding, is the source of the difficulty in the comprehension of relative clauses. Similarly, if we find that DHH children find it hard to repeat questions but succeed in the repetition of embedded sentences without movement, this will support movement as the source of their difficulty rather than embedding.

Method

General Material and Procedure

Before assessing the comprehension and production of structures derived by syntactic movement, we used a screening test to make sure that the sentence stimuli in the experiments were perceived correctly by each DHH participant (all of them wore consistently their hearing aids or a cochlear implant) and that the participants’ performance was not influenced by problems in hearing the sentences. In this screening test, every participant was asked to repeat aloud 10 simple sentences with sibilants, which were read by the experimenter with her lips concealed. Children who made errors on more than two sentences did not participate in the study. Only children who succeeded in the screening test participated in the four other experiments. In the following experiments, the children could use lipreading.

Each participant was tested in a quiet room in four sessions. The children participated voluntarily in the experiments and they were told that they could stop whenever they wanted. The tests were administered in the same order to all children, according to the order they are presented in the article: After the hearing screening, the children participated in a relative clause comprehension pretest, and then a Wh-question comprehension test, a Wh-question elicitation test, and a sentence repetition test. No time limit was imposed in any of the experiments, and the experimenter repeated every item as many times as the participant requested (except for the repetition task). The experimenter did not give the participants any response-contingent feedback as to their success or failure in the test items, only general encouragement. If the participant looked tired or asked for a break, the test was stopped and was continued in the next meeting. During the sessions, every response that differed from the target was written in detail by the experimenter, and correct responses were scored with a plus sign. In addition, all the sessions were audio-recorded and then transcribed in full by the two authors after each session.

Participants

The participants were 11 Hebrew-speaking children with hearing loss from birth. They were eight girls and three boys, aged 9.1–12.4 years (M = 10.2, SD = 1.2). They had moderate-to-severe hearing loss and were trained only in oral language. At the time of testing, they were studying in primary schools in hearing classes with inclusive schooling using oral education, and each of them received additional support from a special teacher of the deaf, 2–4 hr a week. All the participants consistently wore binaural hearing aids (eight children) or used a cochlear implant (three children). The background information on the participants’ hearing and schooling is presented in Table 1. Subject files included no other disabilities, and in all
cases neither parent was deaf, and they all came from a family that spoke only Hebrew.

The control groups included hearing children with typical language development, without neurological or developmental difficulties, and without socio-emotional behavior problems. They were taken from public schools serving a middle-class population, similar to the DHH participants. There were three control groups. The hearing control group of the question comprehension and production tests (Experiments 1 and 2) consisted of 12 children, aged 7.5–9.0, with a mean of 8.3. We selected hearing children in a chronological age at which children have recently acquired object question comprehension according to previous research, and this created a control group that was 2 years younger than the DHH group. The performance of the DHH participants in the repetition task (Experiment 3) was compared with the repetition of 35 five-year-old hearing children (Friedmann, Fattal, & Fattal-Valevski, 2010). The performance of the DHH children in the pretest of relative clause comprehension was compared with that of a hearing control group of 14 fourth graders aged 8.10–9.6.

Initial Syntactic Screening of the Participants: Comprehension of Relative Clauses in a Sentence–Picture Matching Task

Because one of the aims of this study was to explore the source of the difficulty DHH children demonstrate in the comprehension of relative clauses, by also testing other structures that include Wh-movement (but do not include embedding), we started by assessing the participants’ ability to understand relative clauses. Friedmann and Szterman (2006; Friedmann et al., 2010) assessed the comprehension of relative clauses and topicalization sentences of 20 Hebrew-speaking orally trained DHH children aged 7.8–9.9. The results indicated a considerable difficulty in the comprehension of object relatives and topicalization object–verb–subject (OVS) sentences. In these movement-derived sentences, the children found it difficult

### Table 1 Background information on the deaf and hard-of-hearing participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age at testing</th>
<th>Gender</th>
<th>Age at hearing impairment diagnosis</th>
<th>Age at the beginning of intervention (hearing aid fitted)</th>
<th>Etiology</th>
<th>Degree of hearing loss (dB, unaided)</th>
<th>Device at present</th>
<th>Age at implantation</th>
<th>Object relative comprehension</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.10</td>
<td>Male</td>
<td>5.0b</td>
<td>8.6</td>
<td>Preterm baby</td>
<td>r, 55; l, 55 HA</td>
<td>—</td>
<td>—</td>
<td>Impaired</td>
</tr>
<tr>
<td>2</td>
<td>1.9</td>
<td>Female</td>
<td>4.0</td>
<td>4.0</td>
<td>Unknown</td>
<td>r, 50; l, 50 HA</td>
<td>—</td>
<td>—</td>
<td>Impaired</td>
</tr>
<tr>
<td>3</td>
<td>10.9</td>
<td>Female</td>
<td>0.6</td>
<td>3.6</td>
<td>Genetic</td>
<td>r, 85; l, 85 HA</td>
<td>—</td>
<td>—</td>
<td>Impaired</td>
</tr>
<tr>
<td>4</td>
<td>4.12</td>
<td>Female</td>
<td>5.0</td>
<td>5.0</td>
<td>Unknown</td>
<td>r, 80; l, 85 HA</td>
<td>—</td>
<td>—</td>
<td>Impaired</td>
</tr>
<tr>
<td>5</td>
<td>8.9</td>
<td>Female</td>
<td>4.6</td>
<td>8.7</td>
<td>Childhood illnesses</td>
<td>r, 65; l, 60 HA</td>
<td>—</td>
<td>—</td>
<td>Impaired</td>
</tr>
<tr>
<td>6</td>
<td>8.9</td>
<td>Female</td>
<td>0.4</td>
<td>0.9</td>
<td>Complication in birth</td>
<td>r, 75; l, 65 HA</td>
<td>—</td>
<td>—</td>
<td>Impaired</td>
</tr>
<tr>
<td>7</td>
<td>6.9</td>
<td>Female</td>
<td>2.0</td>
<td>3.0</td>
<td>Unknown</td>
<td>r, 55; l, 65 HA</td>
<td>—</td>
<td>—</td>
<td>Impaired</td>
</tr>
<tr>
<td>8</td>
<td>6.9</td>
<td>Female</td>
<td>1.0</td>
<td>8.0</td>
<td>Premature baby</td>
<td>r, 65; l, 45 HA</td>
<td>—</td>
<td>—</td>
<td>Impaired</td>
</tr>
<tr>
<td>9</td>
<td>3.12</td>
<td>Female</td>
<td>0.6</td>
<td>3.4</td>
<td>Unknown</td>
<td>&gt;95c CI 3.4</td>
<td>CI</td>
<td>3.4</td>
<td>Impaired</td>
</tr>
<tr>
<td>10</td>
<td>6.9</td>
<td>Male</td>
<td>Birth</td>
<td>2.0</td>
<td>Preterm baby</td>
<td>&gt;95c CI 2.6</td>
<td>CI</td>
<td>2.6</td>
<td>Impaired</td>
</tr>
<tr>
<td>11</td>
<td>1.9</td>
<td>Male</td>
<td>0.9 (did not contribute to hearing)</td>
<td>0.9</td>
<td>Complication in birth</td>
<td>&gt;95c CI 0.9</td>
<td>CI</td>
<td>0.9 (effective only from age 4.0)</td>
<td>Impaired</td>
</tr>
</tbody>
</table>

Note. HA = hearing aid; CI = cochlear implant.

*a*The age of the hearing aid fitting is usually also the age of the beginning of intervention in the areas of auditory perception, speech production, and language.

*b*Participant 1 started speaking only at age 3 and was treated since then by a speech pathologist, but the hearing impairment as a source of deficit was only detected when he was 5.0.

*c*The three participants who used CI had hearing loss above 95 dB prior to implantation. At present, they are having 30–40 dB in the implanted ear.
to determine who did what to whom in the sentence. A further study that assessed these children's production of relative clauses yielded similar results. The participants demonstrated a significant difficulty not only in the production of object relatives, in which the canonical order of the thematic roles is not preserved, but also in the production of subject relatives, in which the canonical order of the thematic roles is preserved (Friedmann & Szterman, 2006; Szterman & Friedmann, 2007). To see whether DHH children who have a problem in relative clauses also have difficulties in Wh-questions, we had to assess first whether the participants in the current study show the same pattern with respect to relative clauses.

We assessed the comprehension of relative clauses using the same sentence–picture matching task used in Friedmann and Szterman (2006; BAMBI, Friedmann & Novogrodsky, 2002). The participant heard a semantically reversible sentence read by a native speaker of Hebrew and saw two pictures on the same page, one above the other: In one picture, the roles matched the sentence; in the other picture the roles were reversed. The participant was then asked to point to the picture that correctly described the sentence. The test included a total of 40 sentences: 20 subject relatives (Show me the boy that kisses the grandpa) and 20 object relatives (Show me the boy that the grandpa kisses). All verbs were agentive transitive. Sentences were randomly ordered so that there was no sequence of more than two sentences of the same type; the correct picture in each pair was randomized too: The correct picture was sometimes the top picture, and sometimes the bottom picture, with no more than two consecutive pointing on the same position.

The control participants (14 fourth graders, aged 8.10–9.6) had a mean score of 94% correct answers, whereas the 11 DHH participants performed below this score.3 As a group, the performance of these 11 participants was considerably below that of the control group ($U = 12$, $p = .0004$).4 The participants who had a difficulty in the comprehension of object relatives did not show difficulty in the comprehension of subject relatives: They performed well on subject relatives, and not differently from the control group ($U = 67$, $p = .44$), and performed significantly better on subject relatives than on object relatives ($T = 0$, $p = .002$). For 7 of the 11 participants, the performance on subject relatives was significantly better than on object relatives. The comparison of each DHH individual with the control group showed that the performance of 7 of the 11 participants was significantly below that of the control group on object relatives ($p < .05$, using Crawford & Howell’s, 1998, t test). Only one DHH participant performed significantly below the control group in the subject relatives. The comparison of the performance of each participant to chance level showed that seven of the DHH participants performed at chance on object relatives, indicating a guessing pattern. All the participants performed significantly above chance level on subject relatives.

In Experiments 1–3, we investigated whether these DHH children who had a difficulty in the comprehension of relative clauses also show a difficulty in the comprehension and production of Wh-questions.

Experiment 1 assessed the comprehension of Wh-questions using a picture selection task, comparing object questions (in which the order of the thematic roles is noncanonical) and subject questions (in which the order is canonical and the movement does not cross another argument), and comparing who- and which-questions. Experiment 2 tested the production of who-questions using an elicitation task with pictures, comparing object and subject questions. Experiment 3 assessed the children's ability to repeat Wh-questions and other sentences with Wh-movement in comparison with simple sentences and embedded sentences without Wh-movement.

**Experiment 1: Comprehension of Wh-Questions in a Picture Selection Task**

The ability of the DHH children to understand Wh-questions was assessed using a picture selection task.

**Procedure.** The experimenter asked a question while the participant was looking at a picture with three figures. The participant was then requested to point at the figure that answered the question.

**Materials.** Twenty pictures were presented, each picture included three figures: two of the same type, which differed in at least one feature (a blue and a purple elephant; a blond and a red-head girl), and a third figure of a different kind. In the picture, the first figure
was performing an action on the second, and the second figure was performing the same action on the third figure, which was of the same type of the first one (Figure 1). The pictures were randomly ordered, so that there were not more than two consecutive pictures in which the agent was on the same side of the picture and not more than two consecutive pictures in which the correct answer was in the same position. Each picture was presented four times, each time with a different type of question. The questions were randomly ordered, so that no more than two questions of the same type appeared consecutively.

All the sentences were semantically reversible so that the comprehension of the meaning of the words alone cannot assist in the interpretation of the sentences. The figures in each sentence (and picture) were always of the same gender and number (a female nurse and a female soldier, a little boy and a grandfather, etc.), in order to preclude an agreement cue on the verb (as verbs in Hebrew agree with the subject in gender, number, and person). The test included 80 questions of four types: 20 subject which-questions (5), 20 object which-questions (6), 20 subject who-questions (7), and 20 object who-questions (8).

(5) Subject which-question
eyzo yalda melatefet et ha-ima?
Which girl caresses ACC (accusative case marker)
the-mother
Which girl caresses the mother?

(6) Object which-question
et eyzo yalda ha-ima melatefet?
ACC which girl the-mother caresses
Which girl does the mother caress?

(7) Subject who-question
mi melatefet et ha-ima?
Who caresses ACC the-mother
Who caresses the mother?

(8) Object who-question
et mi ha-ima melatefet?
ACC who the-mother caresses
Whom does the mother caress?

Results. The main finding of the Wh-question comprehension experiment is that the DHH children who had impaired comprehension of object relatives also demonstrated impaired comprehension of another structure that involves the Wh-movement of the object across the subject: object which-questions. Most of the children performed well on subject questions (both who and which) and on object who-questions, as shown in Figure 2.

Whereas the performance of the DHH children in the comprehension of subject and object who-questions was high (95% in subject who-questions and 96% in the object who-questions), their performance in subject and object which-questions was poorer: They performed 89% correct on subject which-questions and only 69% on the object which-questions. Within subject questions, subject who-questions were significantly better than subject which-questions ($T = 0, p = .02$); within object questions, object who-questions were significantly better than object which-questions ($T = 0, p = .002$). No difference was found between subject and object who-questions (almost all the participants showed the same performance in the two types of questions), but there was a significant difference between the subject and object which-questions: The comprehension of object which-questions was significantly poorer than the comprehension of subject which-questions ($T = 0, p < .0001$).
The DHH participants performed below the control group in the comprehension of subject *which*-questions ($U = 18, p = .002$) and in the object *which*-questions ($U = 1, p < .0001$). Their performance on the subject and object *who*-questions did not differ from that of the control group.

To assess, for each individual in the DHH group, whether his/her performance was within the range of the performance of the control group or significantly below it, we used the Crawford and Howell’s (1998) $t$ test (see also Crawford & Garthwaite, 2002), a test that was designed for the comparison of a single participant with a control group. We used an alpha level of .05 in these comparisons too. According to the Crawford and Howell’s $t$ test, each of the 11 DHH participants who demonstrated impaired comprehension of object relatives also performed significantly below the control group in the comprehension of object *which*-questions.

The comparison of the performance of each participant to chance level, which indicates how many of the participants were guessing in each question type, indicated that 5 of the 11 DHH participants performed at chance in the object *which*-questions, 2 performed at chance level in the subject *which*-questions, and only 1 participant performed at chance level in the subject *who*-questions. All the participants performed significantly above chance level on the object *who*-questions.

### Experiment 2: Production of Wh-Questions in an Elicitation Task

The DHH children’s production of Wh-questions was assessed using an elicitation task with a picture. Subject questions were compared with object questions.

**Procedure.** The participant saw a picture that included one figure performing an action on another. In each picture, the participant could see one figure and an action (washing, combing); the other figure, the agent or the theme, was concealed with a piece of silver cardboard (cut artistically around the silhouette of the concealed figure). The participants were required to ask a question for which the answer would be the concealed figure. Right after the participant asked a question (grammatical or ungrammatical), the experimenter revealed the figure. The experiment started with an example picture for which the children were asked to produce a question and the experimenter explained the task. The experimenter emphasized that the concealed figure is animate—it is either a person or an animal (both triggering the same animate *wh*-morpheme, *mi*, who in Hebrew).

**Materials.** Every participant saw 40 pictures and was requested to produce accordingly 40 questions: 20 subject questions (9) and 20 object questions (10).
The subject and object target questions were randomly ordered, so that there was no sequence of more than two items in which the target question was of the same type.

(9) Target question—subject who-question
(Figure 3)
mi roxec et ha-yalda?
Who washes ACC the-girl
Who washes the girl?

(10) Target question—object who-question
(Figure 4)
et mi ha-para melakeket?
ACC who the-cow licks
Whom does the cow lick?

Results. The DHH children who demonstrated a difficulty in the comprehension of object relatives and object which-questions also found it very difficult to produce Wh-questions (see Figure 5). They produced only 78% correct subject questions and 61% correct object questions, whereas the control group performed 99.6% correct on both structures. The DHH children performed significantly below the control group on both subject questions \((U = 39, p = .05)\) and object questions \((U = 19.5, p = .002)\). The production of subject questions of the DHH children was significantly better than their production of object questions \((T = 0, p = .004)\).

The comparison of the performance of each DHH participant to the control group indicated that 5 of the 11 participants produced significantly fewer grammatical subject questions than the controls, and 8 participants produced significantly fewer grammatical object questions than the controls.

Types of responses and errors in the production of questions Object questions. Not only the percentage of the questions that were correctly produced can be telling with respect to the syntactic deficit of the DHH children, much can be learned from the types of erroneous responses they provided for the target questions. As shown in Table 2, when the DHH participants were asked to produce object questions, in many cases (20 responses of the 220 target object questions) they produced ungrammatical questions. The ungrammatical responses included the omission of the accusative marker, using an incorrect argument structure or an incorrect derivational morphology of the verb, and producing the object question with a doubling of the moved component, or gap filling.

In other cases, the DHH children tried to avoid producing object questions. One of the ways they used was producing subject questions instead of object questions (28 responses). Only two of these subject questions were grammatical and maintained the correct meaning of the question. In other cases, they produced a subject question with a reversal of the thematic roles of the target question, using an incorrect object, typically, first-person pronoun, and other
ungrammatical subject questions. Other ways the DHH children used to avoid the production of object questions were frequent production of simple declarative sentences and production of questions with an inanimate object, or production of adjunct questions (see examples for these erroneous productions in Appendix A). Some of the children’s responses included more than one error type.

Subject questions. The production of subject questions was better than that of the object questions but still caused considerable difficulty. Of the 220

| Table 2 Types of errors of the deaf and hard-of hearing participants in the relative clause elicitation task |
|-------------------------------------------------|-------------------------------------------------|---------------|
| Target object questions                         | Total   | % Response |
| Grammatical object questions                    | 135     | 61           |
| Accusative marker omission (ungrammatical)      | 11      | 5            |
| Incorrect argument structure (ungrammatical)    | 5       | 2            |
| Doubling of the object and filling the gap (ungrammatical) | 4 | 2          |
| Subject questions instead of object questions    | 28      | 13           |
| Correct subject questions                       | 2       | 1            |
| Subject questions with an inversion in the meaning | 8   | 4            |
| Subject questions with an incorrect verb or with a reflexive verb | 6 | 3          |
| Ungrammatical subject questions                 | 4       | 2            |
| Subject questions with incorrect or no object   | 8       | 4            |
| Simple sentence                                 | 29      | 13           |
| Avoiding animate object                         | 3       | 1            |
| Adjunct questions (why)                         | 4       | 2            |
| Target subject questions                        | 220     |              |
| Grammatical subject questions                   | 171     | 78           |
| Subject question with a single noun phrase      | 4       | 2            |
| Ungrammatical subject questions                 | 14      | 6            |
| Subject questions with an incorrect verb or with a reflexive verb | 8 | 4          |
| Simple sentences                                | 19      | 9            |
| Ungrammatical object questions                  | 3       | 1            |
| Indirect object question                        | 1       | 0            |
target subject questions, 49 productions were incorrect and nontarget. As shown in Table 2, when requested to produce a subject question, in many cases the DHH participants produced ungrammatical subject questions. In other cases, they avoided the production of subject questions and produced simple sentences or wrong object questions instead.

In the incorrect production of subject questions, the DHH children omitted one of the animate NPs, produced ungrammatical subject questions, and used verb morphology that does not fit the number of arguments in the sentence, such as a reflexive verb with an object. In other cases, the children produced simple sentences instead of subject questions, or ungrammatical object questions (see examples for these erroneous productions in Appendix A). The omission of the NP in the question and the use of a reflexive verb (a verb with only one argument) instead of a transitive verb (with two arguments) probably make the question easier by removing the difficulty of having two arguments in the sentence that should receive thematic roles.

Subject and object question production. Thus, some of the DHH children found it difficult to produce not only object questions but also subject questions. In the section that discusses the relations between the performances in the various tasks, we will show that these children were also impaired in the comprehension and repetition of subject questions.

Experiment 3: Repetition of Wh-Questions and Other Structures With and Without Movement

Experiment 3 tested the syntactic abilities of the DHH children using a repetition task. The repetition task enables full control of the target sentences and suggests a simple way to examine the syntactic ability in various structures using the same task. We used the repetition task to examine how DHH children repeat Wh-questions.

We used the repetition task also to seek for the source of the difficulty in the comprehension and production of relative clauses and questions. As we found in the assessment of the participants’ relative clause comprehension (and in previous studies—Friedmann & Szterman, 2006; Friedmann et al., 2010; Szterman & Friedmann, 2003, 2007), many DHH children encounter difficulties in the comprehension and production of relative clauses. Relative clauses like *This is the girl that grandma drew* include two sources of complexity and hence two sources of possible difficulty: They include Wh-movement from object position and include embedding. A way to examine if the source of the difficulty is the movement or the embedding is to investigate sentences with Wh-movement and without embedding, and sentences with embedding and without Wh-movement. For this purpose, the repetition task compared object relatives, which include both Wh-movement and embedding, with Wh-questions and topicalization sentences, which include Wh-movement but no embedding, and with sentences with sentential complements of verbs, which include embedding but no movement. We also included in the task simple sentences without movement and without embedding.

Repeating a sentence in one’s native language is not a passive phonological copy of the input sentence. It rather involves comprehension and production, and therefore, difficulties in the comprehension and production of a syntactic structure are manifested in difficulties to repeat this structure (Friedmann, 2007; Friedmann & Grodzinsky, 1997; Friedmann & Lavi, 2006; Lust, Flynn, & Foley, 1998). Specifically, when we compare sentences that are similar in all respects (same length and words) and differ only in the relevant syntactic feature tested, then if a participant succeeds in repeating one structure but fails in the other structure, this might indicate a specific difficulty with the tested structure. Consistent structural errors in the repetition of a certain structure by a child (and good repetition of the control sentence) can thus indicate a deficit in this specific structure or that this structure is not mastered yet.

Procedure. The experimenter said a sentence, and the participant was requested to count to 3 out loud and then to repeat the sentence as accurately as possible. The counting was used to prevent rehearsal in the phonological loop (Baddeley, 1997; Friedmann & Grodzinsky, 1997) and hence to preclude phonological echoing. In the analysis of errors, structural errors were scored separately from lexical errors that did
not affect the structure and the thematic roles in the sentence. Before the beginning of the repetition task, the experimenter made sure that the participants knew all the nouns and verbs in the target sentences.

**Materials.** The sentences for repetition included subject and object *which*-questions, object relatives, object topicalization, simple sentences, and embedded sentences with a sentential complement (see Table 3). The sentences of the various types were presented in a random order. The test included 60 sentences, all with four words (accusative markers, embedding markers, and prepositions were counted with the word following them). All the sentences derived by Wh-movement were semantically reversible. The simple sentences included either a transitive or an intransitive verb, and the verbs in the embedded clauses in the embedding condition were intransitive. In each of the sentences that included a transitive verb, the two NPs were of the same gender, to preclude a grammatical gender cue on the subject and object.

**Results.** The DHH children who had impairment in the comprehension of object relatives and object *which*-questions and in the production of object questions also found it very difficult to repeat object *which*-questions and the other structures derived by Wh-movement: object relatives and topicalization sentences. The results presented in Figure 6 and in the analysis below include only structural errors, whereas sentences that were repeated only with lexical errors were scored as correct repetitions for this analysis. The results clearly reflect difficulties with certain syntactic structures, but not in others, indicating that the difficulty in this task reflects a syntactic difficulty rather than a working memory one, as all the sentences had the same number of words and syllables (see also Berent, 1996, for similar results indicating that the sentence length was not a crucial factor in whether or not DHH children understood it, only its syntactic structure).

In the repetition of *which*-questions, the DHH children repeated correctly 80% of the subject questions (in which the movement does not cross another NP) but only 55% of the object questions (in which the object crosses the subject). The difficulty the DHH children have with these *which*-questions becomes evident when their performance is compared with that of a comparison group of 35 typically developing 5- to 6-year-old children. As shown in Table 4, young typically developing children already repeat all the subject questions correctly and make less than one error on average in repeating the object questions. In the repetition of the other structures derived by Wh-movement,

---

**Table 3** Types of sentences included in the repetition task

<table>
<thead>
<tr>
<th>Type</th>
<th>Wh-movement</th>
<th>Embedding</th>
<th>Sentences</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Which subject</em> question</td>
<td>Yes (without crossing)</td>
<td>No</td>
<td>5</td>
<td>eyze saxkan raa et ha-more? which actor saw ACC the-teacher</td>
</tr>
</tbody>
</table>
| *Which object* question | Yes         | No        | 5         | ACC which teacher the-boy likes  
|                         |             |           |           | *Which teacher does the boy like?*                |
| Object relative         | Yes         | Yes       | 10        | zo ha-talmida she-ha-mora xipsa. this the-pupil that-the-teacher searched |
|                         |             |           |           | *This is the pupil that the teacher looked for.* |
| Object topicalization   | Yes         | No        | 10        | et ha-mora ha-zo ha-talmida xipsa. ACC the-teacher the-this the-pupil searched |
|                         |             |           |           | *This is the teacher that the pupil looked for.* |
| Simple                 | No          | No        | 20        | etmol ha-yalda nishka et ha-ganenet. yesterday the-girl kissed ACC the-kindergarten-teacher |
|                         |             |           |           | *Yesterday the girl kissed the kindergarten teacher.* |
| Embedded               | No          | Yes       | 10        | aba amar she-ima yeshena daddy said that-mommy sleeps |
|                         |             |           |           | *Daddy said that mommy is sleeping.*              |
the DHH participants also showed a clear deficit, repeating correctly only 73% of the object relative sentences and 61% of the topicalization sentences, again, a rate that was considerably lower than the rate of the much younger hearing children.

Crucially, whereas these DHH children had a great difficulty with the movement-derived sentences, they performed well in the repetition of the simple sentences and the embedded sentences without the movement. They repeated correctly 96% of the simple sentences and 98% of the embedded sentences.

The DHH children repeated correctly significantly fewer object questions than simple sentences \((T = 0, \ p = .004)\) and embedded sentences \((T = 0, \ p = .008)\). Their repetition of declarative sentences derived by Wh-movement was also severely compromised, with significantly fewer object relative clauses and topicalization (together) repeated correctly than simple sentences \((T = 0, \ p = .004)\) and embedded sentences without movement \((T = 0, \ p = .008)\). The DHH children’s ability to repeat object questions was similar to their ability to repeat object relatives and topicalization structures \((T = 3, \ p = .08)\). Their repetition of simple sentences and embedded structures was similar and very high.

Thus, the DHH children showed poor repetition of object questions, topicalization, and object relatives, whereas they repeated simple and embedded sentences without difficulty. Because object questions, topicalization, and object relatives share the property of being derived by Wh-movement, this repetition pattern suggests that the source of the difficulty is this type of movement. The results also clearly indicate that difficulty in relative clauses does not result from the involvement of embedding because the embedded sentences without movement (the sentential complements) yielded good repetition.

Whereas the repetition of structures derived by Wh-movement of the object across the subject was impaired, the performance in the subject questions, which are derived by Wh-movement but preserve the canonical order of the thematic roles, and do not involve crossing of one argument across the other one, was better. Subject questions yielded significantly better repetition than the object questions \((T = 0, \ p = .004)\). The repetition of subject questions was still

**Table 4** Percent correct repetition of the various sentence types in the deaf and hard-of hearing children (aged 9–12 years) and in typically developing hearing children aged 5–6 years

<table>
<thead>
<tr>
<th></th>
<th>Subject question</th>
<th>Object question</th>
<th>Object relative</th>
<th>Topicalization</th>
<th>Embedding</th>
<th>Simple</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deaf/heard of hearing</strong></td>
<td>Average % correct</td>
<td>80.0</td>
<td>54.5</td>
<td>72.7</td>
<td>60.9</td>
<td>97.8</td>
</tr>
<tr>
<td>Participants of 11 below 80%, (n)%</td>
<td>4 (36)</td>
<td>8 (73)</td>
<td>5 (45)</td>
<td>5 (45)</td>
<td>1 (9)</td>
<td>2 (18)</td>
</tr>
<tr>
<td><strong>Hearing 5-year-olds</strong></td>
<td>Average % correct</td>
<td>100</td>
<td>89</td>
<td>96</td>
<td>93</td>
<td>100</td>
</tr>
<tr>
<td>Participants of 35 below 80%, (n)%</td>
<td>0 (5 (14))</td>
<td>0 (5)</td>
<td>0 (3 (9))</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
poorer than the repetition of the simple and embedded sentences (80% compared with 94% and 96%, respectively) and still much below the repetition of the hearing young children.

In the individual analysis of performance of each participant, we considered a performance of 80% correct and above in a specific type of structure as an indicator of mastery of this structure (along the lines of the analysis of the sentence repetition task in Friedmann & Lavi, 2006). Performance below 80% was considered an indication of difficulty in this structure. According to this calculation, presented in Table 4, only two of the participants had a difficulty in the simple sentences (and they also had difficulties in all other type of sentences), and only one participant had a difficulty repeating the embedded sentences (as well as all other sentence types, including the simple sentences), whereas 5 had a difficulty in object relatives and topicalization, 4 had a difficulty in subject questions, and 8 of the 11 had a difficulty in the repetition of object questions.

Error analysis. In the analysis of the errors in repetition, we distinguished between structural errors, in which the child changed the structure of the sentence, changed the thematic roles in it, or produced an ungrammatical sentence, and lexical errors, which included substitutions of an NP with another NP that did not appear in the target sentence (a singer → a dancer), a substitution of the verb with another verb with the same argument structure (like → love), omission or addition of the definite article (the grandma → grandma), or an omission, substitution, or addition of a temporal phrase (yesterday → today). Some lexical substitutions were indicative of a problem with the thematic roles of the sentence and were hence counted as structural errors. These included substitution of one of the NPs in the sentence with the other NP, yielding a sentence in which one of the NPs appears on both roles (This is the girl that grandma drew → This is the grandma that grandma drew) and reversals (This is the girl that grandma drew → This is the grandma that the girl drew).

Lexical errors. The analysis of the lexical errors raised an interesting finding: The difficulty in the sentences derived by syntactic movement was expressed not only in structural errors but also in lexical errors—the children made more lexical errors in the sentences derived by Wh-movement (object relatives, topicalization, and object questions) than in the simple and embedded sentences without movement ($\chi^2 = 4.17$, $p = .04$), suggesting that the increased syntactic difficulty yielded also more lexical errors.

Types of structural errors produced. In the repetition of subject and object questions, most errors of the DHH children involved the accusative marker (6 such errors in subject questions and 21 in object questions of the 55 target questions of each type). In Hebrew, accusative markers appear with the (definite) object (Danon, 2001, 2006; Ruigendijk & Friedmann, 2008; Shlonsky, 1997), which, in the sentences that we used, was always the theme. A child who cannot identify the thematic roles in a movement-derived sentence will also not be able to know to which of the arguments the accusative marker should be attached, and as a result would not be able to assign the accusative marker to the theme (the object). Hence, thematic role difficulties can be reflected in accusative marker errors. In the repetition of Wh-questions, the DHH children either omitted the accusative marker, so there was no accusative-marked NP in the sentence (although both NPs were definite), or marked both NPs with an accusative marker, which is, again, ungrammatical. Another type of error in the object questions was the production of subject questions instead of object questions (see Appendix A for examples of erroneous repetitions).

Importantly, the omission of the accusative marker occurred only in sentences that are derived by Wh-movement. In simple sentences with a definite object, no accusative marker was omitted. This supports the view that the accusative marker errors in the movement-derived sentences were related to the difficulty in the comprehension of the thematic roles, rather than to a deficit in the case system.

In the repetition of object relatives, the main errors were the production of subject relatives or simple sentences instead of the target object relative (17 subject relatives and 7 simple sentences). In the repetition of topicalization, the common errors were the
production of a simple sentence (11 responses), a production of a simple sentence with an inversion or doubling of the roles (10 responses) or deletion of the object (4 responses), or a production of an ungrammatical or unfinished sentence (16 responses). The errors the children produced in the repetition task not only changed the structure of the sentence, but also frequently changed its meaning.

Another important finding pertains to the connections between the children’s performance in the various types of sentences. All the children who had a difficulty in the repetition of object relatives and topicalization had a difficulty also in the repetition of object questions. All the children who had a difficulty in the repetition of subject questions had a difficulty also in the repetition of object questions. The two children who had difficulty repeating simple sentences and the child who had difficulty repeating the embedded sentences also had a difficulty in the repetition of all the structures that included movement: object questions, object relatives, and topicalization. We can also look at the connections between the structures from the other direction: The two girls who succeeded in the repetition of the object questions repeated all the other types of structures without any errors.

**The Connections Between Children’s Performances in the Various Tasks**

Looking at the three Wh-questions experiments, we see that the children who showed deficits in the comprehension of relative clauses also had difficulties in the comprehension and production of Wh-questions. All the 11 participants who showed impaired comprehension of object relatives in the preliminary assessment had a difficulty in at least two of the three tasks that tested object questions—the comprehension task, the production task, and the repetition task.

All the 11 participants who had difficulties in the comprehension of object relatives were also impaired (performed significantly below the control group) in the comprehension of object questions; five of them even performed at chance level on the object *which*-questions. Three participants showed impaired comprehension of subject questions as well.

very similar findings came from Wh-question production. Of the 11 children who failed to comprehend object relatives and object questions, 8 participants showed impaired production of object questions (performed significantly below the control group) and 5 also had a difficulty in the production of subject questions. In addition, 9 of the 11 children who had a difficulty in the comprehension of relative clauses were also impaired in the repetition of object questions, 5 had a difficulty in the repetition of object relatives and topicalization, and 3 had a difficulty in the repetition of subject questions. The three participants who failed to understand subject questions also showed marked difficulty in the production of subject questions (and two of these participants also could not repeat these questions).

In all the (comprehension and production) experiments, a hierarchy of difficulty between the subject and object questions could be seen: There were children who had a difficulty only in object questions, and there were children who had a difficulty in both subject and object questions. All the children who failed to comprehend and produce subject questions also failed to comprehend object questions, in all the tasks. The two children who had a difficulty in the repetition of the simple sentences and embedded sentences also had a difficulty in all other structures.

Thus, the difficulty that is expressed in the comprehension of object relatives was also evident in the comprehension and production of object questions. In addition, the difficulty to comprehend and produce object relatives and questions is also reflected in the children’s ability to repeat these structures. A poor ability to repeat sentences was also noticed in the repetition of topicalization sentences. Therefore, the common syntactic characteristic of these structures—all being derived by Wh-movement—seems to be the cause to their difficulty in comprehension and production.

**Discussion**

This study explored the effect of hearing loss from birth on the comprehension, production, and repetition of Wh-questions and other syntactic structures that are derived by Wh-movement of school-age
DHH children. The main results of this study can be summarized as follows:

1. DHH children who have a difficulty in the comprehension of object relatives show similar difficulty in the comprehension of Wh-questions, which are derived by the same type of syntactic movement, Wh-movement.

2. They have a considerable difficulty in the comprehension of object \textit{which}-questions but show better performance on subject questions (both \textit{who} and \textit{which}) and object \textit{who}-questions.

3. DHH children are also impaired in the production of Wh-questions. When they are asked to produce object questions, they often produce subject questions instead, produce simple sentences, or produce other errors that indicate the miss-assignment of roles in the sentence. Their production of subject questions is also worse than that of hearing children who were 2 years younger. The DHH children also produce more ungrammatical questions (subject and object) than hearing children.

4. DHH children also show considerable difficulty in the repetition of object \textit{which}-questions, as well as object relatives and topicalization sentences, which are all derived by Wh-movement. Like in the production task, in repeating object questions they often change the object question into a subject question, or produce errors that indicate the miss-assignment of roles in the sentence. When they are asked to repeat object relatives or topicalization sentences, they change the sentences into simple sentences or reverse the thematic roles in the sentence.

5. DHH children who are impaired in the comprehension of object relatives and in the comprehension and production of Wh-questions do not have a difficulty in the repetition of simple and embedded sentences that are not derived by Wh-movement.

A Deficit in Movement or a Deficit in Embedding?

One of the aims of the current study was to determine whether the difficulty of DHH children in the comprehension and production of relative clauses (Friedmann & Szterman, 2006; Friedmann et al., 2010) should be ascribed to a deficit in syntactic movement or to a deficit in embedding. To determine between the movement and the embedding accounts, we tested two types of structures: structures with movement without embedding and structures with embedding without Wh-movement. We tested Wh-questions, which are structures with movement but without embedding, in comprehension, production, and repetition tasks. In the repetition task, we also included sentences of the second type: sentences with embedding but without movement.

Our results demonstrate that DHH children have a notable difficulty in structures derived by Wh-movement without embedding: They showed impaired comprehension, production, and repetition of Wh-questions, and impaired repetition of topicalization sentences. Alongside their impaired performance in these structures, the children performed very well in the repetition of embedded sentences that do not involve movement. The poor performance in structures derived by Wh-movement, even without embedding, and the good performance in embedded structures without movement lead to the conclusion that DHH children have a difficulty in sentences derived by Wh-movement (specifically, as we will see below, in the assignment of thematic roles to NPs in sentences derived by Wh-movement, when the object crosses the subject). They do not have a specific problem in embedding.

This conclusion is consistent with previous results regarding the difficulties Hebrew-speaking DHH children have also in the comprehension of topicalized OVS sentences (Friedmann & Szterman, 2006). Like Wh-questions, topicalized sentences are derived by syntactic movement of the object but do not include embedding; thus, the deficit in them supports a deficit in Wh-movement. Another finding from previous studies that suggests additional support for impairment in Wh-movement, rather than in embedding, is the way DHH children produce relative clauses (Friedmann & Szterman, 2006). First, the DHH children produced embedded sentences without movement instead of object relatives. Second, they showed relatively good production of subject relatives,
which include embedding (but in which the movement does not cross another argument). Finally, they used twice as many object relatives with a resumptive pronoun (such as her in This is the grandma that the girl drew her) than hearing children. These sentences include embedding but do not include Wh-movement (only a dependency between the pronoun and an antecedent; Friedmann & Costa, in press; Friedmann, Novogrodsky, Szterman, & Preminger, 2008), indicating again that the difficulty is a result of the movement rather than the embedding component of the relative clauses. The identification of the underlying deficit as a deficit in movement rather than embedding also has important implications for rehabilitation: It points to a domain of considerable difficulty, on the one hand, and suggests that it is possible to rely on the good syntactic abilities (i.e., embedding) in the remediation of the impaired ones, on the other (i.e., syntactic movement).

A Deficit in Role Assignment When the Movement Crosses Another Argument

The deficit in Wh-movement takes a very specific form, which is manifested both in the children’s scores on the various question types and in the erroneous responses they provided. First, a clear difference was found between subject and object questions. In the comprehension, production, and repetition tasks, the DHH children performed significantly better on subject questions than on object questions. Similar results were reported in Berent (1996) who found that DHH students were more successful in forming (written) questions involving subject position (55.5% correct) than they were on direct object position (41.6%) and object of preposition position (41.3%). The main difference between subject and object questions relates to whether or not the Wh-movement of an argument crosses the other argument. For example, the subject question “Which elephant washed the boy” includes movement (of which elephant), but this movement does not cross the other argument in the sentence, the boy. In contrast, the object question “Which elephant does the boy wash” includes a movement of the object, which elephant, across the subject, the boy. This, we suggest, is the crucial difference that causes subject questions to be significantly better than object questions in comprehension and production: Movement of one NP over another NP makes Wh-movement structures more difficult.10

The errors the DHH children produced in the question production task are also informative in this respect. When trying to produce object questions, they sometimes produced subject questions instead, thus using a structure with movement, but in which the movement does not cross the other argument. In other cases, they produced simple sentences, completely without Wh-movement. In other attempts to produce object questions, they omitted the accusative marker in the questions they produced, doubled the object, or used a verb with the wrong argument structure. The preference for nonmovement structures and these three error types indicate a difficulty in the construction of movement-derived sentences and in the assignment of thematic roles to arguments that crossed another argument: The omission of the accusative marker indicates that the child did not assign the correct thematic role to the NPs in the sentence (as the accusative marker marks the object, which, in the sentences we used, was the theme); object doubling is a way of “canceling” the syntactic movement by filling the gap of movement of the object from its place after the verb; and the incorrect argument structure is an evidence to the difficulty in the setting of the thematic grid of the sentence (there were no errors in the argument structure of verbs in the simple sentences or the subject questions that the children produced, only in the object questions). Other error types that helped the children avoid the crossing of one argument over the other and the difficulty that results from the need to assign the appropriate thematic roles to two arguments in the question were errors in which the full NP was omitted, by changing the transitive verb to a reflexive or intransitive verb, or simply by omitting one of the NPs in the question.

This characterization of the deficit as a difficulty in the assignment of roles to an argument that moved across another argument is also supported by the children’s repetition pattern. When repeating structures derived by Wh-movement (object questions, object relatives, and topicalization), the children often changed them into sentences that are not derived by
syntactic movement or that contain movement that does not cross the subject—simple sentences, subject relatives, or subject questions. They also omitted the accusative marker, doubled it, or changed the thematic roles of the target sentence. As mentioned above, the difficulties with the accusative marker and the inversion of the roles are evidence to the difficulty in the assignment of thematic roles in a movement-derived sentence. The repetition of sentences that are derived by Wh-movement as sentences without movement or as sentences in which the movement preserves the canonical order and does not cross another argument allows them to avoid the production of structures that are difficult for them.

An interesting finding that emerges from the comprehension task, and which allows us to further refine our understanding of the deficit, is the difference between which- and who-questions. Object questions of the “which” type were more difficult for the DHH children than the who-questions, although both question types contain movement of the object across the subject. Similar findings were reported for young typically developing children at the ages of 3.5–5.5—in these ages, the children already comprehended object who-questions but still had difficulties understanding object which-questions (Friedmann et al., 2009). Friedmann et al. explained the difference between these two types of questions in that in object which-questions like Which elephant does the boy wash?, a full (lexically restricted) NP (the elephant) crosses the subject, which is also a full NP (the boy), whereas in object who-questions like Whom does the boy wash?, the NP that moves (whom) and crosses the subject is not a full NP. It thus seems that the difficulty in the comprehension of the movement-derived sentences for the DHH children arises, like for young typically developing children, only in structures in which one full NP crosses another full NP. Such a refinement of the extent of the difficulty can explain why object who-questions are better comprehended than object which-questions.

This explanation can also account for Berent’s (1996) findings according to which the production of questions involving a simple Wh-phrase (who) was better than that of questions involving a complex Wh-phrase containing a possessive NP (whose lawyer).

In the object questions that Berent used, such as “Who did the wife leave on the road,” the moved element is who, namely, a phrase which is not a full NP, crossing a full NP (the wife), whereas the whose-questions he used, like “Whose lawyer did the secretary punch in the nose?” involve a movement of a full NP object, whose lawyer, across the subject, the secretary, which is also a full NP.

Importantly, the difficulty in crossing movement is already solved around the age of 6 for hearing typically developing children, and they already show mastery of (final branching) relative clauses in this age (Berman, 1997; Friedmann, Aram, & Novogrodsky, in press; Friedmann et al., 2009; Friedmann & Novogrodsky, 2004). Unlike them, this difficulty persists in third- and even fourth-grade DHH children. Of the 18 participants we initially tested, 11 showed impairment in the comprehension and production of Wh-movement-derived structures: Wh-questions, object relatives, and topicalization. The mean age of the participants was 10.2. In other words, many of the DHH children experience in elementary school a great difficulty in the comprehension and production of structures that typically developing children in much younger ages already comprehend and produce. Some studies with older participants show that they still have severe difficulties in certain syntactic structures and perform significantly below hearing participants even when they are 15 (Delage & Tuller, 2007) or even 21 years old (Haddad-Hanna & Friedmann, 2009).

Order of Acquisition in DHH and Typical Development

The examination of the types of structures that each of the DHH children could and could not repeat in the repetition task allows us to characterize the development of syntactic abilities in the DHH children as a delayed process that follows the same milestones as the normal development but does not reach its final stages. The repetition task included various structures—structures without syntactic movement: simple sentences and sentences embedded to a verb; structures with Wh-movement: topicalization, relative clauses, and Wh-questions; and structures with a short movement of an NP from object to subject position.
(A-movement, see footnote 7): sentences in subject–verb order that include unaccusative verbs. This task allows us to examine the hierarchy of acquisition of the different types of sentences. If a Guttman scale (Guttman, 1944) can be identified, according to which, consistently, each participant who can repeat a certain structure can already repeat another structure, and each participant who cannot repeat a certain structure also cannot repeat a different type of structure, we can come up with a hierarchy of acquisition of the relevant structures. Friedmann and Lavi (2006) found, using this repetition task in 60 normally developing children and the above rationale, a very clear order of acquisition. First, structures without movement and with A-movement are acquired and then Wh-movement is acquired (the last stage in Hebrew is V-C movement, the movement of the verb to the second position in the sentence, which will not be discussed in this article, see Friedmann & Costa, 2011).

The DHH children who participated in the current study showed the same hierarchy as did the young hearing children—they did not repeat correctly structures with Wh-movement if they had not acquired A-movement, for example. However, whereas hearing children already master all types of syntactic structures at this age, some of the DHH children showed that they have not acquired some of the later-acquired structures.

The resemblance between the DHH children and the typically developing children in the order of acquisition of the different structures is encouraging and is consistent with the findings concerning the typical order of acquisition in English (Berent, 1996; Quigley, Wilbur, et al., 1974), but the difficulties that emerge from the various studies, implying that the acquisition of syntax came to a standstill and does not reach its final stages, indicate that syntactic intervention is required, to try and bring the syntax of the DHH children to a level comparable with their hearing peers.

The Importance of Early Intervention for Later Syntactic Abilities

In a previous study (Friedmann & Szterman, 2006), we found that the crucial factor determining whether or not a DHH child can have normal syntactic abilities in school age was whether or not he/she received the necessary linguistic input during the critical period for first-language acquisition. Namely, the (orally trained) DHH children who performed well on relative clauses and topicalization structures in Friedmann and Szterman’ study were those who had a hearing aid fitted before the age of 8 months. Other background factors such as degree of hearing loss and type of hearing device (hearing aids or cochlear implants) did not seem to affect syntactic performance. In the current study, too, none of the participants received intervention before the age of 8 months, and all but two of the DHH children with syntactic impairment started their intervention and had hearing aids fitted or cochlear implants implanted only after they were 2 years old, and for some of them even after the age of 8 years, which might underlie their severe syntactic difficulties.

It is quite possible that when children with hearing loss are very young, when they are babies less than 1 year old, their language impairment is not evident to their caregivers and to health and education professionals and does not markedly affect their communication, and therefore, the urgent need for intervention and amplification does not arise from the interaction with the children. However, crucially, the findings from the current study testing their language abilities many years later, when they are in fourth grade, and previous studies (Friedmann & Szterman, 2006; Yoshinaga-Itano, 2003; Yoshinaga-Itano & Apuzzo, 1998a, 1998b) indicate how crucial intervention is in the first year of life, as this is the critical age for language input that will determine further syntactic development. Even if the syntactic impairment is hard to detect at early ages, the recommendation should be unequivocal—to provide babies with any sort of hearing device as early as possible.

To summarize, this study indicated that DHH children who are orally trained and who started intervention after the age of 8 months have severe impairment in the comprehension and production of Wh-questions. In everyday conversations, with their family and friends, children are often in need to ask questions, and are often asked questions they are expected to answer. Academic environment in school and afternoon academic activities are also very demanding with respect to question comprehension. Almost all exams
require the ability to understand questions, in order to be able to express knowledge and understanding in all fields. As one child told us, describing an exam in which he failed, “I knew the material for the exam by heart, I simply didn’t understand the questions!”. Their severe difficulties in the comprehension and production of questions can thus have far-reaching implications for social interaction, academic achievements, and well-being in school. It is therefore essential to include in the diagnosis of every child with hearing loss an assessment of syntactic abilities, including the ability to understand and produce Wh-questions and, if necessary, treat these structures.

Notes

1. Or a copy, under some recent linguistic theories (Boškovic & Nunes, 2002; Chomsky, 1995).

2. We run this research in Hebrew, in which the structure of Wh-questions is similar to English in the two relevant dimensions we mentioned: Like in English, the basic word order in Hebrew is subject–verb-object, and the movement of the Wh-phrase to the beginning of the sentence in Wh-questions is obligatory. Thus, subject questions involve movement, but this movement does not cross the object, and object questions involve movement of the object across the subject. Which- and who-questions in Hebrew are also quite similar to English, with a single word for who and two words, which + NP, for the which-questions. Two relevant properties of Hebrew Wh-questions that differ from the English ones are the existence of an accusative marker (marked ACC in the examples) before the object, and the fact that Hebrew does not require do-support, so an auxiliary is not needed after the Wh-morpheme, and the main verb itself is inflected in questions.

3. The initial group that was tested in this syntactic screening test included 18 DHH children. The seven additional children (five girls and two boys, aged 9.7–11.5 years; two cochlear implant and five other hearing aids) showed good performance in the relative clause screening test and therefore were not included in the study.

4. Participant 10 in Table 1 did not participate in the sentence–picture matching task but was included in the relative-clause-impaired group on the basis of his poor performance in a task of relative clause repetition.

5. We could not use Crawford and Howell’s (1998) t test to compare performances with control in the other question types because there was no variance in the control group, as all the control participants performed perfectly on these conditions. However, three DHH participants performed below 90% in the subject which-questions, and one performed below 90% on the subject and object who-questions.

6. Notice that if the factors along which we classify the structures are the involvement of the CP projection, then all of the Wh-movement structures we tested, relative clauses, Wh-questions, and topicalization, involved overt material in CP, and so did the sentences with the sentential complement embedding. As will become evident in the Results section, the findings of the repetition task indicate that neither embedding nor CP is the source of the syntactic difficulty in hearing loss.

7. The 20 simple sentences included 10 sentences in subject–verb order with unergative or transitive verbs, and 10 sentences in subject–verb order that included an unaccusative verb. The sentences with the unaccusative verbs allowed us to assess another type of syntactic movement: movement from object to subject position. According to syntactic theory, the single argument of unaccusative verbs like fall, vanish, and broke is the theme, which is base-generate in the object position, after the verb (_ fell the pencil). The sentence the pencil fell, thus, requires the argument the pencil to move from object to subject position. This type of short movement is termed “A-movement.” As we will see below, the DHH children showed no problem in the repetition of this type of syntactic movement. The test also included sentences with verb movement, which will not be reported here.

8. Moreover, recall that the study initially included 18 children with hearing loss. Eleven of them showed significant difficulties with relative clauses and were included in the report of the other tasks, and 7 children showed relatively good performance in relative clauses, as well as in the comprehension and production of Wh-questions. When we compared the repetition of the two subgroups, the group of DHH children that have a difficulty in the comprehension and production of Wh-movement made significantly more lexical errors than the group of DHH children that did not have this syntactic difficulty. Of the 36 lexical errors that were produced in the sentences with the syntactic movement (questions, object relatives, and topicalization), 31 errors, which are 86% of the errors, were produced by the group of children with the syntactic difficulty.

9. The good performance in embedding also indicates that the deficit of these children is not in CP, the highest domain in the syntactic tree. If they had a CP deficit, embedded sentences without movement would have also been expected to be impaired.

10. Another way of looking at the difference between subject and object questions relates to the canonicality of the argument order. In subject questions, the canonical agent–theme order is preserved. In object questions, however, the movement of the object across the subject creates a noncanonical order, in which the theme precedes the agent and the verb.

Funding

Israel Science Foundation (1296/06 to NF).

Conflicts of Interest

No conflicts of interest were reported.
Acknowledgements

We deeply thank Michal Nave for her collaboration on this research.

References


**Appendix A**

**Examples for errors in the various production tasks**

**Errors in the production of object questions**

Omission of the accusative marker

**Target:** et mi ha-yeled menashek?

**ACC who the boy kisses**

**Whom does the boy kiss?**

**Response:** mi ha-yeled menashek?

**Who the boy kisses**

**Incorrect argument structure or verb template with inappropriate number of arguments**

**Target:** et mi ha-yeled mesaben?

**ACC who the-boy soaps**

**Whom does the boy soap?**

**Response:** ha-yeled et mi hu mitkaleax?

**The boy whom does he soap-refl?**

**Doubling of the moved component or filling the gap (ungrammatical)**

**Target:** et mi ha-ish mecalem?

**ACC who the-man photographs**

**Whom does the man photograph?**

**Response:** mi aba mecalem yeled?

**who daddy photographs boy**

**whom does daddy photograph a boy?**

**Production of subject question with an inversion in the meaning of the question**

**Target:** et mi ha-pinguin doxef?

**ACC who the-penguin pushes**

**Whom does the penguin push?**

**Response:** mi doxef et ha-pinguin?

**who pushes ACC the-penguin**

**Who pushes the penguin?**

**Production of subject question with incorrect object**

**Target:** et mi ha-girafa melakeket?

**ACC who the-giraffe licks**

**Whom does the giraffe lick?**

**Response:** mi melakek oti?

**Who licks me?**
Production of subject question with incorrect verb or with a reflexive verb
Target: et mi ha-yeled mesaben?
ACC who the-boy soaps
Whom does the boy soap?
Response: mi mitraxec et ha-yeled?
Who washes-refl ACC the-boy?
Who washes-refl the boy?

Production of simple sentences
Target: et mi ha-yalda mesareket?
ACC who the-girl combs
Whom does the girl comb?
Response: ha-yalda mesareket et... the-girl combs ACC...
The girl combs...

Production of adjunct questions
Target: et mi ha-nasix mexase?
ACC who the-prince covers
Whom does the prince cover?
Response: lama davka ha-nasix mexase?
why davka the-prince covers
Why, of all people, the prince covers?

Errors in the production of subject questions
Avoidance from the production of one of the animate phrases in the sentence
Target: mi menagev et ha-yeled?
who dries ACC the-boy
Who dries the boy?
Response: mi noten magevet?
who gives towel
Who gives a towel?

Ungrammatical subject questions
Target: mi melatef et ha-kelev?
who caresses ACC the-dog
Who caresses the dog?
Response: mi melatef oti et ha-kelev?
who caresses me ACC the-dog
Who caresses me the dog?

Production of the a structure that does not fit the argument structure of the verb
Target: mi menadned et ha-yeled?
who pushes ACC the-boy
Who pushes the boy?
Response: mi mitnadned et ha-yeled?
who pushes himself ACC the-boy
Who pushes himself the boy?

Production of simple sentences instead of subject questions
Target: mi martiv et ha-ish?
who wets ACC the-man
Who wets the man?
Response: ha-yeled shofex al aba shelo.
the-boy spills on father his
The boy spills on his father.

Production of ungrammatical object questions
Target: mi melatef et ha-kelev?
who caresses ACC the-dog
Who caresses the dog?
Response: et mi ha-yeled melatef et ha-kelev?
ACC who the-boy caresses ACC the-dog
Whom does the boy caresses the dog?

Structural errors in the repetition task
Omission of the accusative marker in subject question repetition
Target: eyze melex hifxid et ha-leycan?
which king scared ACC the-clown
Which king scared the clown?
Repeated: eyze melex hifxid ha-leytsan?
which king scared the-clown?

Doubling of the accusative marker in object question repetition
Target: et eyze isha ha-yalda cilma?
ACC which woman the-girl photographed
Which woman did the girl photograph?
Repeated: et eyze yalda cilma et ha-yalda?
ACC which girl photographed ACC the-girl?

A repetition of an object question as a subject question
Target: eyze mora ha-yalda ohevet?
ACC which teacher the-girl likes
Which teacher does the girl like?
Repeated: eyze yalda ohevet et ha-mora?
which girl likes ACC the-teacher
Which girl likes the teacher?
A repetition of an object relative as a subject relative
Target: ze ha-shoter she-ha-balash xipes.
this the-policeman that-the-detective searched
This is the-policeman that-the-detective looked for.
Repeated: ze ha-shoter she-xipes et ha-balash.
this the-policeman that-searched ACC the detective
This the-policeman that looked for the detective.

A repetition of an object relative as a simple sentence
Target: zo ha-mora she-ha-talmida ra’ata.
this the-teacher that-the-pupil saw
This is the teacher that the pupil saw.
Repeated: ha-mora ha-zot ra’ata et ha-talmida.
the-teacher the-this saw ACC the-pupil
This teacher saw the pupil.

A repetition of a topicalized sentence as a simple sentence
Target: et ha-ganenet ha-zo ha-yalda xibka.
ACC the-kindergarten-teacher the-this the-girl hugged
This kindergarten-teacher, the girl hugged.
Repeated: ha-yalda ha-zot xibka et ha-ganenet.
the-girl the-this hugged ACC the-kindergarten-teacher
This girl hugged the kindergarten-teacher.

A repetition of a topicalization sentence as a simple sentence with an inversion of the roles (also includes a lexical substitution)
Target: et ha-mora ha-zo ha-talmida xipsa.
ACC the-teacher the-this the-pupil searched
This is the teacher the pupil looked for.
Repeated: ha-mora ha-zot hi xipsa et ha-yalda ha-zot.
the-teacher the-this she searched ACC the-girl the-this
This teacher, she looked for this girl.

A repetition of a topicalization sentence as a subject relative
Target: et ha-mora ha-zot ha-saxkanit ahava.
ACC the-teacher the-this the-player loved
This is the teacher the player loved.
Repeated: zot ha-mora she-ahava kaduregel.
this the-teacher that-loved soccer
This is the teacher that loved soccer.