CHAPTER 4

Relative clause acquisition in Hebrew and the learning of constructions

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In this chapter, I outline the developmental path of relative clauses in Hebrew while asking more general questions about how constructions are learned. I argue that Hebrew-speaking children show a gradual expansion of uses that is sensitive to the distributional patterns in their input. This pattern, found both in comprehension and production, is consistent with usage-based predictions about how constructions are learned. Taking Hebrew relative clauses as a case-study, I show how children's own uses become more semantically and structurally complex, and how their understanding develops to rely less on morphological cues. By looking closely at production and comprehension patterns we can see that children's use of relative clauses, like that of other constructions, develops gradually over time in ways that are sensitive to language-general and language specific cues. Finally, I suggest that the frequency of multi-word sequences (larger than one lexical word) plays a role in children's expansion of uses: Other things being equal, children prefer to produce construction variants with a higher chunk frequency.

Introduction

The ability to produce and comprehend relative clauses is often considered a milestone in language acquisition. It demonstrates young learners' mastery of recursion and their ability to use and understand non-local dependencies. Relative clauses also have unique semantic and pragmatic functions: to use them appropriately children need to learn the syntax, semantics and pragmatics of their use. These characteristics have made the acquisition of relative clauses a popular topic of investigation. In particular, the syntax of relative clauses, and how children learn it, has been the focus of much debate between usage-based and generative accounts of syntactic development (e.g., Borer & Wexler, 1987; Diessel & Tomasello, 2000, 2005). At the same time, while unique in their complexity, relative clauses are similar to other constructions in exhibiting a form-function mapping that translates into specific semantic and syntactic patterns. In this chapter, I trace the

developmental path of relative clauses in Hebrew, while showing what this path can tell us about learning syntactic constructions more generally.

In many generative accounts, children learn syntactic constructions by activating an innate set of rules (Chomsky, 1965; Pinker, 1984). Children need enough input to activate the rule, but once it is learned, they should be able to produce and comprehend the relevant syntactic structure equally well in different contexts and configurations. In this framework, learning a construction can be seen as moving from a state of no knowledge to a state of full knowledge.

Usage-based models predict a much more gradual path of development where children slowly build up knowledge about how and when a construction can be used (Berman, 1987; Goldberg, 2003, 2006; Lieven, Pine & Baldwin, 1997; Tomasello, 2000, 2003). This process is marked by a slow expansion of uses: to know a construction isn't an all-or-nothing state. Instead, children start out with a restricted early inventory that reflects how they have heard a construction being used. Over time, they begin to use constructions with a greater range of verbs and objects, and in more varied pragmatic contexts (e.g., Akhtar, 1999; Childers & Tomasello, 2001; Dabrowska, 2000). Consider, for example, the move from the early question *What's Mommy doing?* to *What's toy doing?*, where the subject (*Mommy)* is replaced by a less frequently used noun. Later uses include questions like *What's Georgie saying?*, where both the verb and the subject differ from those of the early formulae (Dabrowska, 2000).

The prediction is that children may find some instances of a construction easier to produce and understand than others, and that this will be influenced by usage-patterns. The more similar a configuration is to what children actually hear, and the better it fits the conventional pragmatic use, the easier it will be for them to use and understand it. For instance, children are more likely to correctly invert the auxiliary in English for certain wh-word + NP combinations like *can I*, which are used more often (Dabrowska, 2000; Dabrowska & Lieven, 2005): their knowledge of when an auxiliary is inverted varies for different instantiations of the same construction.

In the case of relative clauses, children also need to learn how to resolve the non-local dependency and assign the modified NP the correct thematic role in the embedded clause[1]. Even for adults, not all relative clauses are equally easy to understand (Gibson, 1998; Warren & Gibson, 2002; Mak, Vonk, & Schriefers, 2002). How hard it is to figure out who is doing what depends on the length of the dependency, how confusable the two NPs are (the modified and the embedded NP), and

1. I use the term modified NP to refer to the head of the clause (**the boy** that the girl chased), and embedded NP to refer to any NP that appears within the embedded clause (the boy that **the girl** chased).

the kinds of semantic and morphological cues found in the clause (e.g., case-marking, agreement, animacy, etc.). For example, in head-initial languages like English (and Hebrew), object relatives – where the dependency is less local, and where the speaker needs to maintain two NPs in memory before reaching the verb – tend to be harder to process than subject relatives (Gibson, 1998). But this difficulty is reduced when there are pragmatic, semantic and/or morphological cues that enhance the thematic assignment and make it more predictable (Gordon et al., 2001; Warren & Gibson, 2002; Mak et al., 2002). Object relative clauses like *the movie that I saw* with inanimate heads and pronominal subjects are no harder to understand than subject relatives like *the hikers that climbed the rock* (Mak et al. 2002; Reali & Christiansen, 2007a). Since inanimate entities are less likely to be Agents, having an inanimate first NP biases towards an object relative reading, and makes the two NPs more distinguishable. In addition, having pronominal subject reflects the givenness of subjects in general and of modifying clauses in particular, and the case-marking on the embedded pronoun enhances its role as the Agent of the clause. These factors combined make some object relatives easier than others for adults.

Adult speakers make use of multiple cues in resolving dependencies. To become proficient language users, children need to develop a similar ability to draw on multiple sources of information in forming an interpretation. They need to learn which cues are informative in their language, and how they align with thematic assignment (e.g., animate entities tend to be Agents).

Looking at the acquisition of relative clauses from the perspective of construction learning, we can ask whether the process shows the gradual mastery predicted by usage-based accounts and the reliance on multiple cues found in adult processing. Do children slowly expand their ability to produce and comprehend relative clauses? Is this expansion sensitive to the distributional properties of relative clauses in their input? Is children's ability facilitated when there are more cues to thematic assignment? Do they make use of the full range of cues their language provides, and if so, when?

In this chapter, I address these questions by looking in detail at how children learn to produce and comprehend relative clauses in Hebrew. Hebrew relative clauses are relatively similar in structure and function to English ones (Borer, 1984; Sharvit, 1999). But because Hebrew is rich in inflectional morphology, it provides cues to thematic assignment not found in English. Hebrew-speaking children need to learn how to mark these cues in production, and draw on them in comprehension. Hebrew allows us to explore language-general features of construction learning (gradual expansion of use, sensitivity to distributional patterns), while at the same time asking how, and when, children make use of language-specific cues.

In the next section I present a sketch of relative-clause structure in Hebrew. I then look at spontaneous speech to see how their use develops over time. I ask what early relative clauses look like, how similar they are to adult uses, and how their complexity develops. The third section focuses on children's comprehension to show that they understand some relative clauses better than others, and that their interpretation reflects sensitivity to distributional patterns and an ability to integrate multiple cues. In the final section, I draw on the acquisition of the dative construction in English to look at some mechanisms that may shift children towards more abstract representations of constructions.

Relative clauses in Hebrew

Hebrew is a basically SVO language in which relative clauses always follow the noun they modify (Berman, 1978; Givón, 1973; Shlonsky, 1997). Hebrew has restrictive and non-restrictive relative clauses, and both types have semantic and pragmatic features similar to those of English relative clauses. Hebrew relative clauses are preceded by the obligatory complementizer */ʃe/* 'that'. The same complementizer (ʃe) introduces relative clauses, complementizer clauses, and verbal complements. The complementizer is not marked for agreement of any kind, and gives no information about the thematic role of the modified NP. Example (1) shows a right-branching subject relative clause and example (2) shows a right-branching object relative clause (Hebrew also has center-embedded relative clauses).[2]

(1) *Raiti et ha-yeled ʃe-tafas et ha-kelev*
saw.1SG ACC the-boy that-caught ACC the-dog
'I saw the boy that caught the dog'

(2) *Raiti et ha-yeled ʃe-ha-kelev tafas*
saw.1SG ACC the-boy that-the-dog caught
'I saw the boy that the dog caught'

Word order is freer than in English and OVS configurations are not infrequent, but are pragmatically marked (Givón, 1973, 1976). The relative clause follows the modified noun even when that noun is fronted and topicalized.

Hebrew verbs, in main and embedded clauses, agree with the subject in number, gender and often person (agreement is marked for all persons in past and future tenses, but not in the present tense). In many cases, the verbal morphology

2. The following abbreviations are used in glosses throughout: ACC = accusative case, NOM = nominative case, FEM = feminine, MASC = masculine, 1SG = first person singular, 3SG = third person singular, PL = plural.

tells you who is doing what: from the verb, you can tell the number, gender and person of the Agent. This information may be especially useful for resolving unbounded dependencies like the ones found in relative clauses. In Hebrew, as long as the modified NP and the embedded NP differ in number, gender or person, the verb will uniquely pick out one of them as the Agent of the embedded clause[3].

Example (3) shows a subject relative clause where the modified NP is masculine, and the embedded subject is feminine. Example (4) shows an object relative clause with the same NPs. In both, the verb form can only agree with only one of the NPs.

(3) *Ha-axot* *ʃe-**mecayeret*** *et* *ha-yeled*
the-nurse.FEM that-draws.FEM ACC the-boy
'The nurse that draws the boy'

(4) *Ha-axot* *ʃe-ha-yeled* ***mecayer***
the-nurse.FEM that-the-boy draws
'The nurse that the boy draws'

Hebrew is a pro-drop language: first-person and second-person pronominal subjects can be omitted when the verb is inflected for number/person (past and future tenses only). Case-marking on pronouns and NPs provides another cue for thematic assignment. All pronouns (first, second and third, singular and plural) have different forms in the nominative, the accusative and the oblique (they are unmarked in the nominative and marked differently in the accusative and the oblique). For example, the first-person pronoun is 'ani' in the nominative and 'oti' in the accusative. Definite lexical NPs also have different forms in the nominative and the accusative: they appear with a preceding *et* 'ACC' in the accusative but not in the nominative (*ha-yalda* [the-girl] vs. *et ha-yalda* [ACC the-girl]). The form tells the speaker whether the entity in question is the subject or object of the clause, even if the word order inside the embedded clause is scrambled.

Finally, Hebrew makes use of resumptive pronouns in certain grammatical positions. Resumptive pronouns are disallowed in subject position, optional in direct object position, and obligatory in oblique position (Givón, 1973)[4]. Example (5) shows an object relative clause with a resumptive pronoun (in bold) where the two NPs differ in gender. Resumptive pronouns agree in gender, number and

3. This is not true for verbs in present tense, which are only marked for gender and number.

4. The distribution of resumptive pronouns in spoken Hebrew is not as clear-cut, in particular, the obligatory status of resumptive pronouns in oblique positions seems to be changing (Ariel, 1999). The status of resumptive pronouns in subject position may be different in verb-less clauses: both children and adults occasionally produce resumptives in such clauses (Arnon, 2005b).

person with the modified NP, another cue to how the dependency should be resolved (note also that the masculine verb-form calls for a masculine subject).

(5) *Raiti et ha-axot* *ʃe-ha-yeled* *mecayer* ***ota***
saw.1SG ACC the-nurse.FEM that-the-boy draws her
'I saw the nurse that the boy is drawing her'

The developmental path of relative clauses in Hebrew

What do children's relative clauses look like in Hebrew? In this part, I outline the developmental path of relative clauses in Hebrew while exploring the predictions outlined in the introduction about how constructions are learned. I use production data to ask if children's uses expand gradually. I use comprehension findings to see if children's performance is uniform for all instances of a construction and, if not, whether it is affected by the same kinds of distributional features and processing pressures that affect adults.

Production

The first step in understanding how children acquire relative clauses is to look at spontaneous speech to see what they actually produce. If we want to ask if children show a gradual expansion of uses, we need a record of the kinds of relative clauses they use over time. Many studies have used experiments to look at the elicited production and comprehension of relative clauses in Hebrew (e.g., Arnon, 2005a, 2010; Berman, 1986; 1997; Friedmann & Novogrodsky, 2004), but there has been less work outlining their developmental path using spontaneous speech.

Researchers often draw on examples from spontaneous speech to support developmental claims (e.g., Berman, 1985), but there hasn't been, to date, any corpus study devoted to the detailed analysis of Hebrew relative clauses in a larger sample of child speech. From other languages, we know that such investigations can shed light on how constructions are first used and expanded (e.g., Diessel & Tomasello, 2000; Brandt, Diessel & Tomasello, 2008), and can corroborate or refine previous developmental claims.

I conducted a preliminary investigation of this kind by looking at the relative clauses produced by two siblings (the data is taken from the Ravid database, Ravid, 1995). I chose to focus in depth on two children because in this way, I could track children's productions from the earliest relative clauses to later more complex ones. Given the small number of children, and the relatively small number of recordings (about twice per month), this is only a first step in the analysis of children's

spontaneously produced relative clauses in Hebrew. But it can still illuminate how children learn the construction.

The corpus

I extracted all the Hebrew relative clauses from the Ravid database (Ravid, 1995). The database is based on a six-year longitudinal study of two children (aged 1;8 and 0;9 at the beginning of the recordings). Both children are growing up as monolingual Hebrew speakers in a middle-class, urban environment. I extracted all the utterances that had the complementizer */ʃe/* in them and separated the relative clauses from verbal complements[5]. The corpus contained 87 child relative clauses produced between the ages of 2;2–6;3 (60% of produced by the older sister, 40% by the younger brother).

Coding

Following the coding scheme presented in Diessel & Tomasello (2000), I hand-coded all the relative clauses for (1) the syntactic role of the modified NP in the main clause (main-subject, main-object, main-oblique, main-predicate nominal, and main-isolated noun phrase), and (2) the syntactic role of the modified NP in the embedded clause (subject, direct object, and oblique). To get another measure of the semantic content of the clause, I also coded the embedded clauses for verb type–– transitive, intransitive, and verb-less (there are several clausal constructions in Hebrew that can appear without a verb, Doron, 1983). In addition I coded the clauses for (1) the animacy of the modified and embedded NPs (animate vs. inanimate), and (2) the referential type of the modified and embedded NPs. I coded NP-type using two pronominal categories and one lexical category.

The pronominal categories were: PRONOMINAL (first person: *ani* 'I', *anaxnu* 'we', *oti* 'me', *otanu* 'us '; second person: *ata* 'you.MASC', *at* 'you.FEM', *atem* 'you.PL.MASC', *otxa* 'you.ACC.MASC', *otax* 'you.ACC.FEM', *otxem* 'you.ACC.PL.MASC; third person: *hu* 'he', *hi* 'she', *hem* 'they.MASC', *hen* 'they.FEM', *oto* 'him', *ota* 'her', *otam* 'them.MASC', *otan* 'them.FEM'), and OMITTED SUBJECT (for past tense clauses with first or second person marking on the verb only)[6]. The lexical category was LEXICAL NP (including proper names and kinship terms). The categories collapse

5. Relative clauses that were realized without the obligatory complementizer would not be found using this search method, meaning that very early uses could have been missed.

6. I initially had a separate category for third-person pronouns, since those are not necessarily discourse-given. Because there were only two utterances with a third-person pronoun in the corpus I opted for one PRONOMINAL category instead.

gender and number but maintain a distinction between discourse-given entities (first and second person) and discourse-new ones (lexical NPs), and between pronominal subjects that are realized and ones that are omitted.

Results and discussion

The earliest relative clauses appear a few months after each child's second birthday, matching previous reports (Berman, 1985; 1997). Interestingly, despite claims that subject relatives appear earlier (Berman, 1986; Friedmann, Aram, & Novogrodsky, in press), I found both subject and object relatives among children's first relative clauses. Note that my data does not include relative clauses without complements: it is possible that some early relative clauses were not detected. However, it is unlikely that this caused the observed pattern. Unlike English, the complementizer is obligatory for both subject and object relatives, meaning there is an equal chance to miss both subject and object relatives. Moreover, the ages looked at are very similar to those tested in previous studies. Consider the following examples, from the first ten relative clauses produced by the children (age-of-production and gender given in brackets):

(6) *Hirkavnu et ze et ha-parcuf ʃe-maya natna li*
built.1PL ACC that ACC the-face that-maya gave.FEM to.me
'We built that, the face that Maya gave me' (2;2, M)

(7) *Yeʃ od bubot ʃe-hem xolot*
there more dolls.FEM.PL that-they.MASC sick.FEM.PL
'There are more dolls that are sick' (2;4, M)

(8) *Haze ʃe-hafax et ha-perax*
that that-turned.over ACC the-flower
'The onethat turned over the flower' (2;4, F)

The examples include both subject and object relative clauses. In fact, sentence (6), a rather complex object relative clause, is the first relative clause attested for the younger brother in the corpus.

Overall, object relatives were most frequent (N = 43, 49%), followed by subject relatives (N = 33, 38%), and oblique relatives (N = 11, 13%)[7]. The distribution is similar when we look only at the first 10 relative clauses from each child (N = 20):

7. It is encouraging that these proportions, while taken from only two children, are very similar to the ones reported in Arnon (2010a) based on a larger corpus study (using speech from 40 children). This larger corpus was not suitable for the current investigation since it was based on cross-sectional elicited narrative data, and not longitudinal naturalistic data, which is needed to track the development of early relative clauses.

55% were object relatives, 35% subject relatives, and 10% oblique relatives. From early on, children produce a variety of relative clause types, and use them to assign various thematic roles to the modified NP. The relative frequency of the clause types is similar to that found for child and child-directed speech in Hebrew (Arnon, 2010a), for child German (Kidd et al., 2007), and for adult-to-adult speech in English (Roland et al., 2007).

Interestingly, the proportions differ from the ones found in studies using elicited production where children produce subject relatives with greater frequency and ease than object relatives (Berman, 1985; Günzberg-Kerbel, Shvimer & Friedmann, 2008; Varlokosta & Armon-Lotem, 1998). This discrepancy is probably related to the kinds of relative clauses children are asked to produce: In experiments children are often asked to describe animate entities. In natural speech, animate entities are usually modified by subject relatives but in experiments children are asked to modify them using object relative clauses as well (which usually modify inanimate entities). While both clause types are equally plausible given the experimental stimuli, only one type (the subject relative) is used for modified animate entities in natural speech. This results in a difference between what children usually produce and what they are asked to produce in the experimental set up. Whatever its source, the discrepancy highlights the need to draw on both experimental and spontaneous data in studying child language.

How adult-like are children's relative clauses?

To produce correct relative clauses in Hebrew, verbs need to agree in number, person, and gender with the embedded subject. From the earliest relative clauses, children mark these agreement patterns without error. In sentence (6), produced at age 2;2, the verb form correctly agrees with the feminine subject and not with the masculine modified NP. The corpus included no cases where children marked agreement with the incorrect entity (e.g., with the modified NP instead of the embedded subject), or where they failed to mark agreement at all. Faithful to the input they hear, children are already inflecting verbs correctly when they start to produce relative clauses[8].

Another way to evaluate the maturity level of children's relative clauses is to ask whether they exhibit the same pragmatic relations and patterns found in adult speech. I focus on two dimensions: animacy of the head, and the referential type of the embedded NP. Object relative clauses tend to be headed by inanimate NPs while subject relative clauses appear mostly with animate NPs (Mak et al., 2002).

8. This is not to say that all of children's relative clauses were adult-like. Some of them had unusual word order while others used inappropriate lexical items but none had agreement errors.

This reflects the link between animacy and thematic role: animate entities make better Agents while inanimate entities make better Patients. This pattern is found in children's relative clauses: 98% of object relatives are headed by an inanimate NP while only 51% of subject relatives are headed by such NPs. A similar pattern is found when looking only at the 20 earliest relative clauses: all the object relatives have inanimate heads but only 42% of subject relatives do.

The relatively high number of subject relative clauses with inanimate heads can be traced back to (a) the existence of verb-less embedded clauses in Hebrew where the subject-referent is not performing an action but is being modified by a noun, adjective, or preposition (for example *tavnit ʃe-betox ha-megira* [tray that-inside the-drawer] 'tray that is inside the drawer'). Such clauses can modify both animate and inanimate entities; and (b) the prevalence of relative clauses headed by agentive-like weapons such as *missile*, *gun*, and *bomb*... (these made up over half of the inanimate-headed subject relatives). Sentence (9) shows an example of an object relative with an inanimate head, and sentence (10) has a subject relative with an agentive inanimate head.

(9) *Ima, tiri et ha-ec ʃe-ciyarti*
Mom look.FEM ACC the-tree that-drew
'Mom, look at the tree that I drew' (3;2, M)

(10) *Veze ha-rove ʃe-horeg if*
and this the-gun that-kills man
'And this is the gun that kills people' (3;8, M)

Relative clauses, like main clauses, show linkage between discourse-status, referential form, and syntactic role. In main clauses, subjects tend to be given and pronominal, while objects tend be new and non-pronominal (e.g., *I saw a man*, Du Bois, 2003; Francis et al., 1998). A similar pattern is found in relative clauses across languages (Fox & Thompson, 1990). In speaking to children, Hebrew-speaking adults tend to produce object relatives with pronominal subjects, and subject relatives with lexical objects (Arnon, 2010a). We can look at children's utterances to see whether their choice of referential form also exhibits these discourse-governed patterns.

Of the object relatives that had a subject[9], 51% had a pronominal subject, and in another 42% the subject was omitted all together (this is allowed in Hebrew when the verb is inflected for number and person). Only 3 object relatives had a non-pronominal subject. The pattern was different for subject relatives where all but one transitive clause had a lexical NP as the object. In producing relative

9. Hebrew has subject-less clauses where the verb is either in the passive or appears in 3rd-person-plural to indicate an unspecified Agent.

clauses, children use a variety of referential forms in pragmatically appropriate ways, similar to adult usage. The current sample is too small to ask when and how these abilities develop, but these questions can (and should) be addressed for early relative clauses from a larger sample of children.

So far, the relative clauses children produce, including the very first ones, look a lot like those used by adults: children use them to express a variety of thematic relations; they are correctly marked for agreement; and reflect pragmatically-driven choices of referential form and animacy. In fact, early relative clauses in Hebrew seem somewhat more complex than those found in English. Compare the following examples of early English relative clauses (taken from Diessel & Tomasello, 2000) to the Hebrew examples (6)–(8) produced by children in the same age range.

(10) That's a turtle swim 2;2
(11) That's the rabbit fall off 2;4
(12) Who's that fit on the train 2;3

The Hebrew examples involve more NPs, and are more varied in terms of the syntactic role of the head in the main clause. Notably, the Hebrew examples don't have the agreement omission errors found in the English relative clauses (e.g., *swim, fit*). Hebrew's rich inflectional system may actually make it easier for children to produce relative clauses because there are additional cues to mark who is doing what inside the embedded clause.

How does the construction develop over time?

In what sense, then, do children expand their uses of the relative clause construction? Even though many of the properties of 'mature' relatives are present in early relative clauses, there are interesting ways in which the construction becomes more complex. In particular, children learn to use relative clauses to express richer semantic propositions (Diessel & Tomasello, 2000). The semantic complexity of the construction in Hebrew develops in several ways. First, children start to use relative clauses to talk about different kinds of events happening in different times. Early relative clauses describe events that happened in the past (59%), or are happening now (41%). Later relative clauses are also used to talk about future events, as well as possible and necessary events (using modal verbs like 'can' or 'should'). Compare utterances (14), (15), and (16).

(13) *Sefer ʃe-hu nofel*
book that-he falls
'A book that falls' (2;4, F)

(14) Nesaper lo sipurim ʃe-at sipart lanu
tell.3PL him stories.PL that-you.FEM told.FEM to.us
'We will tell him stories that you told us' (3;6, F)

(15) *Ani osa kailu ʃe-ani bixlal loh ivanti ma ʃe-ata omer*
I do.FEM like that-I at.all not understood what that-you say
'I pretend that I didn't understand any of what you say' (5;5, F)

Example (15) illustrates another way in which clauses become more complex. The utterance in (14) expresses a single proposition that could be paraphrased in one sentence (*the book is falling*). Example (15) expresses two propositions (one in the main clause and one in the embedded clause), which is what we would normally expect from a relative clause (Fox & Thompson, 1990). Example (16) shows syntactic, semantic, and pragmatic complexity: it has two levels of embedding, uses verbs in different tense, and talks about an imagined reality.

Interestingly, the tendency to produce more mono-propositional relative clauses early on is less marked in Hebrew than it is in English, and there are fewer of them overall: 50% of early relative clauses are mono-propositional compared to 44% in the entire corpus (over 80% of early English clauses were mono-propositional compared to 70% overall, Diessel & Tomasello, 2000). Early relative clauses in Hebrew also show less developmental change in argument structure: most of both early and later clauses are transitive (in English, they are intransitive). The sample is too small to draw strong conclusions but it raises interesting questions about the interplay between morphological richness and the semantic complexity of early relative clauses.

Children's relative clauses do develop structurally. One of the non-adult features in children's relative clauses in Hebrew is the inappropriate use of resumptive pronouns (Armon-Lotem, Botwinik-Rotem, & Birka, 2006; Friedmann, Aram, & Novogrodsky, in press; Varlokosta & Armon-Lotem, 1998). We find ungrammatical resumptive pronouns in subject position (17), and ungrammatical resumptive NPs in object position (18) (only pronouns can appear here).[10]

(16) *Et ha-daysa ʃe-**hi** kara*
ACC the-porridge that-she cold.FEM
'The porridge that she is cold' (3;5, F)

(18) *Et ha-balon ʃe-Sivan atfa **balon***
ACC the-balloon that-Sivan wrapped.FEM balloon
'The balloon that Sivan wrapped the balloon' (3;5, M)

10. Since there were also two instances of missing obligatory oblique resumptives (az nishma et ma she dibarnu 4;1), I don't discuss them further (but see Armon-Lotem et al. 2006).

Resumptive NPs, as in (18), only appear in early clauses. Resumptive subjects (17) last longer, but their use is reduced (from 58% in early subject relatives to 33% overall). Children seem to over-use resumptive pronouns initially, maybe as a way of enhancing the role of the modified NP in the embedded clause.

In sum, spontaneous production illustrates the gradual way that children's ability to produce relative clauses develops. The current chapter joins previous accounts emphasizing the gradual nature of speech development in Hebrew (e.g., Berman, 1985; Berman & Neeman, 1994). On the one hand, early clauses show many of the features of adult ones. Children started out producing a range of clause types: their use wasn't limited to one syntactic configuration. They used clauses to express a range of thematic relations, and correctly inflected the verbs to agree with the grammatical subject. They followed adult pragmatic conventions with regard to animacy and the alignment of syntactic position and referential form. They used relative clauses to convey information in a way that was adult-like. At the same time, there is a gradual expansion in the semantic complexity of the message conveyed by the utterance, and a modification of non-adult features (like the over-use of resumptive pronouns). Children become more skilled with the construction over time. I turn now to comprehension to ask how children develop an understanding of relative clauses and whether they rely on language-specific cues in the process.

Comprehension

Children's comprehension of relative clauses has been studied extensively (see Diessel, 2004). As in other languages, Hebrew-speaking children find object relatives harder to understand than subject relatives. Even though children produce and hear both forms, they have a harder time understanding object relative clauses (Arnon, 2005a, 2010a; Friedmann & Novogrodsky, 2004). In some studies, Hebrew-speaking children are still at chance at age 5;0 (Friedmann & Novogrodsky, 2004). This apparent asymmetry provides a good way to investigate the mechanisms at work in children's learning of these constructions and their ability to attend to language-specific cues.

One interpretation is that children have not yet mastered the syntactic rules needed to understand object relatives, specifically, they are not capable of understanding structures that involve syntactic movement (Friedmann & Novogrodsky, 2004). As a result, they are unable to form the link between the head NP and its role in the clause, and so have a hard time interpreting object relative clauses correctly. Children's difficulty is seen as a unique developmental stage that ends when the rule is learned.

Alternatively, children's difficulty may be driven by input patterns and processing pressures that play a role throughout the life span (Arnon, 2005a, 2010a; Kidd et al., 2007). In object relatives, the distance between the head NP and the embedded verb is longer than in subject relatives: listeners have to maintain two NPs in memory before assigning thematic roles. Adults have a harder time resolving the dependency when it is longer, when the NPs are more confusable, and when there are fewer cues that support the thematic assignment (e.g., it is harder when both the Agent and Patient of the embedded clause are animate, Mak et al., 2006). If similar processing pressures affect children, then some object relatives should be easier than others. Difficulty should be reduced when the thematic assignment is more predictable (e.g., in terms of animacy) and is reinforced by semantic and morphological cues.

Object relatives may also become easier when they are more similar to what children actually hear and produce. While the object relatives that children produce tend to have pronominal subjects (like adult ones), the clauses they are tested on usually involve two lexical NPs (e.g., *the duck that **the boy** is chasing*, Sheldon, 1974; Correa, 1995). Unlike spontaneous object relatives, the subject does not refer to a given entity (or if it does, it isn't marked with a pronominal form as expected). More generally, the kinds of items children are tested on don't always comply with the pragmatic conditions on the use of relative clauses (Hamburger & Crain, 1982), or with the linkage between discourse-status, syntactic position and referential form.

Under this alternative interpretation, comprehension (like production) is a gradual process sensitive to usage patterns and processing biases. Children start out understanding some object relatives. They draw on multiple cues in figuring out who is doing what. Over time, as they accumulate more experience with language, they develop more abstract knowledge of the construction while still attending (like adults) to language-general (e.g., animacy) and language-specific (e.g., case-marking) cues. Importantly, there isn't any one point in development that marks the move from no understanding to full understanding.

If this interpretation is correct then (a) children should show better comprehension with object relatives that are more similar to what they hear, and (b) their difficulty should be reduced when the thematic assignment is reinforced by multiple cues. In Hebrew, this means that children should show reduced difficulty when the verb-form agrees with only one of the NPs.

Input patterns and gender agreement

In my own work (Arnon, 2010a), I've compared children's comprehension of object relative clauses with first-person subjects (e.g., *The nurse that I am drawing*)

and lexical NPs (*The nurse that the girl is drawing*) to demonstrate their sensitivity to distributional patterns, and to undermine claims about an across-the-board difficulty with all object relative clauses. Even though Hebrew-speaking children rarely produce object relatives with lexical subjects, and even though having two lexical NPs makes the NPs more confusable and harder to process, children's comprehension has typically been assessed using object relatives with two animate lexical NPs. Their poor performance was seen as indicating that they hadn't yet mastered the construction (Friedmann & Novogrodsky, 2004). If, alternatively, children can understand some object relatives better than others, and this depends on input patterns and processing pressures, they should show good comprehension in the pronoun condition (see Arnon, 2010a).

Method

Using a modified picture-selection task, I asked 23 4;6 year-old Hebrew-speaking children to comprehend subject and object relatives clauses. This is a good age to test since children at this age have shown poor performance in previous studies (Arnon, 2005a; Friedmann & Novogrodsky, 2004). The pictures showed two events involving the same entities but with their roles reversed (e.g., a nurse drawing a girl, and a girl drawing a nurse). They also contained a distracter entity (e.g., a nurse talking on the phone). Because there are multiple entities of each kind (three nurses and two girls), use of relative clauses to identify a specific referent is pragmatically felicitous (e.g. Hamburger & Crain, 1982). Unlike in previous studies, all the entities had the same accessory (e.g., shoes), but painted a different color. I assessed comprehension by embedding relative clauses within questions about the colors of accessories (e.g. Hebrew: *eize ceva hana'alaim ʃel ha-axot ʃe-ha-yalda mecareyet*? [which color the-shoes of the-nurse.FEM that-the-girl draws.FEM], 'What color are the shoes of the nurse that the girl is drawing?').

Object and subject relatives were tested in two conditions: with embedded lexical NPs and with embedded first person pronouns. The left-hand panel of Figure 1 shows a picture for the lexical NP condition. The right-hand panel shows the same event for the pronoun condition. Pictures for the pronoun condition were created by replacing one of the entities with a photo of the author. This enabled me to use relative clauses with a first person (e.g. Hebrew: *eize ceva hana'alaim ʃel ha-axot ʃe-ani mecareyet?* [which color the-shoes of the-nurse.FEM that-I draw.FEM], 'What color are the shoes of the girl that I am drawing?'), while keeping the items effectively identical (same verb, same distracter).

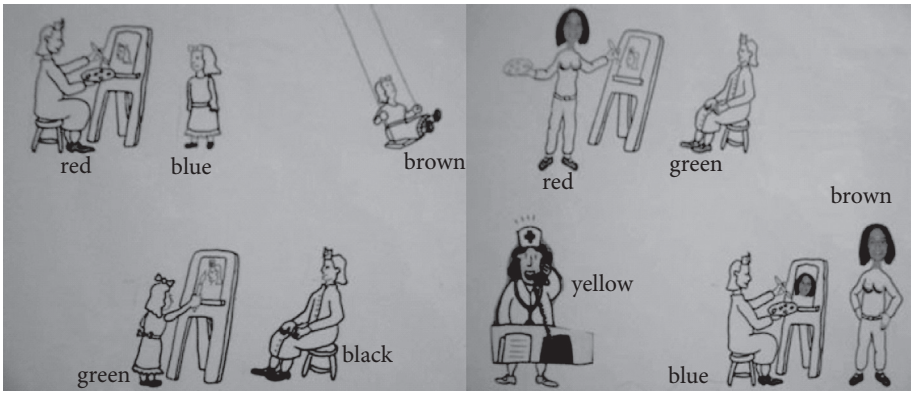

Figure 1. Example pictures for the lexical NP and pronoun conditions with colors of shoes (the attribute asked about) indicated on the figure (taken from Arnon, 2010a, permission from Cambridge University Press)

I constructed sixteen pictures using eight transitive verbs (*push*, *catch*, *feed*, *draw*, *wash*, *brush*, *clean*, *kiss*), with each verb used once in the lexical NP condition and once in the pronoun condition. All entities (*monkey, nurse, dog, lion, clown, bear, cowboy, giraffe, girl, elephant, cat, princess, chicken, king, policeman*) and verbs appear on the MacArthur Communicative Development Inventory (CDI) battery for three-year-olds. Each picture was presented once with an object relative clause and once with a subject relative clause. The items were presented in a semi-randomized fashion, so children heard no more than two consecutive items of the same type (subject/object, pronominal/lexical).

Results and discussion

Children were indeed better at comprehending object relatives with pronominal subjects: they were correct 85% of the time in this condition compared to 69% in the lexical NP condition ($B = 0.96$ ($SE = 0.31$), $p = 0.002$[11]). Contrary to previous reports (Friedmann & Novogrodsky, 2004), 4;6 year-olds showed good comprehension of object relatives when those were more similar to the ones they hear and produce. In addition, children found certain configurations easier than others within the same construction.

Children's improvement parallels reports for adult performance and suggests a common sensitivity to complex distributional patterns. Object relatives with pronouns are congruent with the linkage of discourse status and referential form: subjects

11. I used mixed-effect logit models (Baayen et al., 2008) to analyze the results. These models are better suited for analyzing categorical data and allow you to control for random subject and item effects simultaneously. For further discussion see Jaeger, 2008.

of embedded clauses are often given, and given entities are most often referred to with pronominal forms (Du Bois, 2003). Children, like adults, are sensitive to this pattern, showing better comprehension of object relatives with pronominal subjects.

The relation between distributional features and comprehension is complicated by children's performance on subject relatives. Figure 2 shows the proportion of correct responses for subject and object relatives. Subject relatives were easier than object relatives, even in the pronoun condition (96% correct for subject relatives vs. 84% for object relatives, B = 1.55 (SE = 0.45), $p < 0.001$). This is surprising given that pronominal subject relatives are much less frequent than pronominal object relatives (Reali & Christiansen, 2007a; Roland et al., 2007).

Why then are object relatives still harder? For starters, children still need to process two NPs before reaching the verb (even if one of those is pronominal). Additionally, the object relatives here had different animacy features from those in spontaneous speech. Most object relative clauses in Hebrew have inanimate heads, but the ones children were tested on had animate heads. The gap between object and subject relatives may disappear when using relative clauses with an inanimate head and a pronominal subject (compare *The ball that I hit* vs. *The ball that hit me*).

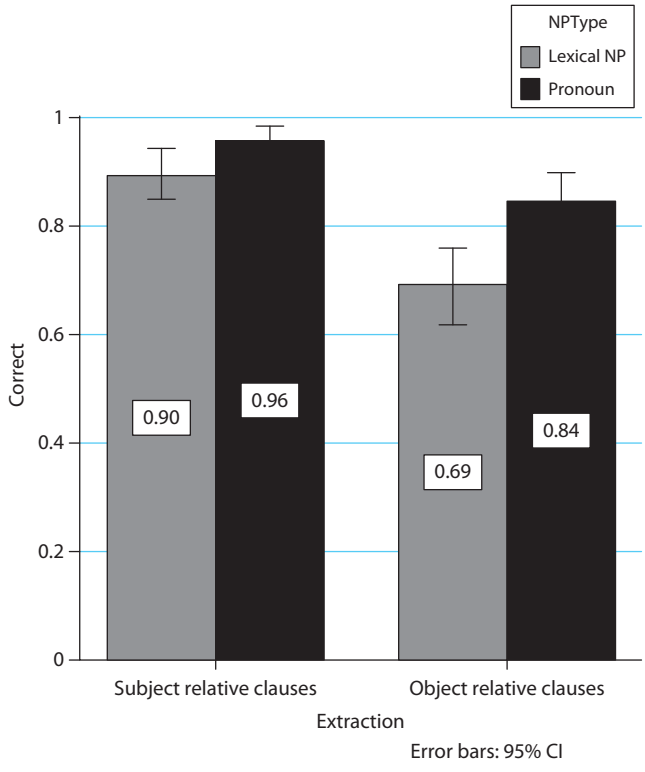

Figure 2. Proportion of correct responses by Extraction and NP type (taken from Arnon, 2010a, permission from Cambridge University Press)

The findings also reveal that children had less difficulty when there was a gender mismatch between the modified NP and the embedded one (this happened in some, but not all the items). Since verbs are marked for gender in Hebrew, this provided an additional cue for thematic assignment. Where the two NPs differ in gender, the verb is marked as either masculine or feminine, indicating who the Agent is. Children performed better on relative clauses with gender cues than those without (88% vs. 82%, B = 0.57 (SE = 0.25), $p = 0.02$). The improvement was greater for object relatives (82% with gender cue vs. 72% without) where resolving the dependency is harder to begin with.

In summary, by the age of four and a half, Hebrew-speaking children are better at comprehending more ecologically valid object relatives and at using language-specific morphological cues (gender agreement between the subject and the verb) in interpreting relative clauses.

Integrating multiple cues

The results of other studies also show that children are sensitive to language-specific cues and show reduced difficulty when there are more cues to thematic assignment. While many of these studies were done with another goal in mind (advocating movement-based explanations of children's difficulty), they still demonstrate children's ability to integrate multiple cues in resolving dependencies.

Günzberg-Kerbel, Shvimer and Friedmann (2008) looked at the comprehension of relative clauses by Hebrew-speaking children between 3;7 and 5;5. They manipulated several factors, two of which I focus on here: gender agreement and the number of realized NPs. Using a picture-selection task, they presented children with relative clauses with and without a gender mismatch. In half of the clauses, the head NP and embedded NP had the same gender, and in the other half, they had a different gender. Children were significantly better at comprehending relative clauses when there was a gender mismatch (85% correct vs. 76% correct), and the effect was stronger for object relatives (67% vs. 81%,). Children were using language-specific morphological cues to aid interpretation.

In another set of studies, the same researchers manipulated the number of NPs in object relative clauses. By using a form of impersonal passive, where there is no subject (the verb appears in 3rd-person plural form to indicate an unspecified Agent, something like *the horse that brushing him*) they eliminated the additional NP that intervenes between the head NP and the embedded verb. By using free object relatives, where the head NP is replaced with an accusative-marked *wh*-word, they eliminated the head NP (*et mi ʃe-ha-yeled menadned* [ACC who that-the-boy rocks], 'who the boy rocks'). In both cases, children have only one NP to process before they assign thematic roles. Consistent with the idea that children's

difficulty reflects memory-based processing pressures, comprehension was better for object relatives that contained only one NP. A later study using the same manipulations (Friedmann, Belletti, & Rizza, 2009), found that 4;6 year-olds understood 'one-NP' object relatives (free ones and ones with impersonal passives) just as well as they understood subject relatives. Some object relatives were as easy as subject relatives.

By comparing children's comprehension of various kinds of object relative clauses, we can identify several patterns. Children understand some object relatives better than others; they are sensitive to distributional patterns in their input; they draw on multiple cues in forming an interpretation. As a result, children (like adults) find some instances of the construction easier than others. Children's difficulty can be understood as a magnified version of what adults experience: where adults merely slow down, children's understanding breaks down. Over time, and with experience, this breakdown disappears, transformed into 'regular' processing (where there is still a cost, albeit a smaller one, associated with certain relative clauses). Comprehending these constructions emerges as a gradual process where some variants are understood earlier and better than others.

What early constructions look like and how they develop over time

So far, I have looked at only one prediction made by usage-based models: that construction learning is a gradual process affected by usage patterns. But in order to understand how children reach adult-like knowledge of constructions, we need to explain how early uses get expanded and abstracted over time. We need to know (1) what early constructions look like, and (2) what the mechanism is that allows children to develop their complexity and abstractness.

Usage-based and exemplar models suggest that children learn language by abstracting over stored utterances – they start out with largely unanalyzed chunks that are then analyzed and segmented (Abbot-Smith & Tomasello, 2006; Bod, 1998, 2006; Tomasello, 2003). Given the nature of children's input, and the characteristics of their perceptual system, these early building blocks will include a mix of words, fragments, and short multi-word utterances. Linguistic units larger than words are predicted to play a crucial role in language learning. Larger, multi-word units provide children with early lexical chunks to be used in production (e.g. *spill-it*, Peters, 1983; Tomasello, 1992), and allow children to discover constructions, grammatical relations and relevant co-occurrence patterns that may be harder to establish without the ability to compare multi-word units (e.g., agreement patterns). Multi-word phrases in particular may play an important role by allowing children to learn grammatical relations in a top-down fashion: discovering

grammar by analyzing larger chunks of language may be better than learning those same regularities by combining already analyzed units (Arnon, 2010b).

There is growing evidence that children can and do attend to multi-word units. Infants are sensitive to clause-level boundaries before they can detect smaller phrasal and word boundaries (e.g., Jusczyk et al., 1992; Soderstrom et al., 2005). Perceptually at least, infants are capable of extracting multi-word units from speech early on. Young children make use of 'frozen' chunks in their early productions (e.g., Lieven et al., 2003), while older ones (three-year-olds) remain sensitive to the properties of four-word phrases (Bannard & Matthews, 2008; Matthews & Bannard, 2010). Their production of single words is affected by larger chunks in which the appear (Arnon & Clark, 2011). Taken together, these findings support the idea that multi-word chunks are part of children's initial linguistic inventory.

Extending these ideas to construction learning suggests that children's early constructions may consist of frozen chunks, which are then analyzed and segmented to create schemas and slots (Bod, 2006; Lieven et al. 1997; Lieven et al., 2003, 2009). But we are still left with the question of how early uses get analyzed and expanded. I suggest here that this process of analysis may be affected (among other things) by the frequency of specific lexical sequences used with that construction.

Just as frequency plays a role in children's early lexical and morphological uses, it may also affect the way constructions are learned. In particular, chunk frequency may affect the way early constructions get expanded: given the choice, children will use constructions with a higher chunk frequency. In the case of relative clauses, children would have an easier time using (and understanding) object relatives when the subject-verb combination is more frequent (e.g. *The dog that I saw* vs. *The dog that he petted*). Such a finding has been reported for adults (Reali & Christiansen, 2007a, 2007b) – adults were quicker to read relative clauses that had more frequent subject-verb combinations – but has not been tested developmentally.

We can test this prediction by looking at a choice between two constructions that differ only in word order. The two variants will result in a different sequencing of words while having similar syntactic structure. If children's choices are affected by chunk frequency, we would expect them to be more likely to produce the variant that results in a higher-frequency sequence. One such construction is the dative alternation in English: speakers are faced with a choice between two realizations that differ in the ordering of the constituents (double object: *John gave Mary the book* vs. prepositional object: *John gave the book to Mary*). If children prefer to produce variants that are higher in chunk frequency, then they should prefer the double object variant when the verb + theme sequence is more frequent (e.g., *John gave them to Mary*), and prefer the prepositional variant when the verb + recipient sequence is more frequent (e.g. *John gave me the book*).

To test this prediction, I used a database of 538 datives produced by 7 children. Previous work has shown that there are multiple factors that influence which variant children and adults chose to produce (Bresnan et al., 2007; de Marneffe et al., 2011). Among other things, children are affected by the pronominality and length of the theme and recipient, and by the bias of the specific verb. Building on these findings, I could ask whether the frequency of the verb + first object (the theme in the DO and the recipient in the PO) also played a role in children's choices. By adding the frequency of the verb-recipient and verb-theme sequences to the existing model, I could ask whether they affect children's choices when other factors are controlled for. I estimated the chunk frequency of both sequences using a 4-million-word subset of the CHILDES database.

Chunk frequency seems to affect children's choices. Children were more likely to use the double object variant when the verb-theme sequence was more frequent ($p < .0001$). For example, when it led to an utterance like *show me your toys* (*show me* has higher chunk frequency than *show your toys*). Conversely, they were more likely to use the prepositional object variant when the verb-recipient sequence was more frequent ($p < .0001$), as in the utterance *give it to Karen* where *give it* has higher chunk-frequency than *give Karen*. Whichever realization led to a higher chunk frequency was the one preferred. This, of course, doesn't explain why certain combinations are more frequent than others. Nor does it devalue any of the many semantic and pragmatic factors that influence syntactic choices. But it suggests that children's use of a construction, and the way they expand these uses, is also affected by the frequencies of multi-word sequences in the speech around them.

Conclusions

I began this chapter by asking what the acquisition of relative clauses in Hebrew can tell us about the learning of constructions more generally. In particular, I wanted to see if children show the gradual expansion of uses predicted by usage-based models (Tomasello, 2000; Bannard, Lieven, & Tomasello, 2009). The findings for Hebrew are consistent with this prediction. Children start to produce relative clauses of various types around age 2;0. Their early uses reflect distributional and pragmatic patterns in their input but are not yet fully adult-like. Over time, children's clauses become more complex semantically, and more adult-like in structure. There is a similar pattern in comprehension where children find some configurations harder than others. Children do not suddenly understand all relative clauses. Only with time and experience do they develop a more abstract knowledge of the construction that allows them to interpret relative clauses that are different from the ones they normally hear and produce.

Looking at Hebrew – a language with rich inflectional morphology – illustrates how children make use of language-specific cues in both production and comprehension (Bates & MacWhinney, 1989). The verbal agreement patterns of Hebrew may make it easier for children to produce and comprehend relative clauses: the verb-form provides additional information about how to resolve the dependency. Future work is needed to see when this sensitivity develops and whether some cues (e.g., number) are more useful than others (e.g., gender). By looking at Hebrew we can investigate the interplay between language-general and language-specific cues in acquisition.

In the current chapter, I have outlined the developmental path of relative clauses in Hebrew while asking more general questions about how constructions are learned. Taking Hebrew relative clauses as a case study, we saw how children's own uses become more semantically and structurally complex, and how their understanding develops to rely less on morphological cues. By looking closely at production and comprehension patterns we can see that children's use of relative clauses, like that of other constructions, develops gradually over time in ways that are sensitive to language-general and language specific cues. Looking for the point in time when a construction is 'learned' obscures the complex (and sometimes non-linear) ways that children's knowledge develops. Instead, we need to map the multiple paths and routes that children take on the way to more abstract knowledge.

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