Relative clause acquisition and representation

Evidence from spontaneous speech, sentence repetition, and comprehension

Silke Brandt and Evan Kidd
University of Basel and University of Manchester

According to usage-based approaches, representations and processing of linguistic constructions emerge from usage events. We present corpus data, which show that object relative clauses are mostly attached to an inanimate head NP and contain a pronominal subject (***the ball*** *that* ***he*** *just threw*). In two experiments, English- and German-speaking children were best at processing object relatives identical in form and function to these frequent exemplars. In contrast to earlier studies, we did not find that subject relatives were always easier to process than object relatives. Our data provide further evidence suggesting that children and adults do fine-grained analyses of their linguistic input, and that linguists should do the same to derive hypotheses about the nature of linguistic representations and processing.

Keywords: empirical methods, language acquisition, syntactic representations, usage-based, relative clause

1. Introduction

Using both corpus and experimental data and choosing the correct experimental method or using a variety of experimental methods is crucial when it comes to analyzing and describing children's acquisition of linguistic constructions. First of all, when we look at data from children's spontaneous speech, we have to deal with sampling issues. That is, even dense databases, which are based on about five or more one-hour recordings of caretaker-child interaction per week, do not catch enough exemplars of infrequent complex structures or infrequent lexical items within specific constructions to allow for reliable calculations and conclusions (Rowland and Fletcher 2006, Tomasello and Stahl 2004). In addition, most corpus data come from a limited number of specific settings and contexts, such as playtime

with the caretaker, which can further restrict the range of linguistic constructions used by the children (cf. Behrens 2008).

When we want to do a detailed analysis of children's representations of complex constructions that are quite infrequent in spontaneous speech, such as relative clauses (cf. Brandt, Diessel, and Tomasello 2008), we thus need to set up experiments to probe children's knowledge of these constructions. However, like data from spontaneous speech, data from experimental settings also have to be interpreted with some caution. Children have relatively short attention spans, limited working memory, limited cognitive control, etc., and these general cognitive limitations have an impact on children's behavior in language experiments as well as their language production in natural settings (e.g. Felser, Marinis, and Clahsen 2003, Hamburger and Crain 1984, Trueswell 2008, Valian 1991). For example, young children might not be able to act out or produce sentences such as '*the chicken that the cow kicks bites the pig* or '*put the frog on the napkin in the box*' because they have limited cognitive control as well as limited working or short-term memory, which does not allow them to deal with such long sentences and complex scenes, and not because they lack a representation of embedded structures or (reduced) relative clauses.

Interestingly, studies that use different methodologies to test children's representations of linguistic structures sometimes diverge in their results and conclusions. For example, several preferential-looking studies suggest that children as young as 1;9 (i.e. one year; nine months) have an abstract, verb-general presentation of the transitive construction (e.g. Gertner, Fisher, and Eisengart 2006, Naigles 1990). However, studies where children were asked to act out or point to scenes described by transitive sentences with novel verbs, or where children were asked to produce transitives with novel verbs, suggest that children do not have a fully abstract, verb-general representation of the transitive construction before the age of 2;6 or 2;8 (e.g. Akhtar 1999, Tomasello, Brooks, and Stern 1998). These latter studies indicate that children start with verb-specific representations that gradually develop into abstract, verb-general representations of the transitive construction.

Abbot-Smith, Lieven, and Tomasello (2008) propose that children's varying behaviors across different methods is due to the fact that some methods, such as preferential looking, depend on weak representations of linguistic structures, whereas other, more active and complex methods like act-out or pointing require the coordination of various cognitive and sensory-motor processes and thus depend on stronger representations (see also Abbot-Smith and Tomasello 2006). Importantly, unlike nativist-generative accounts of language acquisition (e.g. Marcus 1998, Radford 1990), usage-based accounts such as that proposed by Abbot-Smith et al. (2008) do not assume that children either have or have not acquired specific constructions or categories at a certain point in development; rather, these accounts suggest that categories and constructions are gradually learned from and strengthened by exemplars

in the input. Children are assumed to have an abstract – though weak – representation of the transitive, for example, as soon as they show some knowledge of transitive sentences with some verbs in their comprehension or production behavior. Each exemplar that, based on formal, functional, and/or relational similarities, can be categorized as an instance of a particular category or construction strengthens the representation of that category or construction (cf. Abbot-Smith and Tomasello 2006). Thus, the more transitives a child experiences and recognizes as instances of that construction, the stronger her representation of the transitive construction becomes. However, in order to really develop a strong item-general representation of the transitive, children have to hear and use this construction with a variety of verb types and noun or pronoun types (see also Bybee 1995, Goldberg 1995, Langacker 2000). At the same time, as children derive abstract linguistic categories and constructions from particular exemplars, they also build up item-specific representations that are connected to the more abstract representations. If, for example, children hear many transitives with the verb *push*, these exemplars will support the strengthening of both an abstract transitive SVO schema and a more item-specific S *push* O schema (Abbot-Smith and Tomasello 2006).

Since children at around age 2;0 have heard and produced a great number of transitives with familiar verbs such as *push* or *kick*, they presumably have strong item-specific representations of transitives with familiar verbs, such as S *push* O or S *kick* O. When they are asked to act out or produce a transitive with a novel verb, however, they have to work with a verb-general representation, such as SVO, which is not as strong as their item-specific representations (cf. Abbot-Smith et al. 2008).

The assumption that weak representations allow for positive results from looking-time measures, but not for positive results in more active paradigms, such as reaching or pointing, is supported by studies on the development of object permanence. For example, in a study by Baillargeon (1987), 3;5 month-olds witnessed how a box was hidden behind a screen. Then they either saw the screen rotating through a full 180° without the box reappearing (impossible event), or they saw the screen rotating only until reaching the hidden box (possible event). The infants looked longer at the impossible event than the possible event. However, Munakata, McClelland, Johnson, and Siegler (1997) demonstrated that 7 months olds are still more likely to reach for or release objects that were moved behind transparent barriers than objects that were moved behind opaque barriers. These results suggest that infants can represent objects even if they are out of sight, but initially these object representations are too weak to guide reaching or other active, more complex behaviors, which require the coordination of several cognitive and sensorymotor processes and thus need more processing capacity. Simulations with Parallel Distributed Processing models suggest that object representations become stronger with more experience with absent objects, and that these stronger

representations potentially lead to positive results when measuring infants' object permanence with more active and complex tasks (Munakata et al. 1997).

Similarly, Chang, Dell, and Bock (2006) simulated the difference between looking-time and production measures in experiments on the acquisition of the transitive construction with a connectionist model. In summary, the graded representations account suggests that more complex or active tasks rely on stronger representations, and that the strengths of the representations, in turn, depend on the number of exemplars supporting the specific representations. Strong representations allow for some automatization, which, in turn, frees up some processing capacity to deal with the task demands (Case 1985, Munakata et al. 1997, Siegler 2000).

Experience with specific linguistic constructions also plays an important role in some accounts of adults' language processing. MacDonald and Christiansen (2002), for example, suggest that individual differences that are found in psycholinguistic experiments, and that are traditionally attributed to differences in working-memory capacity (e.g. Just and Carpenter 1992, King and Just 1991) are really an effect of the individuals' experience with specific linguistic structures, which in turn have an impact on their linguistic processing strategies and capacities (see also MacDonald 1999). For example, King and Just (1991) found an interaction between verbal working memory and relative-clause type: participants with lower working memories showed longer reading times and poor comprehension of object relatives (e.g. *the reporter that the senator attacked praised the judge*) in comparison to subject relatives (e.g. *the reporter that attacked the senator praised the judge*), but no such difference was found for high-span readers. Just and Carpenter (1992) take this as evidence for a separate verbal working memory, which influences sentence processing. This claim is based on the assumption that the processing of object relatives requires greater working memory because the distance between the filler or head NP and the gap is greater than in subject relatives (for similar approaches see Gibson 1998, Gordon, Hendrick, and Johnson 2004). However, MacDonald and Christiansen (2002) argue that these data can also be interpreted as evidence supporting the Frequency*Regularity Hypothesis (Seidenberg 1985). In English, subject relatives have more in common with frequently used canonical SVO sentences than do object relatives. In both subject relatives and canonical SVO sentences, the NP preceding the verb is the subject and the NP following verb is the object. For the interpretation of subject relatives, English-speaking subjects can thus use the same processing strategies as for the interpretation of simple sentences. The successful interpretation of object relatives, on the other hand, depends on direct exposure to irregular OSV structures (MacDonald and Christiansen, 2002: 40, for a similar approach to children's processing of relative clauses see Diessel and Tomasello 2005). To explain why people with higher verbal working memory are better at processing object relatives, it is argued that people

with high verbal working memory have more experience with processing linguistic stimuli in general. And people who have more experience with sentence processing in general also have more experience with processing object relatives and other non-canonical structures. In support of this claim, Wells, Christiansen, Race, Acheson, and MacDonald (2009) showed that adult participants who were exposed to an equal amount of both subject and object relatives showed a decrease in reading time for object relatives relative to subject relatives, suggesting that exposure to infrequent forms results in an attenuation of processing difficulty traditionally explained by appeals to either working memory or syntactic derivation.

To summarize, the claims by Abbot-Smith et al. (2008; see also Abbot-Smith and Tomasello 2006) and MacDonald and Christiansen (2002) suggest that linguistic experience shapes linguistic processing. In MacDonald and Christiansen's connectionist approach, experience has a direct impact on sentence processing. In their Simple Recurrent Network model, they do not separate linguistic processing from linguistic representations. Linguistic knowledge is thought to 'emerge from the interaction of network architecture and experience' (Mac Donald and Christiansen 2002: 37) (see also Elman 1990, Seidenberg and McClelland 1989). In contrast, Abbot-Smith et al. (2008), like other usage-based approaches, suggest that linguistic experience shapes and strengthens linguistic representations, which, in turn, have an impact on language processing and the level of automatization in sentence parsing (see also Langacker 2000). Whether linguistic experience has a direct impact on language processing, or whether it is mediated by changes in linguistic representations, is hard to decide on empirical grounds.

In the following, we will present a corpus study that investigated the kinds of relative-clause representations German-speaking children might develop from the exemplars in their input. Furthermore, we will present results from a corpus study looking at German- and English-speaking children's own production of relative-clause constructions and two different experimental tasks (sentence repetition and referential selection) that tested German- and English-speaking children's representations of subject and object relative clauses.

As has been shown for adults (e.g. Gibson 1998, Just and Carpenter 1992), in the majority of past studies that tested comprehension or production of relative clauses, children performed better on subject relatives (e.g. *the dog that bites the cat*) than on object relatives (e.g. *the dog that the cat bites*). It has been suggested that this asymmetry is due to limited working memory (Booth, MacWhinney, and Harasaki 2000), perspective shifts (MacWhinney 1982), non-adult parsing strategies (e.g. Tavakolian 1981), difficulty with sentences that involve movement (e.g. Friedmann and Novogrodsky 2004, Goodluck, Guilfoyle, and Harrington 2006), and non-canonical word order in object relatives (e.g. Diessel and Tomasello 2005). However, all of these studies neglected some crucial formal and functional differences between

subject and object relatives that might be encoded in children's (and adults') representations of relative-clause constructions. We detail these below.

2. Subject and object relatives in spoken corpora

Looking at more than 400 relative clauses in spoken English discourse, Fox and Thompson (1990) found that, while subject relatives are most often used to provide information about animate entities, object relatives are used to ground inanimate entities in discourse. Therefore, object relatives are much more likely to be attached to inanimate head NPs. The grounding is accomplished by linking the inanimate entities to given discourse participants, expressed by pronominal *I* or *you*, or other given referents in the immediate context, expressed by third person pronouns or proper names. By being explicitly related to given referents, the new inanimate entities are made relevant to the ongoing discourse (Fox and Thompson 1990: 300). The corpus study showed that object relatives are overwhelmingly used with inanimate head NPs (such as *the car* in (1)) and pronominal relative-clause subjects (such as *she* in (1)), as in the following example (Fox and Thompson 1990: 303):

(1) ***The car*** *that* ***she*** *borrowed had a low tire.*

This distribution can be derived from two more general linguistic patterns. First of all, subjects are topical; they refer to given referents, which are encoded by pronouns (cf. Du Bois 1987). Secondly, objects tend to be inanimate (cf. Mak, Vonk, and Schriefers 2002, 2006). Similar distributional patterns were recently reported by Roland, Dick, and Elman (2007) and Reali and Christiansen (2007a). Roland et al. (2007), for example, investigated a variety of written and spoken English corpora and found that the vast majority (e.g. 80% in the Switchboard data) of object relatives in the spoken corpora had pronominal subjects. They also report that animate head NPs are mainly used with subject relatives, whereas inanimate head NPs are most often used with object relatives.

Statistical regularities found in written corpora or adult-adult interaction do not necessarily have to show up in child-directed speech, but when we look at the input of a German-speaking child, we can see the same pattern. Within a sample of almost 150 object relatives, 85% contain pronominal subjects, and 78% are attached to inanimate head NPs (Brandt 2005). Looking at spoken corpora from four English children and one German child between the ages of 2;0 and 5;0, we found that both English- and German-speaking children use object relatives with inanimate heads 75% of the time. In addition, in both languages, at least 75% of the object relatives produced by the children had pronominal subjects (Kidd, Brandt, Lieven, and Tomasello 2007). Similarly, Diessel (2009) showed that, in spoken corpora,

English-speaking children almost exclusively use subject relatives with animate head NPs, and that the vast majority of non-subject relative clauses (i.e. object relatives or adverbial relatives) are used with inanimate head NPs and pronominal subjects. Thus, the same constraints that influence relative-clause production in adults seem to influence children's relative-clause production in spontaneous speech.

In the vast majority of previous studies on relative-clause acquisition children were tested on object relatives with animate head NPs and lexical relative-clause subjects, such as '***the chicken*** *that* ***the pig*** *pushed jumped over the sheep*' (Corrêa 1995). Children performed poorly on these sentences, without exception. There is evidence that children (and adults) perform fine-grained statistical analyses of their input (e.g. MacDonald 1999, Tomasello 2003). As described above, it has also been suggested that linguistic experience shapes children's and adults' representations of grammatical structures, which, in turn, have an impact on their processing capacities and strategies (cf. Abbot-Smith et al. 2008). Therefore, we suggest that the difficulties with object relatives observed in previous studies were, at least in part, due to the fact that the test sentences did not match the kinds of object relatives that children and adults had heard and produced before.

In fact, more recent studies in adult psycholinguistics have shown that high processing costs associated with object relatives can be reduced or eliminated when the clauses are attached to inanimate heads (Mak et al. 2002, 2006; Traxler, Morris, and Seely 2002, Traxler, Williams, Blozis, and Morris 2005), or when they contain pronominal subjects (Gordon, Hendrick, and Johnson 2001, Reali and Christiansen 2007a, 2007b; Warren and Gibson 2002, 2005). Our first experimental study (Kidd et al. 2007) was a sentence-repetition task that investigated whether children's difficulty with object relatives can also be reduced or eliminated once the test sentences are formed according to the constraints identified in the corpus studies.

3. Sentence repetition

We asked 3- and 4-year old English- and German-speaking children to imitate subject- and object relatives with animate and inanimate head NPs as well as object relatives with pronominal and full-NP subject. The children were tested on the following kinds of sentences:

(2) *This is* ***the boy*** *that* ***the girl*** *teased at school yesterday.* (obj_an_np)
(3) *That is* ***the dog*** *that* ***you*** *stroked in the park yesterday.* (obj_an_pro)
(4) *Here is* ***the food*** *that* ***the cat*** *ate in the kitchen today.* (obj_in_np)
(5) *There is* ***the book*** *that* ***you*** *read in the front room last night.* obj_in_pro)
(6) *Here is* ***the lady*** *that helped the girl at school today.* (subj_an)
(7) *Here is* ***the plant*** *that grew in the garden last summer.* (subj_in)

All test sentences were controlled for length in terms of words and syllables. In the German test sentences, all NPs were masculine singular and thus unambiguously marked for case. There were four test items in each condition and some less complex fillers, such as coordinate structures, which were presented to the children in randomized orders. The characters described in the sentences were present as small toys. The children were told that they played the parrot game, where they would have to say *exactly* the same as the experimenter.

Following expectations derived from the distributions found in the naturalistic data, children from both age groups and both languages made fewer errors when repeating object relatives with inanimate heads (examples (4) and (5)) and/or pronominal subjects (examples (3) and (5)) than object relatives with animate heads (examples (2) and (3)) and/or full-NP subjects (examples (2) and (4)) (see Figures 1 and 2). Conducting an ANOVA on children's performance on the object relatives, we found significant main effects for the animacy status of the head NP (English: $F_{(1,47)} = 6.44$, $p = .015$; German: $F_{(1,46)} = 9.07$, $p = .004$) and the form of the relative-clause subject (English: $F_{(1,47)} = 12.06$, $p = .001$; German: $F_{(1,46)} = 60.35$, $p < .001$). Both German- and English-speaking children performed best when they were tested on those kinds of object relatives that they most often say and hear in discourse. Moreover, children did not have more problems repeating object relatives that followed the constraints found in natural language than repeating subject relatives. The subject-object asymmetry reported in a great number of previous studies was thus eliminated with these prototypical object relatives. In contrast to those early accounts of syntactic acquisition that attributed children's difficulties with object relatives to poor syntactic knowledge, non-adult processing strategies, or limited working memory, we showed that their syntactic knowledge is closely tied to their linguistic experience. Furthermore, although the 4-year-olds performed better overall, none of the main effects showed an interaction with age. This suggests that, like adults, even the younger children are sensitive to these discourse constraints.

Focusing on the children's performance on subject relatives, Figures 1 and 2 show that the English-speaking children performed better on the subject relatives with animate head NPs, whereas the German-speaking children performed better on the subject relatives with inanimate head NPs. German- and English-speaking children regularly use subject relatives with both inanimate and animate head NPs (cf. Kidd et al. 2007). We can only speculate that the German-speaking children had fewer problems imitating subject relatives with inanimate head NPs because these test sentences were always intransitive, whereas the subject relatives with animate heads were all transitive (see examples above). The English-speaking children, on the other hand, might have had more difficulty with the subject relatives with inanimate head NPs because they were expecting an object relative after hearing a string such as INANIMATE – *that*. In English, only the material following

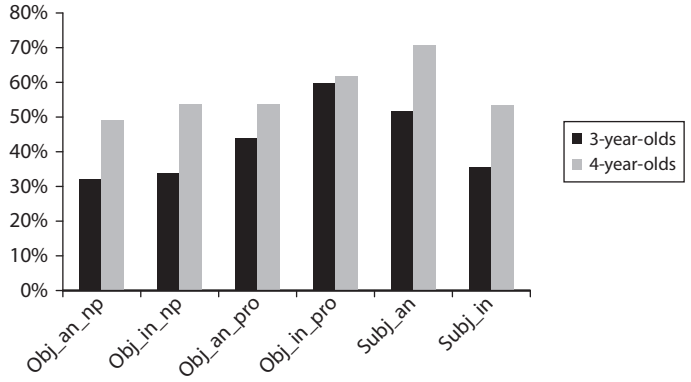

Figure 1. Percentage correct imitation by English-speaking children

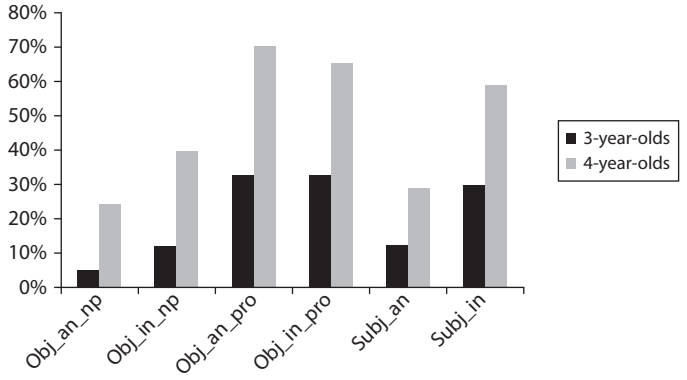

Figure 2. Percentage correct imitation by German-speaking children

the relativizer indicates whether the sentence is a subject or object relative. The German-speaking children only heard strings with case-marked relative pronouns, such as INANIMATE – *den* 'who-ACC' or INANIMATE – *der* 'who-NOM', where the relative pronoun already indicates whether the following clause is a subject or an object relative (cf. Kidd et al. 2007).

Given our sentence-repetition task, we cannot be completely sure that as well as testing production we were also testing relative-clause comprehension, as has been the case in most of the previous studies on relative-clause acquisition. Although there are studies suggesting that children's imitation behavior is good evidence for their grammatical competence (for an overview see Lust, Flynn, and Foley 1996), and that sentence imitation involves sentence comprehension

(Potter and Lombardi 1990, 1998; Sachs 1967), we cannot fully rule out that some of the children we tested were just mimicking the experimenter.

To our knowledge, there are two comprehension studies that looked at animacy or the form of the relative-clause subjects as factors influencing children's difficulty with object relatives.[1] Controlling the number of animate vs. inanimate entities in subject- and object-relative constructions, Corrêa (1995: 194) showed that 'object focus sentences (...) appeared to be particularly affected by animacy'. Portuguese-speaking children had fewer problems acting out object relatives with two animate referents and an inanimate head, such as (8), than object relatives with three animate referents including an animate head, such as (9):

(8) *The sheep pushed* ***the fence*** *that the horse knocked down.*
(9) *The pig pushes* ***the sheep*** *that the horse knocked down.*

In a study with Hebrew-speaking children involving production and comprehension, Arnon (2010) showed that children better understood object relatives containing pronominal subjects than object relatives with full-NP subjects. However, we are not aware of any study that systematically tested children's comprehension of object relatives controlling for both factors. Therefore, we designed a referential-choice task that tested children's understanding of subject- and object relatives, controlling for animacy of the head NP and the discourse status and form of the subject in object relatives and the object in subject relatives (Brandt, Kidd, Lieven, and Tomasello 2009). In contrast to the act-out method that has been used in most studies on children's relative-clause comprehension (e.g. Corrêa 1995, Eisenberg 2002, Goodluck and Tavakolian 1982, Kidd and Bavin 2002, Sheldon 1974), the referential-choice task places minimal demands on the children. We were thus able to show relative-clause comprehension in children much younger than in most previous studies, where successful comprehension is not typically evident until around 4 years or later.

4. Referential selection

In our second study we asked young 3-year-old German- and English-speaking children to select a referent that the experimenter described with either a subject- or an object relative clause. Subject relatives had pronominal or full-NP objects, while object relatives had pronominal or full-NP subjects. We always used third person singular and case-marked pronouns *he* (in German *er*) and *him*

1. Goodluck and Tavakolian (1982) also showed that the number of animate entities in subject relatives influences the ease of comprehension in children.

(in German *ihn*). The referent of the third person pronoun was always the same toy doll, *Peter*, who was introduced at the beginning of the experimental session and who kept reappearing for all sentences containing pronouns. Finally, object relatives had animate or inanimate head NPs. In order to only have plausible transitive relative clauses, subject relatives always had animate head NPs. These manipulations resulted in six conditions, as shown in Table 1. There were four test items in each condition, and the test sentences were controlled for length in terms of words and syllables. As in the previous study, the German sentences contained only masculine singular NPs, which are unambiguously marked for case.

All animals, inanimate entities, and humans that were referred to in the test sentences were present as small toys. The animals and inanimate entities served as referents for the relative-clause head NPs. We had two of each kind that could easily be distinguished by size, color, and/or shape. For example, we had a big lion and a small lion.

In order to set a context in which a relative clause could be used to identify a referent, the experimenter presented, for example, one of the two lions and a dog and said: *Look, the dog is chasing this lion*. Then she acted out this first background scene and put the first lion on one side of a disk that was fixated in front of the child. Then she presented the second lion with the same dog and said '*Look, the dog is pushing this lion*'. This scene was also acted out, and the second lion was put on the other side of the disk by the experimenter. These background scenes were followed by a distracter scene, where the dog did something else, and then the experimenter used a relative-clause construction, such as '*Can you give me the lion that the dog chased?*' to tell the child to pick one of the two lions.

This procedure is different from that of previous relative-clause comprehension studies (e.g. Corrêa 1995, Eisenberg 2002, Goodluck and Tavakolian 1982, Kidd and Bavin 2002, Sheldon 1974), where children were asked to act out relative-clause constructions containing two clauses, such as '*The chicken that the pig pushed jumped over the sheep*' (Corrêa 1995). In order to succeed in this

Table 1. Examples of test sentences for each condition

	subj	**obj**
an_np	*Can you give me* ***the dog*** *that chased* ***the lion****?*	*Can you give me* ***the monkey*** *that* ***the frog*** *combed?*
an_pro	*Can you give me* ***the donkey*** *that just tickled* ***him****?*	*Can you give me* ***the donkey*** *that* ***he*** *just fed?*
in_np		*Can you give me* ***the cake*** *that* ***the uncle*** *stole?*
in_pro		*Can you give me* ***the ball*** *that* ***he*** *just threw?*

act-out task, children have to understand agent-patient relations expressed in the sentence, i.e., they have to understand 'who is doing what to whom'. In the referential-selection task we used for the current study, the children have to match agents or patients with verbs or actions. For example, what distinguishes the small and the big lion is that one was chased by the dog, while the other one was pushed by the dog. Therefore, based on the link between a certain lion and a certain action the child can choose the correct referent after hearing *can you give me the lion that the dog chased?* without necessarily fully understanding 'who did what to whom'. However, in order to succeed in the task used here, the children still need to parse the relative clause as a restrictive noun modifier.

We used this task because it places minimal demands on the children. The act-out task had been criticized before for being too demanding and not showing children's full grammatical competence (e.g. Hirsh-Pasek and Golinkoff 1996). The referential-choice task allows us to test children who are quite young. Moreover, it allows us to use relative clauses in an experimental setting for the same purpose for which they are used in real life: to identify things (e.g. Givón 1993, Lehmann 1984) and link new entities to given entities (Fox and Thompson 1990). Relative-clause constructions like the ones that were used in the act-out tasks in previous studies mentioned above, on the other hand, are rarely used in real life (cf. Diessel 2004).

For the main analysis, we coded whether the children chose the correct referent described by the relative clause. In accordance with the results from the corpus studies and the sentence-repetition task (Kidd et al. 2007), German- and English-speaking 3-year old children showed better comprehension of object relatives with inanimate heads and/or pronominal subjects than object relatives with animate heads and full-NP subjects (see Figure 3 below). An ANOVA on children's performance on the object relatives showed that both factors, the animacy of the head NP and subject type within the relative clause, had a significant effect on the German children's performance (animacy: $F_{(1,23)} = 19.75$, $p < .001$; subject type: $F_{(1,23)} = 5.03$, $p = .035$). The English-speaking children performed significantly better on object relatives with pronominal relative-clause subjects ($F_{(1,19)} = 4.93$, $p = .039$). They also showed better performance on object relatives with inanimate heads, but the effect did not reach significance ($F_{(1,19)} = 2.86$, $p = .11$).

Importantly, what Figure 3 also shows is that neither the English-nor the German-speaking children always performed better on subject relatives than on object relatives. In fact, children from both languages performed better on object relative clauses with inanimate head NPs than on the subject relative clauses. Moreover, the English data and an ANOVA across languages showed an interaction between NP type and structure. Taken together, the German and English children showed better performance on object relatives with pronominal subjects than object relatives with full-NP subjects, but it did not matter whether the subject relatives contained

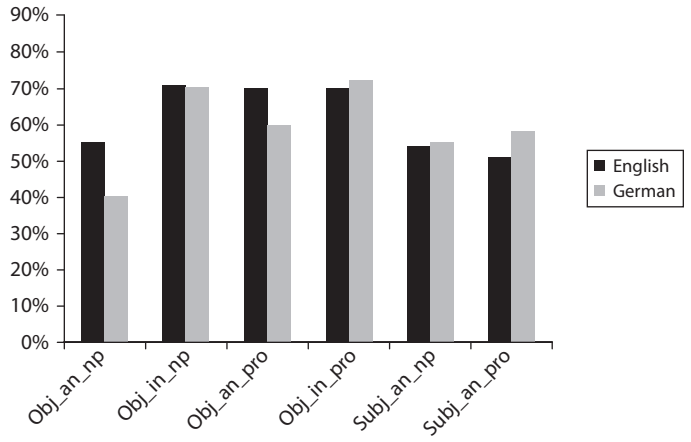

Figure 3. Percentage correct choice in referential-selection task

full-NP or pronominal objects ($F_{(1,42)} = 8.04$, $p = .007$). This is probably due to the fact that, in general, objects are expressed by both lexical NPs and pronouns, whereas subjects are most often expressed by pronouns or null forms (e.g. Du Bois 1987).

5. Discussion

We now have converging evidence from two corpus studies, two experimental tasks and two languages supporting the claim that linguistic experience shapes children's representations of relative-clause constructions, which in turn have an impact on their processing of these complex structures (or perhaps that sentence processing is directly influenced by linguistic experience, see MacDonald and Christiansen 2002 and discussion above). Our corpus studies showed that, like adults, German- and English-speaking children mainly use object relatives with inanimate head NPs and pronominal subjects. In the first experimental task, children had to imitate subject and object relative clauses (Kidd et al. 2007). In the second task, another group of German- and English-speaking children were asked to select a referent based on a description with a subject or object relative clause (Brandt et al. 2009). In both tasks, German- and English speaking children showed better comprehension and production of those object relative clauses that were formed according to the constraints found in the corpora.

In terms of methodology, we can conclude that, despite potential problems of sampling or limited contexts, a corpus analysis can be a good potential indicator of children's knowledge of linguistic constructions. The two experimental tasks

presented here might be criticized since in order to succeed in these tasks, children need to have a good short-term memory. In the sentence-repetition study, children had to recall sentences with 11–13 words; in the referential-selection task, children had to remember two background scenes and also parse quite long sentences. However, within both studies, all test sentences were matched for length; they only differed in structure (object vs. subject relatives), semantics (animate vs. inanimate head NPs), and lexical items (full-NP subjects vs. pronominal subjects). And it turned out that the semantic and lexical differences that are born out of discourse pressures (cf. Fox and Thompson 1990) make the difference.

Unlike in most previous experimental studies on relative-clause acquisition and processing, the children in our experimental tasks did not always perform better on subject relatives than on object relatives. It is thus unlikely that only factors such as limited working memory, non-canonical word order, problems with perspective shifts, or problems with sentences involving movement were responsible for children's poor performance on object relatives in past studies, as has been suggested, for example, by Booth et al. (2000), Diessel and Tomasello (2005), MacWhinney (1982), and Friedman and Novogrodsky (2004). We do not want to make the strong claim here that none of these factors has an influence on children's processing of relative clauses or other linguistic constructions, but we suggest that there is an additional factor that can explain a big part of the variance observed in children's and adults' processing of object relative clauses with different formal and functional features: linguistic experience.

A number of studies have already demonstrated that children start with item-specific representations of various constructions, such as the transitive, complement clauses, or wh-questions (e.g. Kidd, Lieven, and Tomasello 2006, Rowland 2007, Tomasello 2000). What all of these studies have shown is that, especially early in development, children are best at comprehending or producing these various constructions when they contain the same lexical items with which they are most frequently used in the input. At the same time, there is evidence that children also start to build up some more item-general and abstract representations of linguistic constructions as soon as they start to use or comprehend some item-specific structures (e.g. Gertner et al. 2006). But these abstract representations seem to be weaker than the more frequent item-specific structures and often lead to positive results only in looking-time studies (cf. Abbot-Smith et al. 2008).

Evidence for some lexically specific representations of object relative clauses was provided by a study by Reali and Christiansen (2007b). Using *Google* counts, they found that there are some highly frequent, lexically specific pronoun-verb combinations in object relatives. For example, *the* X *who* ***I met*** is far more frequent than *the* X *who* ***I distrusted***. In a complexity-rating and a self-paced reading task, English-speaking adults indicated that doubly-nested object relatives containing

highly frequent pronoun-verb combinations were easier than object relatives with less frequent word combinations. Reali and Christiansen (2007b) take this as evidence that parts of object relatives are recognized and accessed as lexically specific strings or chunks.

In the studies that are presented in the current chapter, we did not control for lexically specific patterns in relative clauses. However, the test sentences that children had least problems with in comprehension and production can be categorized as prototypical object relatives. They contained inanimate head NPs and pronominal subjects, but not always the exact same pronominal forms that are most frequently found in object relatives in spontaneous speech. The prototypical object relatives in the referential-selection task contained third person singular pronouns, whereas object relatives in spontaneous speech most often contain first or second person singular pronouns (Kidd et al. 2007). The fact that children still performed better on these prototypical object relatives than on the less prototypical object relatives that contained full-NP subjects and animate head NPs suggests that even the younger children have already developed a semi-abstract representation of these structures, such as INANIMATE – PRO – VERB, which is strong enough to let them succeed in quite active tasks.

In the sentence-repetition study, we did not find any significant interactions with age, which indicates that the 3-year-olds are sensitive to the same factors (i.e. animacy of the head NP and type of relative-clause subject), and that they are operating with the same kinds of representations of object relatives as the 4-year-olds. The 4-year-olds just performed better overall. As indicated by results from other studies, even adults are operating with the same kinds of semi-abstract, prototype representations of these complex structures (e.g. Reali and Christiansen 2007a, Traxler et al. 2005). Moreover, we also found the same pattern of results in the referential-selection task and the sentence-repetition task. If we compare the 3-year-olds' performance across tasks, they performed better in the referential-selection task than in the sentence-repetition task overall, but we still found the same main effects in both tasks. As noted in the introduction, many studies testing children's comprehension of simple transitives showed effects of item specificity in young children and with relatively active and complex tasks as opposed to older children or looking-time paradigms (cf. Abbot-Smith et al. 2008, Tomasello 2000). The studies presented here as well as other studies on children's and adults' processing of object relative clauses, on the other hand, show prototype effects across development and various tasks. This might be due to the fact that transitives are used for a greater variety of functions, and that they are used with a greater variety of lexical items (e.g. Thompson and Hopper 2001). In addition, most studies on children's comprehension of transitives investigated whether children comprehend these structures with novel verbs (e.g. Tomasello 2000), whereas

our studies investigated how or whether children produce and comprehend relative clauses with prototypical and less prototypical, but not unfamiliar, head NPs and subject types.

Future research will have to show whether children perform even better when they are tested on object relatives with highly frequent lexically specific patterns, as has been shown for adults (Reali and Christiansen 2007b), and whether they can develop an even more abstract and strong enough representation, such as NP – PRO – VERB, if they are trained on more varied input. At this point we are also unable to tell on which grounds children develop semi-abstract or prototype representations of object relatives. We will have to carry out training studies to investigate whether children make comparisons across several object relative exemplars when these exemplars are used in the same contexts, when they serve the same function (e.g. to ground inanimate entities in the ongoing discourse), and/or when they contain the same lexical items (e.g. pronominal *you* as the relative-clause subjects). In spontaneous speech, these factors are most often confounded. In our experiments, we found effects of formal and semantic properties, but future studies could also systematically control for effects of context and function.

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