Donkey Anaphora in Child Grammar

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1.   Introduction

Beginning with Heim (1982) and Kamp (1981) and continuing through current versions of Discourse Representation Theory, linguistic analyses of donkey sentences have had two main goals (e.g., see Groenendijk and Stokhof, 1991; Kamp and Reyle, 1993). One is to provide a semantics that assigns the same truth conditions to both relative clause donkey sentences like (1) and conditional donkey sentences like (2). The second goal is to ensure that the truth conditions of donkey sentences of both kinds correspond to the 'Strong' reading, according to which both (1) and (2) are true only if every boy in the discourse context takes every dog that he has to the park.

(1)   Every boy who has a dog takes it to the park.

(2)   If a boy has a dog, he takes it to the park.

Recently, Chierchia (1992, 1995) has challenged both assumptions of the discourse-theoretic accounts. First, Chierchia claims that (1) and (2) have different truth-conditions. Moreover, the basic truth conditions for relative clause donkey sentences correspond to the 'Weak' reading. For (1) to be true on this reading, all that is required is that each boy take at least one of his dogs to the park. The Weak reading of relative clause donkey sentences is generated using the same mechanisms that handle anaphoric relations in discourse. Conditional donkey sentences, by contrast, are interpreted by different mechanisms, which make the Strong reading more readily available in most cases.

In this paper, we draw upon experimental investigations of child language to evaluate the competing theoretical approaches to donkey anaphora. Child language is well

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suited to this endeavor, perhaps even better suited than adult judgments. The interpretation of donkey sentences is subject to great variability across adult speakers; these judgments are influenced by a wide variety of factors, including general knowledge of the world. While children may command the same semantic/pragmatic mechanisms as adults, they are less experienced in the world than adults are; consequently, children are more likely to assign interpretations based purely on grammatical grounds.

This paper presents the results of an experimental investigation of children's understanding of donkey sentences like (1) and (2). The study is specifically designed to differentiate the competing accounts of donkey anaphora. To forestall suspense, the findings of the experiment provide support for Chierchia's account of donkey sentences. Children make clear distinctions between relative clause and conditional donkey sentences. They prefer the Weak interpretation of relative clause donkey sentences, but show no overall preference for one interpretation over the other in interpreting conditional donkey sentences; some children consistently assign the Weak interpretation and others consistently assign the Strong interpretation. The findings resist explanation on any discourse-theoretic account that analyzes relative clause and conditional donkey sentences in the same way.

2.   Anaphora without C-Command

The proposals we evaluate take a different stance on what connection there is, if any, between anaphora in donkey sentences and anaphora in discourse. In ordinary sentence anaphora, binding is permissible only if the quantificational antecedent c-commands the expression that it binds. This is shown by the contrasting grammaticality of (3) and (4). Here and throughout, anaphoric relations are generically represented by underlining.

(3)   Every talkshow host thinks she is underpaid.

(4)   *She thinks every talkshow host is underpaid.

Example (3) can be interpreted as meaning that every talkshow host thinks she, herself, is underpaid. By contrast, (4), cannot have this meaning, because the quantificational NP, *every talkshow host*, does not c-command the pronoun.

In discourse, however, a pronoun can be referentially dependent on a quantificational NP that precedes it, but does not c-command it. For example, in (5) the pronoun, *he*, can refer to the boy introduced in the first sentence. There is no binding in the traditional sense, however, because c-command does not extend across sentences.

(5)   A boy walked in. He sat down.

In donkey sentences, too, anaphoric relations are established in the absence of c-command. For example, in the relative clause donkey sentence (6), the pronoun, *it*, is referentially dependent on the indefinite NP, *a dog*, although the indefinite NP does not c-command the pronoun.

(6)   Every boy who has a dog takes it to the park.

The lack of c-command in the relative clause example is graphically depicted in the tree diagram in (7). As (7) illustrates, a pronoun in the main clause VP of a donkey sentence can be anaphorically linked to an indefinite NP embedded inside a relative clause.

A central goal of all recent analyses of donkey anaphora has been to account for such instances of binding in the absence of c-command. While the two views compared in this paper take a relatively similar stance on the analysis of conditional donkey sentences, they diverge in their analysis of relative clause donkey sentences. Consequently, the accounts make quite different predictions about the interpretations assigned to the two constructions. This permits us to distinguish the two accounts empirically, using children as informants.

(7)
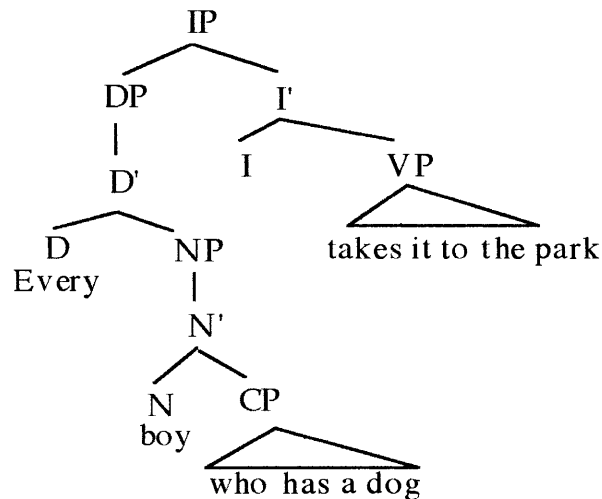
3.   Unselective Binding

In Discourse Representation Theory, the analyses of relative clause donkey sentences and conditional donkey sentences yield the same truth conditions, ones corresponding to the Strong reading.[1] The system developed in Heim (1982) is representative of this approach. Heim (1982) takes both conditional and relative clause donkey sentences to be instances of unselective binding. By unselective binding, anaphoric links are established between quantificational NPs and pronouns that lie outside their c-command domain.

Here is how. In Heim's system, indefinite NPs carry no quantificational force of their own. When an indefinite NP, such as *a boy*, appears in discourse, it is semantically represented by an open predicate with a free variable:

(8)   *a boy* → boy(x)

The open predicate inherits its quantificational force in one of two ways. One pertains to indefinite NPs within the scope of a quantificational element, such as *every* or *always*. In such cases, the domain of the quantificational element is extended beyond its usual limits, so as to encompass all disenfranchised indefinite NPs within its scope. That is, the quantificational element is an unselective binder, with scope even over indefinites that it does not c-command. The other way an indefinite can inherit quantificational force is by Existential Closure, which inserts an existential quantifier to bind indefinite NPs that stand alone, i.e., with no quantificational antecedent.

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[1] Prior to the Heim/Kamp analysis, it was generally held that donkey sentences carried a presupposition of uniqueness, in which case the donkey sentences in (1) and (2) would be false in any context in which there were boys with more than one dog.

An example of unselective binding occurs in conditional donkey sentences like (2), in which the adverb of quantification, *always*, imparts its quantificational force to both of the indefinite NPs, *a boy* and *a dog*. The semantic representation postulated by Heim for such sentences is an extension of an earlier analysis, by Lewis (1979), who was the first to observe that adverbs of quantification can take scope over several indefinites at the same time. In Heim's semantic representation, donkey sentences are partitioned into three parts: a Quantifier, a Restrictor, and a Nuclear Scope. As the sample tripartite structure in (9) indicates, the domain of the Quantifier is given by the Restrictor, and may include more than one open predicate. The Quantifier binds the variables of these predicates, unselectively. The Nuclear Scope states conditions that must be satisfied by the quantified variables. Notice that this representation yields the truth conditions of the Strong reading of the donkey sentence.

(9) | Quantifier | Restrictor | Nuclear Scope |

$\text{ALWAYS}_{x,y}$ $\quad$ boy(x) & dog(y) & has(x,y) $\quad$ takes-to-the-park(x,y)

'(Always) If a boy has a dog, he takes it to the park.'

Relative clause donkey sentences receive a similar analysis in Heim's framework. Like the adverb of quantification, *always*, the universal quantifier, *every*, is analyzed as an unselective binder, with scope over all open predicates inside the Restrictor.

(10) | Quantifier | Restrictor | Nuclear Scope |

$\text{EVERY}_{x,y}$ $\quad$ boy(x) & dog(y) & has(x,y) $\quad$ takes-to-the-park(x,y)

'Every boy who has a dog takes it to the park.'

Comparing (9) and (10), it is clear that relative clause donkey sentences have the same truth conditions as their conditional counterparts; the Strong reading. In short, this is how the truth conditions for both (1) and (2) are derived. In both cases, the sentence is true iff every boy takes every dog that he owns to the park.

Not all donkey sentences are assigned the Strong reading. For example, people generally indicate that (11) is true if each man wears only one hat to the game.

(11) Every man who has a nice hat wears it to the basketball game.

On the unselective binding account, examples like (11) are the exception to the rule. Heim suggests that the preference for the Weak reading of (11) is due to general knowledge of the world: men typically can wear only one hat at a time. In short, when the Weak reading surfaces for either conditional or relative clause donkey sentences, this is the result of real-world knowledge interfering with the normal assignment of the Strong reading.

Despite its appeal, some concerns with the unselective binding analysis have been raised by Chierchia among others (including certain empirical problems which we do not discuss). One concern is that discourse and sentence anaphora are treated as distinct phenomena on the unselective binding account. Of course, this bifurcation of anaphoric relations might ultimately turn out to be necessary, but it is reasonable to ask whether anaphoric relations can be handled by a single mechanism and, if so, what the empirical consequences of such an approach are.

A second issue concerns the chameleon-like character of the universal quantifier. The universal quantifier is ordinarily a Determiner, with the syntactic co-occurence restrictions of a Determiner and with the semantic properties conferred on Determiners, such as the 'lives on' relation (Barwise and Cooper, 1981). According to this semantic notion, the domain of the universal quantification is limited to the individuals denoted by a nominal argument that is right-adjacent to it in the same constituent. On the unselective binding account, however, the universal quantifier behaves like an adverb of quantification, and not like a Determiner, when it appears in a relative clause donkey sentence. Like an adverb of quantification, such as *always* and *usually*, the domain of the universal quantifier may include the contents of another clause; this enables it to have scope over several NPs at the same time. By treating the universal quantifier in a similar fashion, however, the unselective binding account is forced to abandon the proposal that the universal quantifier has the semantic properties of a Determiner in all constructions. Permitting this kind of variability in semantic function should be suspect, in our view, because the syntactic behavior of the universal quantifier is always that of a Determiner.

Another concern is raised by Groenendijk and Stokhof (1991), who observe that the universal quantifier, in its guise as an unselective binder, does not conform to the principle of compositionality. We should ask whether this, too, is necessary; or if compositionality can be achieved in the analysis of relative clause donkey sentences. Finally, Heim's account implies that the Weak reading of relative clause donkey sentences is exceptional. However, as we saw, the Weak reading is readily available for many relative clause donkey sentences.

4.   Dynamic Binding

A unified approach to discourse anaphora and sentence anaphora is advanced by Chierchia (1992, 1995). In Chierchia's system, the same mechanisms that are used to establish anaphoric relations between an indefinite NP in one sentence of a discourse and a pronoun in a subsequent sentence are also responsible for establishing anaphora relations in relative clause donkey sentences. Following Chierchia, we will call these mechanisms 'dynamic binding'. The mechanisms of dynamic binding explain, for example, how the indefinite NP, *a boy*, in the first sentence in (12) can serve as the linguistic antecedent for the pronoun, *he*, in the second sentence.

(12)   <u>A boy</u> walked in. <u>He</u> sat down.

In a dynamic setting, the semantic contribution of a sentence within a discourse has two parts. One part is the usual truth-conditional content of the sentence. In the first sentence in (12), for example, the indefinite NP, *a boy*, establishes a discourse referent; semantically, this is analyzed using an Existential quantifier, which ranges over an individual variable, x. The second part of the semantic contribution of a sentence to a discourse is represented by a propositional variable, p, which is bound by a lambda operator. This propositional variable functions as a placeholder to be filled by the content of subsequent sentences:

(13)   A boy walked in.
        $\exists x \, \lambda p \, [\text{boy} \, (x) \, \& \, \text{walked-in} \, (x) \, \underline{\&} \, p]$

A subsequent sentence in the discourse may contain a singular pronoun which can be construed as introducing a free occurrence of an existing variable, i.e., x. By the definition of dynamic conjunction, $\underline{\&}$, along with lambda conversion, the free variable in the discourse representation of the second sentence is brought within the scope of the existential quantifier in the first sentence. The result is another dynamic formula with a new propositional variable, q, which serves as a placeholder for further discourse.

(14)   ... He sat down.

        $\exists$x λp [boy(x) & walked-in(x) & p] & sat-down(x)

        $\exists$x λq [boy(x) & walked-in(x) & sat-down(x) & q]

In this fashion, the domain of an indefinite NP can be extended indefinitely beyond the sentence that contains it, to include variables (pronouns) in subsequent sentences.

      This brings us to the dynamic binding analysis of relative clause donkey sentences. The Weak reading is basic, according to Chierchia. This reading is derived by the same discourse processes used for (12), along with the definition of dynamic material implication. Example (15) provides a rough indication of how the principles of dynamic binding apply to a relative clause donkey sentence. The goal is to bring the apparently stranded *y* variable in the consequent clause of (i) within the scope of the existential quantifier in the antecedent (relative clause). This is accomplished in Chierchia's system through the interpretation of dynamic material implication, $\rightarrow$. In the metamorphosis from the dynamic connective in (i) to its more customary interpretation in (ii), the portion of the antecedent clause containing the existential quantifier is repeated in the consequent clause. Then, by dynamic binding, the predicate of the main clause comes to reside within the scope of the existential quantifier, as shown in (iii).

(15)   Every boy who has a dog takes it to the park.

    (i) $\forall$x [(boy(x) & $\exists$y (dog(y) & has(x,y))) $\rightarrow$ (takes-to-park(x,y))]

    (ii) $\forall$x [(boy(x) & $\exists$y (dog(y) & has(x,y))) $\rightarrow$

               ($\exists$y λp(dog(y) & has(x,y)) & p)) & (takes-to-park(x,y))]

    (iii) $\forall$x λq[(boy(x) & $\exists$y (dog(y) & has(x,y))) $\rightarrow$

              $\exists$y (dog(y) & has(x,y)) & takes-to-park(x,y))] & q

With the pronoun (i.e., the variable *y*) now bound by an existential quantifier, the representation corresponds to the Weak interpretation, which is satisfied if each boy takes at least one dog that he has to the park. Another point worth noting about this representation of relative clause donkey sentences is that *every* functions as a Determiner, just as it does in other constructions, and all of this is achieved within a semantics that is straightforwardly compositional.

      In Chierchia's system, variations in the interpretations of donkey sentences are attributed to real-world knowledge, just as in Heim's system. According to Chierchia's account, however, it is the Strong reading of relative clause donkey sentences which is exceptional, i.e., the interpretation that is given by a different mechanism, i.e., by an E-type strategy (Evans, 1977; 1980).[2] By this strategy, the pronoun, *it*, in the relative clause donkey sentence under consideration is semantically realized as a contextually specified function from individuals to individuals; in the example, this is a function from boys to their dogs. Thus, (15) would be interpreted as in (16).

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[2] Chierchia is not the first to suggest that the E-type strategy is used to interpret donkey sentences. This idea was first developed in both Evans (1977; 1980) and Cooper (1979). It was later resurrected by Heim (1990), who maintains that use of the E-type strategy carries with it a presupposition of uniqueness (see footnote 1).

(16)   Every boy who has a dog takes it to the park.

$$\forall x\ [\ (boy(x)\ \&\ \exists y\ (dog(y)\ \&\ has(x,y)\ ))\ \to\ (takes\text{-}to\text{-}park(x,f(x)))]$$

where f: boys to dog(s) that they have

Employment of the E-type strategy is dictated by pragmatic forces, though a precise explication of the forces at work remains an open question. Space limitations prevent us from providing further detail on this and other matters, including the means by which conditionals are interpreted in Chierchia's system. Suffice it to say that the interpretation of conditionals also hinges on factors such as topic structure and focal stress. When these factors do not influence the domain of quantification, the Strong reading of conditional donkey sentences seems to be more readily available than the Weak reading (Bäuerle and Egli, 1985; Kadmon, 1987).[3]

In sum, Chierchia's theory of dynamic binding responds to most of the concerns with the unselective binding account. Both discourse and sentence anaphora in the absence of c-command are given a unified analysis; the putatively universal semantic properties of a Determiner are bestowed on the universal quantifier in all constructions; a compositional semantics is maintained; and the semantics closely mirrors the empirical facts, providing for the routine assignment of the Weak reading of relative clause donkey sentences and the Strong reading of conditional donkey sentences. This last observation is the basis for the experimental investigations of children's understanding of donkey sentences, which we turn to in Sections 6 and 7.

5.   Predictions for Child Language

Before we proceed to the child language laboratory, we should first formulate the predictions of the alternative theoretical accounts for the course of language development, and mention relevant empirical results from previous investigations of child language.

To recap, on the unselective binding account, both relative clause and conditional donkey sentences are instances of unselective binding, and both have the truth conditions corresponding to the Strong reading. The Weak reading of a donkey sentence is seen to be a consequence of general knowledge of the world. This observation serves as the foundation for a prediction about the course of language development. Assuming that children accumulate general knowledge of the world only gradually, through experience, we expect young children at least to lack the full adult arsenal of such knowledge. Therefore, the unselective binding account leads us to expect children to initially assign the Strong interpretation to both conditional and relative clause donkey sentences. As children's general knowledge of the world increases, they should add the Weak reading as an interpretive option, where circumstances dictate.

Turning to prior research on child language, it should be noted that the semantic status of the universal quantifier has not been previously addressed by examining children's understanding of donkey sentences. However, we are quick to add that the

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[3] Precisely which indefinites come within the scope of the adverb of quantification is determined by the topic structure of the discourse context and focal stress. For example, if stress is on *trainer*, as in (i), then the quantifier has asymmetric scope over dolphins; if stress is on *dolphin*, as in (ii), it asymmetrically quantifies over trainers.

(i)   If a TRAINER trains a dolphin, she can usually make it do incredible things.
(ii)   If a trainer trains a DOLPHIN, she can usually make it do incredible things.

findings of prior research have led to the conclusion that children initially misanalyze the universal quantifier in much simpler sentences. For example, many English-speaking children incorrectly answer "No" to the question *Is every farmer feeding a donkey?* when presented with a picture in which every farmer is feeding a donkey, but there is also a donkey that is not being fed. Apparently, these children demand symmetry between farmers and donkeys. To explain children's 'symmetrical interpretation' of sentences with a universal quantifier, Philip (1991; 1992) proposes an analysis that has several features in common with Heim's unselective binding approach to donkey sentences. The proposal has come to be known as the *symmetrical account* of children's comprehension errors.

The symmetrical account maintains that, unlike adults, children interpret even simple sentences with a universal quantifier by putting both nominals, *farmer* and *donkey*, into the Restrictor. That is, the universal quantifier is semantically analyzed like an adverb of quantification, and not as a Determiner. The child's analysis of universal quantification differs from that of an adult in a second way, on the symmetrical account; children analyze the universal quantifier as unselectively binding (a disjunction of) event variables, rather than individual variables. Adapting the tripartite framework, the symmetrical account maintains that children assign the semantic representation in (17) to both the sentence *Every farmer is feeding a donkey*, and the sentence *A farmer is feeding every donkey*.

(17)   Every farmer is feeding a donkey. OR A farmer is feeding every donkey.

Quantifier	Restrictor	Nuclear Scope
Every(e)	[PART(farmer(e)) or PART(donkey(e))]	farmer-is-feeding-a-donkey(e)

'For all events e, in which a farmer participates or a donkey
participates (or both), a farmer is feeding a donkey in e.'

In this representation, the universal quantifier *every* ranges over events, indicated by the variable *e*. The events mentioned in the Restrictor form a disjunction: Events in which a farmer participates or ones in which a donkey participates, or both.[4] The test given by the Nuclear Scope states that the sentence is false if any such events do not have a farmer feeding a donkey in them. This explains why children who adopt this semantic representation deny the truth of the sentence *Every farmer is feeding a donkey* if there is an unfed donkey in the domain of discourse. And, this explains why children deny *A farmer is feeding every donkey* in any circumstance in which there is at least one farmer who is not feeding anything.

The upshot of the symmetrical account is that children analyze the universal quantifier as an unselective binder even in simple sentences. Elsewhere, we have presented both theoretical and empirical arguments against the symmetrical account (Crain, Conway and Thornton, 1995). We will not reproduce the arguments here. It should be noted, however, that if the account is correct, it is reasonable to expect children to extend the analysis to relative clause donkey sentences. That is, they should also interpret these sentences as instances of unselective binding, assigning them the Strong reading.

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[4] Because the universal quantifier is downward entailing on the nominal constituent it combines with, the disjunction of nominals, *farmer* and *donkey*, in the Restrictor clause entails that a conjunction of events must satisfy the conditions stated in the Nuclear Scope. Any event in which there is a farmer and any event in which there is a donkey must be an event such that a farmer is feeding a donkey.

One virtue of Chierchia's account, in our view, is that the universal quantifier is seen to function as a Determiner in both ordinary sentences and in relative clause donkey sentences. Assuming that the properties of Determiner quantification are semantic universals and, hence, part of the theory of Universal Grammar, it is conceivable that even young children will access the analysis given by dynamic binding. Having less real-world experience than adults have, we expect young children to adhere more to purely grammatical distinctions. In particular, younger children, at least, may not have attained the kind of real-world experience that is drawn upon in using E-type pronouns. The dynamic binding account leads us to expect that children will assign the Weak interpretation to relative clause donkey sentences, at least initially. Since the semantic analysis of a conditional donkey sentence is derived by different mechanisms, it is difficult to predict what analysis children will assign to them. But, if different mechanisms are involved, at least some children may initially assign the Strong reading to conditional donkey sentences.

In regard to the acquisition of the mechanisms of dynamic binding, we refer the reader to an experiment reported in Conway and Crain (1995). That experiment investigated children's adherence to a constraint on the interpretation of anaphoric relations in discourse. In the same linguistic constructions in which a singular pronoun can be anaphorically linked to a preceding indefinite NP, a pronoun cannot be linked to a quantificational NP with negation or to one with a universal quantifier, as exemplified in (18). As these examples illustrate, there is a constraint precluding the extension of the domain of certain quantificational NPs in discourse. The constraint prohibits sentences with the universal quantifier or ones with negation from receiving a bound variable interpretation, although this interpretation is permitted in sentence grammar, as illustrated by the examples in (19).

(18)   A boy came in. He sat down.
        *Every boy walked in. He sat down.
        *No boy walked in. He sat down.

(19)   Every boy said that he walked in.
        No boy thinks he will sit down.

Since the constraint on discourse binding renders the scopal domain of these quantified NP 'closed' to further occurrences of the relevant variable, this constraint is called 'Closure.' The Conway and Crain study found that three-to-five-year-old children obey the constraint on Closure, despite being tolerant of variable binding with indefinite NPs in discourse, and within sentences. This pattern of results invites us to infer that children know the mechanisms of dynamic binding.

If Chierchia's theory of dynamic binding is correct, then the previous literature on child language leads us to expect children to invoke these mechanisms in interpreting donkey sentences as well. When the Strong reading is assigned to a relative clause donkey, the interpretation of the sentence has been affected by real-world knowledge. Assuming that general knowledge of the world is acquired only gradually, Chierchia's framework leads us to expect children to initially assign the Weak reading to relative clause donkey sentences. As we saw, conditional donkey sentences are interpreted by a different set of mechanisms on Chierchia's account. We also saw that, in the absence of factors such as focal stress, the Strong reading of conditional donkey sentences is more readily available. Therefore, at least some children should be expected to assign the Strong reading to conditional donkey sentences in the experiment presented in the next section.

6.   Experiment I: Relative Clause and Conditional Donkey Sentences

In this experiment, children were presented with both relative clause and conditional donkey sentences like (20) and (21), in contexts compatible with the Weak reading.

(20)   Every boy who has a dog takes it to the park.

(21)   If a girl has a cat, she brushes it before a show.

The experimental task was a variant of the Truth Value Judgment Task (Crain and McKee, 1985). One experimenter acted out stories using toy figures and props. A second experimenter manipulated a puppet, who watched the stories along with the child. The children were told that they were playing a game with the puppet. The puppet said that it was very smart and could tell in advance how each of the stories would end. The child's role in the game was to determine at the completion of the story whether or not the puppet's prediction was borne out. Although neither of the analyses under consideration make specific claims about the influence of tense, examples of donkey sentences in the literature typically contain the present tense form of the verb, both in the relative clause and in the main clause. In keeping with this tradition, the test sentences in our study were presented in present tense. This produces a habitual reading rather than a reportative reading (Parsons, 1990), and seems to make the Strong reading easily accessible. If so, the experiment is biased against Chierchia's prediction that the Weak reading of relative clause donkey sentences is basic. Evidence that children accept this reading, then, would be compelling support for Chierchia's account.

The stories corresponding to both relative clause and conditional test sentences were virtually identical in all respects. Typical lead-in and test sentences are given in (22).

(22)   a. I know a lot about boys and dogs. Every boy who has a dog takes it to the park.

         b. I know a lot about boys and dogs. If a boy has a dog, he takes it to the park.

Although the experiment featured stories that were acted out in real time, the outcome of the story corresponding to (22), which we call a Weak context, is statically represented in Figure 1. The story depicted in Figure 1 had 4 boys and 6 dogs. One boy had a single dog, one boy had two dogs, one had three dogs and one boy did not have any dogs.[5] Following the introduction of characters, but prior to the presentation of the story, the puppet uttered the test sentence, either (22a) or (22b). The experimenter then acted out the story.

The story went as follows: The boys decided to take their dogs to the park because it was such a nice day. The boy with one dog prepared his dog to go to the park by putting a leash on it. The boy with two dogs put a leash on one of his dogs (the dog that was awake), but the other dog was sleeping and could not go to the park. The boy with three dogs put a leash on one of his dogs because that dog was awake, but not on his other two dogs, who were asleep. The boy without any dogs went along with the other boys to the park. Thus, during the course of the story, each dog-owner took only one dog to the park. If the Weak reading is assigned, therefore, the child should say that the puppet's statement is true; if the Strong reading is assigned, the child should say that the statement is false.

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[5]As observed by Hamburger and Crain (1982), children find restrictive relative clauses to be felicitous only when they are used to restrict from a larger set. Based on this observation, each trial included an extra character possessions (e.g. a boy, in this case), who was not in possession of the object mentioned in the relative clause. This extra character was also included on the trials in which the test sentence was a conditional.
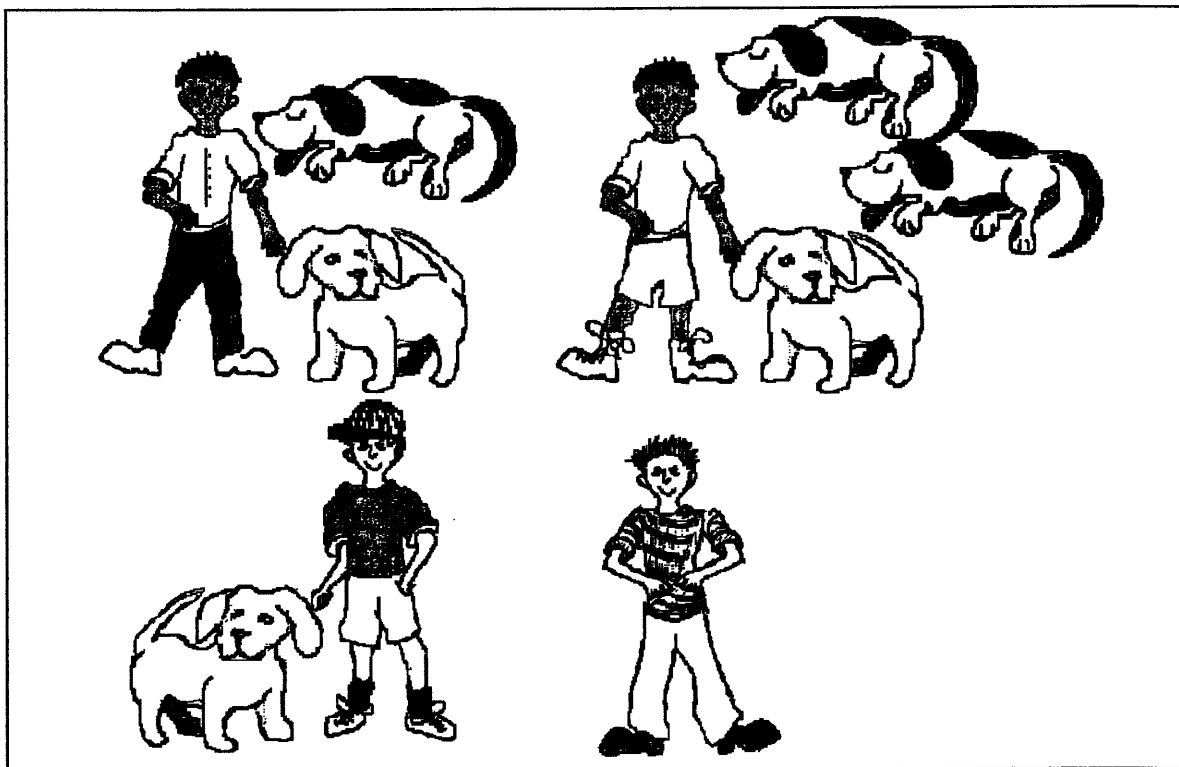
Figure 1: Context Corresponding to the Weak Interpretation

The test sentences were divided along another dimension. On half of the sentences, the nature of the relation between the possessor and the object of possession was one of 'inalienable' possession (a syntactic analysis of this distinction is given in Hornstein, Rosen and Uriagereka, 1995). An example of inalienable possession is the relation between parents and offspring, as in (23) (or the relation between a car and its engine, a table and its legs, and so on). In contrast to this relation is the kind of possession expressed in sentences like (24), where the relation is not one of inalienable possession. For lack of a better term, let us call this relation, 'alienable' possession.

(23)   Every frog who has a baby takes it to the pond.

(24)   Every man who has a snowplow uses it to push snow.

Fifteen children were interviewed in the experiment. They ranged in age from 3;7 to 5;5 (mean age = 4;5). All of the children attended preschool or kindergarten at the Child Development Laboratories at the University of Connecticut, Storrs. The children received 6 trials with relative clause donkey sentences, and 4 trials with conditional donkey sentences. The two sentence types were tested in separate sessions, with filler trials interspersed among the test trials in each session. At least three weeks elapsed between sessions.

Averaging across children, it looks as though children interpret the two types of donkey sentences in roughly the same way. Overall, children accepted relative clause donkey sentences 63% (48/76) of the time in Weak contexts, and they accepted conditional donkey sentences 55% (31/56) of the time in these same contexts. This way of looking at the findings is quite misleading, however, because it obscures the patterns of responses by individual children and it conflates the two types of relative clause donkey sentences (i.e., the distinction of inalienable/alienable possession).

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A finer-grained analysis paints a different picture of children's comprehension of relative clause and conditional donkey sentences. First, we compared relative clause donkey sentences that contained verbs of alienable possession and conditional donkey sentences that contained the same verbs. The overall finding is that children accepted relative clause donkey sentences like (24) 86% (37/43) of the time in Weak contexts, but they accepted their conditional counterparts 46% (13/28) of the time. This difference in rate of acceptance was significant (Chi-square = 6.12; p<.05). Looking next at the data for individual subjects, we found that roughly half of the children (8/15) consistently rejected relative clause donkey sentences like (23), where the relationship expressed inalienable possession; however, these same children regularly accepted sentences like (24), in which the relation was not one of inalienable possession. These children did not exhibit sensitivity to the nature of possession in responding to the conditional donkey sentences. With conditionals, children tended to either reject all of the test sentences, or accept them all.

Continuing to look at the individual subject data, there is further evidence from the present study in support of Chierchia's account of dynamic binding. Every child in the study accepted the Weak reading of relative clause donkey sentences on at least one occasion; however, several children uniformly assigned the Strong interpretation to the conditional donkey sentences. According to the unselective binding account, children should have consistently assigned the Strong reading, rejecting both relative clause and conditional donkey sentences in the Weak contexts. As we saw, this happened only for the conditionals. Similarly, the symmetrical account of children's apparent misunderstanding of simple sentences invited the inference that they would assign the Strong reading to relative clause donkey sentences. This extension of the symmetrical account was not confirmed in the present study.

The next experiment investigates children's use of the principles of dynamic binding in a relative clause construction where the Weak reading is excluded. If children know dynamic binding, as the findings of the present experiment suggest, then the Strong reading should emerge as the analysis hypothesized by children's grammars.

7.   Experiment II: Negative Quantification

Not all relative clause donkey sentences have both Strong and Weak readings. With a negative quantifier, only the Strong interpretation is available. Consider example (25). This sentence is true only on the Strong reading; that is, it is true only if every spaceguy refrains from putting any of his plates in the sink:

(25)   None of the spaceguys who has a plate puts it in the sink.

According to the Weak reading, the relative clause donkey sentence (25) is true if every spaceguy refrains from putting at least one of his plates in the sink -- but not all of the plates must end up in the sink. In the present study, children were presented with sentences like (25) in a context in which the Strong reading was false (i.e. some spaceguy put one of his plates in the sink.) If children have internalized the mechanisms of dynamic binding, their responses in this experiment should be a complete reversal from those evoked in the first experiment. That is, children who accepted relative clause donkey sentences with the universal quantifier should reject relative clause donkey sentences with negation. In addition, children should not permit their judgments to be influenced by the nature of possession in response to the test sentences in this experiment, since dynamic binding does not make the Weak reading available. To test this prediction, the present study including test sentences like (26) as well as ones like (25).

(26)   None of the bears who has a baby feeds it chocolate.

As in the first experiment, a variant of the Truth Value Judgment task was used. And, again, the stories were Weak contexts. An abridged protocol for a typical story is provided in (27). In this story, which corresponds to test sentence (25), there were four spaceguys. Three of the spaceguys were just finishing lunch. There were two possible places to wash plates: a sink and a wishing-well. One of the spaceguys had a huge lunch, and had 3 plates to wash; one had a medium-sized lunch, with two plates to wash; and one spaceguy had only a small lunch, on one plate. After the characters were introduced, the puppet made its guess as to the completion of the story:

(27)   I don't think those spaceguys know that on Earth we wash our plates in a sink. They probably wash plates in wishing-wells on their planet. I think: *None of the spaceguys who has a plate puts it in the sink.*

Beginning with the spaceguy with one plate, the spaceguys rejected the sink as a place to wash plates on the grounds that on their planet, plates are washed in wishing-wells. The last spaceguy (with 3 plates), put two of his plates in the wishing-well, but then decided to put his last plate in the sink, since that was what Earth people did (this was his last day on Earth). Thus, during the course of events, one of the spaceguys does, in fact, put one of his plates in the sink, making the Strong reading false in the context.

We interviewed 12 children, ranging in age from 2;11 - 5;8 (mean age = 4;2). Each child was presented 4 trials (two trials with inalienable possession, and two without) in a single session, interspersed with fillers of unrelated sentence types. Averaging across subjects, we found that children consistently rejected the target sentences in the experimental context, giving 78% (36/46) "No" responses. This result is interpreted as indicating children assigned the Strong reading to the test sentences. This percentage increases to 89% (34/38) correct rejections if the results from two children are excluded from the analysis -- children who accepted all of the test sentences.

A second important finding is that children did not distinguish the test sentences according to the nature of possession that was expressed. Sentences expressing inalienable possession were accepted 77% (19/24) of the time, and sentences which did not express inalienable possession were rejected 79% (17/22) of the time. The absence of a difference in this regard in the present experiment invites us to infer that the distinction found in the first experiment, with relative clause donkey sentences containing the universal quantifier, was not an artifact of the task.

8.   The Accounts Revisited: Dynamic versus Unselective Binding

We conclude by summarizing how the two accounts fared in the two experiments with children. One of the main findings is that children did not interpret relative clause and conditional donkey sentences in the same way. This offers circumstantial evidence against any semantic theory that provides a unified analysis of relative clause and conditional donkey sentences. On such accounts generally, it is assumed that the primary reading of donkey sentences of both types is the Strong reading. As we have seen, this is not how young children analyze relative clause donkey sentences. Children readily accept relative clause donkey sentences expressing 'alienable' possession in Weak contexts, but some children, at least, reject ones expressing inalienable possession in the same contexts. This distinction was not found in conditional examples. Nor was it found when we tested adult controls using both relative clause and conditional donkey sentences. Adults consistently accepted both constructions in the Weak contexts. This underscores a point we made in the introduction -- that children may be better subjects than adults are in evaluating between competing theoretical hypotheses. Because children are less contaminated by general world knowledge, their responses may be more revealing of the natural seams of grammar.

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To sum up, children do not utilize the same mechanism(s) to interpret relative clause and conditional donkey sentences. Of the two accounts, only Chierchia's theory of dynamic binding predicted this. On Chierchia's account, the Weak interpretation of relative clause sentences is given by the dynamic binding process which, as we noted, has already been shown to be available to young children (Conway and Crain, 1995). The findings of both experiments discussed in this paper provide further confirmation for this framework. By adopting the theoretical mechanisms of dynamic binding, we are able to account for children's high rate of acceptance of relative clause donkey sentences which do not express inalienable possession, as well as their high rate of rejection of Weak contexts in response to relative clause donkey sentences with negation.

In previous research, the Strong reading of relative clause donkey sentences is generally attributed to the E-type pronoun strategy. In child grammar, this reading seems to stem from a different source. Children assign the Strong reading primarily for relative clause donkey sentences which express alienable possession, but they adopt an egalitarian standard in interpreting relative clause sentences that express relations of inalienable possession. With conditional donkey sentences, however, this distinction is not utilized; only the Weak reading seems to be available. This suggests that relative clause and conditional donkey sentences are processed by different mechanisms. In conclusion, the present experiments offer strong presumptive evidence supporting Chierchia's theory of dynamic binding.

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