Children's comprehension of distributive universal quantification

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Abstract

Our study explores why children are prone to assign a wider range of interpretations to sentences with distributive universal quantifiers *each* and *every* than adults. Musolino (2009) proposed that children are more permissive than adults because they are prone to assign quantifier spreading interpretations to universally quantified sentences. Our results support the alternative hypothesis that children are more permissive because they are prone to assign cumulative interpretations to universally quantified sentences in a wider range of contexts than adults. Our results reveal that both children and adults assign cumulative interpretations to sentences with universally quantified objects (*Three cowboys are pulling every horse*), but children also tend to assign cumulative interpretations to sentences with universally quantified subjects (*Every cowboy is pulling two horses*). We show that children perform similarly with sentences with universally quantified NPs and sentences with numerical NPs (*Three cowboys are pulling two horses*). We argue that children are more permissive than adults because they are less likely than adults to perceive singular subject-verb agreement as a cue to distributive interpretation. We present a formal semantic model to explain our findings and discuss the implications of our model for recent acquisition research.
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1. Introduction

Children's comprehension of sentences with the universal quantificational expressions *all*, *each*, and *every* has been a central topic in developmental linguistics for more than two decades. Much of the research in this area has focused on children's logical reasoning with universally quantified sentences and the logical properties of universally quantified NPs (Chierchia et al., 2001; Crain, 2012; Gualmini, 2005; Gualmini et al., 2008; Lidz and Musolino, 2002; Musolino and Lidz, 2006; Musolino, 2009; Syrett and Lidz, 2009, and many others) or children's symmetrical judgments of universally quantified sentences (Crain et al., 1996; Drozd, 1996; Drozd and van Loosbroek, 2006; Gouro et al., 2001; Kang, 2001; Philip, 1995, and many others). A recently emerging line of research has focused on children's sensitivity to distributive quantification and the extent to which children access the distributive, collective, and cumulative interpretations adults assign to quantified sentences (Brooks and Braine, 1996; Musolino, 2009; Pagliarini et al., 2012; Syrett and Musolino,

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2015). Although this research has now firmly established that children systematically differ from adults in the way they interpret sentences with the distributive quantifiers *each* and *every* under certain experimental conditions, few formal accounts have yet emerged to describe the linguistic processes and representations underlying children's performance or to what extent these linguistic processes and representations might differ from those of adults.

With our experiment, we take a modest step toward addressing these issues by exploring children's sensitivity to the distributive and cumulative interpretations of sentences with numerical NPs and NPs headed by the distributive determiner *every*. In a recent paper, Musolino (2009) reported that children are prone to accept sentences with *each* as descriptions of contexts depicting cumulative relations. To explain these results, Musolino argued that children tend to assign quantifier spreading interpretations to these sentences analogous to the quantifier spreading interpretations proposed under Geurts (2003) weak quantifier account of children's symmetrical judgments. We designed an experiment to test the predictions of the quantifier spreading account as well as the predictions of an alternative account which claims that children assign cumulative interpretations to universally quantified sentences when they accept them as descriptions of cumulative relations (the Cumulative Interpretation Hypothesis). Our results, we argue, support the cumulative interpretation account. We show that both children and adults are prone to accept sentences with universally quantified objects like *Three cowboys are pulling every horse* as descriptions of cumulative contexts but that children are more permissive than adults in accepting sentences with universally quantified subjects like *Every cowboy is pulling two horses* as well as descriptions of these contexts. We argue that children perform differently than adults not because they employ different linguistic processes and representations than adults do but because they are not as sensitive as adults to singular subject-verb agreement as a grammatical cue to distributive interpretation. We present a formal linguistic model based on Checking Theory (Szabolcsi, 1997) which explains our results with both children and adults, followed by a discussion of the implications of our model for recent research on the acquisition of distributive universal quantification.

We begin by describing our theoretical assumptions.

2. Distributive and cumulative sentence interpretations

Our study concerns the distributive and cumulative interpretations of sentences with two numerical NPs (numNP sentences) like (1) and sentences with matrix subject and object NPs headed by the distributive determiner *every* (*every*NP sentences) like (2) and (3).[1]

(1) Three cowboys are pulling two horses.
(2) Every cowboy is pulling two horses.
(3) Three cowboys are pulling every horse.

A sentence is understood as distributive if a predicate is interpreted as a property of each individual of the plurality to which the predicate applies (Champollion, 2015; Lasersohn, 1998; Schwarzschild, 1996, and many others). (1) has at least two distributive interpretations. The surface scope (SS) distributive interpretation describes situations in which the property of pulling two horses is a property of each individual member of a set of cowboys, where each cowboy is pulling a different pair of horses. The inverse scope (IS) distributive interpretation describes situation in which the property of being pulled by three cowboys is a property of each individual member of a set of horses, where each horse is pulled by a different trio of cowboys. (1) can also receive a scopeless non-distributive cumulative interpretation if the individuals in the set denotations of the two numNPs are understood as exhaustively paired in a cross-product relation denoted by the predicate (Scha, 1981; Schein, 1993, and many others, see Champollion, 2015 for discussion). The cumulative interpretation of (1) describes situations in which each cowboy is pulling at least one horse and each horse is being pulled by at least one cowboy.

An *Every*NP in matrix subject position, as in (2), enforces the distributive interpretation of a sentence where *Every*NP supplies the plurality argument for the distributive relation. Thus, (2) can be used to assert that the property of pulling two horses is a property of each individual cowboy, where cowboys are pulling different pairs of horses. (2) cannot be used to describe situations in which each individual horse is being pulled by a different trio of cowboys (IS distributive interpretation) or situations where individual cowboys and horses are paired in a cross-product relation (the cumulative interpretation). Sentences including *Every*NP direct objects like (3) typically receive IS distributive interpretations (Ioup, 1975) and generally do not receive cumulative interpretations. However, it is widely accepted in the semantics literature that exceptional cases of *Every*NP object sentences exist which naturally receive cumulative interpretations (e.g.,

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[1] Sentences like (1)–(3) also have collective interpretations (see Champollion, 2015 for a detailed summary). For example, (1) can be used to assert that a group of cowboys as a group pulled the same two horses. We do not investigate children's comprehension of collective interpretations in our experiment (but see below for a review of recent developmental research).