Distributive, collective and "everything" in between

Interpretation of universal quantifiers in child and adult language

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In this paper we studied the interpretation of sentences with the Dutch universal quantifiers *alle* (*all*) and *elke* (*each*) in collective, distributive and cumulative situations. In the first experiment, 25 adults and 30 children from 5 and 6 years old performed a truth-value judgement task. Adults and children show similar interpretations for collective and distributive, but perform different for cumulative. As a follow-up we performed a preference task. Participants gave their preferences for the three situations for both quantifiers. Children, regardless of the quantifier, prefer the distributive situation. Adults have a strong preference for distributive for *elke*, showing a wider range of interpretation for *alle*. These data clearly indicate that Dutch children do not yet have acquired the full range of restrictions for the quantifiers *alle* and *elke*.

Keywords: universal quantifiers, collective, distributive, cumulative, Dutch

1. Introduction

Sentences containing Dutch universal quantifiers such as *elke* (*each*) and *alle* (*all*) are complicated to interpret. It requires combining information from different sources, such as semantic, pragmatics and syntax (Brooks & Braine 1996). Some universal quantifiers can evoke different interpretations. For example, the sentence *alle jongens wassen een boot* (*all boys are washing a boat*) can represent a meaning in which all of the boys referred to in the discourse are washing one and the same boat. This interpretation is called the *collective* interpretation (Gil 1982). It can also have the meaning in which each individual boy is washing a different boat. This interpretation is called the *distributive* interpretation (Gil 1982). A third

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possible interpretation is that some boys referred to in the discourse are washing a boat together while other boys referred to in the discourse are washing their own boat. This interpretation is named the *cumulative* interpretation (Scha 1981; Musolino 2009) As shown, the quantifier *alle* can provoke different possibilities and is therefore ambiguous.

The sentence *elke jongen wast een boot* (*each boy is washing a boat*) forces the meaning that each individual boy is washing a different boat, which is the distributive reading. According to Scha (1981), Langacker (1991) and Roeper, Strauss and Pearson (2006) the English universal quantifier *each* has a strong capacity to individuate even as the Dutch universal quantifier *elke* (Van der Ziel 2012). Moreover, Tunstall (1998) argues that *each* requires a meaning that is at least partially distributive. This is in contrast to the quantifiers *alle* and *all*, which, as we have shown, can have multiple interpretations.

Research on the acquisition and interpretation of universal quantifiers goes back to the 1960s and 1970s (Inhelder & Piaget 1964; Anderson 1973; Ioup 1975). More recent previous English and Dutch studies have showed an asymmetry between the interpretation of universal quantifiers in adults and children: children have difficulties with the interpretation of universal quantifiers, whereas adults have no or less problems with the interpretation (Brooks & Braine 1996; Drozd & Van Loosbroek 1999; Brooks & Sekerina 2006; Van der Ziel 2012; Syrett & Musolino 2013). Issues that children have with the interpretations are due to the fact that *all* and *alle* are ambiguous and *each* and *elke* require an interpretation that is distributive (Scha 1981; Tunstall 1998). Studies on the acquisition of quantifiers in different languages (English, Dutch and Serbian) will be discussed in the next sessions.

Syrett and Musolino (2013) studied the interpretation of numerical expressions in distributive and collective situations in English children and adults. In one experiment, the authors included the lexical items *each* (distributive) and *together* (collective) to cue particular readings. They put *each* between the subject and the VP and *together* in the VP modifier position. The results demonstrated that adults perform like expected, where they matched *each* to distributive and *together* to collective interpretations due to this particular cue. Children find both collective and distributive pictures correct for both *each* and *together*, which shows that children have difficulties with restricting the added items. A cross-linguistic study of Drozd et al. (in preparation) showed children's difficulties with the universal quantifier *each* for several languages. They performed an experiment where children and adults had to judge the quantifier *each* for cumulative and distributive events. For Dutch it was shown that both children and adults accepted *elke* correctly for the distributive interpretation, but children had a significantly higher acceptance rate for *elke* than adults in the cumulative condition. Van der Ziel

(2012) demonstrated that Dutch children have difficulties with the interpretation of the Dutch universal quantifier *elke*, because *elke* carries lexical properties for distributivity. Interpreting these properties for distributivity is difficult for children. On the other hand, children did not show problems with the interpretation of *alle*. Knezevic (2014) studied the interpretation of *each* in collective, distributive and partially distributive situations in Serbian adults and children. Adults only accepted *each* for the distributive situation, whereas children accepted *each* for all three situations. This shows that Serbian children are not completely aware of the distributive element of the quantifier *each*. Summarizing, all above studies from different languages show that children have difficulties with restricting additional lexical items with a collective meaning or the universal quantifier *each*.

Preferences also give insight in the interpretation and acquisition of universal quantifiers. Syrett and Musolino (2013) also acted out a preference task in their study, but did only do this with numerical expressions. Brooks and Braine (1996), however, illustrated in a preference task that English children are aware of the restrictions of quantifiers. They conducted a picture selection task with sentences like *all flowers are in a vase* or *each flower is in a vase*. The distributive representation of the sentence implies a one-to-one pairing, whereas the collective interpretation implies a group pairing. When asking for preferences, children showed a preference for collective pictures with sentences containing *all* and distributive pictures with sentences containing *each*, just like the adult participants did. These results revealed that children were aware of the restrictions for quantifiers. Van Koert, Hulk, Koeneman and Weerman (2015) studied the preferences of Dutch and English children for *each* and *every*. The authors showed that the preferences of Dutch and English children largely correspond with those of the adults. However, Dutch children and adults have a stronger preference for distributive for *each* and *every* than English children and adults do.

All above studies show parts of interpretation patterns for adults and children for universal quantifiers. Based on a general tendency it is shown that adults are aware of the restrictions for quantifiers whereas children show more difficulties in interpretation of quantifiers, especially for *each*, due to the distributive properties (Van der Ziel 2012; Drozd et al. in preparation). Moreover, a big part of the studies is about the interpretation pattern of children and adults of English quantifiers. In the current study we focus on judgments and preferences of children and adults to get a complete interpretation pattern for the Dutch universal quantifiers *alle* and *elke*. The aim of this study is to investigate how Dutch children from five and six years old and Dutch adults interpret sentences with *alle* and *elke* in collective, distributive and cumulative situations in a truth-value judgement task and a preference task. We want to discover whether Dutch children also show difficulties with the interpretation of especially *elke*.

2. Expectations

We expect the following responses. Yes-responses are expected on all three situations on the sentences with *alle* for adults (Gil 1982; Van der Ziel 2012). For adults, yes-responses for *elke* are expected for the distributive situation, but not for the collective situation (Van der Ziel 2012). For children, we expect that they would accept the distributive and cumulative and even the collective for *elke* (Van der Ziel 2012; Drozd et al. in preparation;). Generalized, based on the ambiguity of *alle* and the restrictive readings along the lines of distributivity for *elke*, we expect non-adult behaviour for *elke* and much of freedom for *alle* for the children.

Since *alle* is ambiguous, we do not expect strong preferences for collective or distributive for children and adults. We expect a preference for distributive in sentences with *elke* for both children and adults, because *elke* carries the lexical properties for distributivity (Van der Ziel 2012; Van Koert et al. 2015).

3. Truth Value Judgment Task

This experiment tested the comprehension of Dutch adults and children for sentences with the universal quantifiers *alle* and *elke* in collective, distributive and cumulative situations.

3.1 Method

3.1.1 *Participants*

Thirty Dutch children participated in the experiment, consisting of seventeen males and thirteen females. Children were between the ages of 5;0 and 6;12. The mean age of the children was 5;9 years. All children were typically developing and no serious hearing or visual problems were known. Additionally, twenty-five Dutch adults (three males and twenty-two females) with a mean age of 21;0 (age range: 19;0–25;1), were included in the study.

3.1.2 *Materials*

Participants were tested in a truth-value judgment task on a 2x3 design. They were tested on two factors: QUANTIFIER and MOVIE. The factor quantifier varied between the universal quantifiers *alle* (1) and *elke* (2) in six different sentences for *alle* and *elke*.

(1) Alle jongens wassen een boot
all boys wash a boat
'All boys are washing a boat'

(2) Elke jongen kleurt een doos
each boy colours a box
'Each boy is colouring a box'

The movies varied in the number of objects used by the characters in the movie. For the sentence *alle jongens wassen een boot* (1) three different movies are presented. In the 3-item movie, all three characters are washing a different boat (Figure 1.). The 3-item movie is also called the distributive movie. In the 2-item movie, one character washes his own boat, while the other two characters are washing the same boat (Figure 2.). The 2-item movie is also called the cumulative movie. In the third set of movies, the 1-item movies, all three characters are washing the same boat (Figure 3.). The 1-item movie is also displayed as the collective movie.

The experiment was created and presented using E-prime software, which accurately measured the responses of the participants. Each participant was tested on 36 test items equally divided over the presented conditions. 18 items included 6 different sentences with the quantifier *alle* and the 18 items included 6 different sentences with the quantifier *elke*. Every different sentence was once accompanied by the 3-item, 2-item and 1-item movie at some point in the experiment. Only transitive verbs denoting atelic events were used in the test sentences. Ten

Figure 1. Distributive/ 3-item movie

Figure 2. Cumulative/ 2-item movie

Figure 3. Collective/ 1-item movie

filler-items were added to the test and were equally divided over the test items. Filler items were used as distractors. All fillers showed three men doing the same activity, for example jumping.

3.1.3 *Procedure*

Participants were told that the computer was confused and that the computer needed help. They were also told that they would be presented with short movies accompanied by a sentence and that they had to judge whether the sentence gave an accurate description of the presented movie. This instruction was given to both children and adults, to keep the circumstances equal. Participants were firstly presented with two practice items in the form of a correct and incorrect filler item.

A typical test item had the following structure: the movie started and after exactly one second the accompanying sentence started. Participants were asked to press a happy smiley or a sad smiley on the computer keyboard, rejecting or accepting the sentence-movie pair.

3.2 Results truth-value judgment task

The first experiment studied how *alle* and *elke* are interpreted in collective, distributive and cumulative situations.

3.2.1 *Accuracy*

Percentage of yes-responses in the two factors FILM (collective vs. distributive vs. cumulative) and QUANTIFIER (*alle* vs. *elke*) were analyzed within the group of adults and children. Yes-responses can be found in Figure 4. A repeated-measures ANOVA was performed with FILM and QUANTIFIER as within-subject variables. Since the data were not normally distributed for both groups, a Greenhouse Geisser correction was used to correct for the level of significance. For adults, main

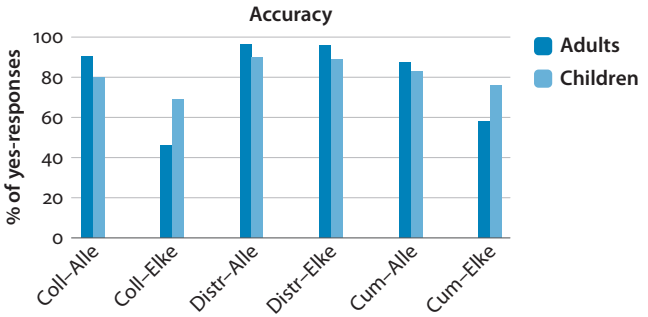

Figure 4. Scores situation by quantifier

effects were found for film ($F(2,24) = 41,48$, $p = .000$, $\eta_p^2 = .633$), and for quantifier ($F(1,24) = 37,43$, $p = .000$, $\eta_p^2 = .609$). Also, significant overall interaction effects were found for film and quantifier ($F(2,24) = 33,617$, $p = .000$, $\eta_p^2 = .583$). For children, main effects were found for film ($F(2,29) = 5.478$, $p = .010$, $\eta_p^2 = .779$), and for quantifier ($F(1,29) = 5.703$, $p = .025$, $\eta_p^2 = .636$). Yet, no significant overall interaction effects were found for film and quantifier ($F(2,29) = 0.966$, $p = .380$, $\eta_p^2 = .201$).

Since the data were not normally distributed, the data of the adults and the children were further analyzed with a non-parametric Wilcoxon Matched-Pair signed rank test. Pairs were made between coll-alle and coll-elke, distr-alle and distr-elke and cum-alle and cum-elke, where distr, coll and cum describe the situation and *alle* and *elke* represent the quantifiers. For adults, no significant difference was found between distr-alle and distr-elke. For the other two pairs, coll-alle and coll-elke and cum-alle and cum-elke, significant effects were found at $\alpha = 0.05$ ($z = -4.031$, $p = .000$) and ($z = -3.787$, $p = .000$), respectively. For children, no significant differences were found for the distributive and cumulative pairs. Between coll-alle and coll-elke a significant difference was found at $\alpha = 0.05$ ($z = -2.300$, $p = .021$).

The differences between adults and children were analyzed with a non-parametric Wilcoxon Matched-pair signed rank test, since the data was not normally distributed. Children and adults were compared on every category (fig 5.). Significant differences were found between adults and children on coll-alle ($z = -2,247$, $p = .025$), coll-elke ($z = -2,190$, $p = .029$), distr-alle ($z = -2.491$, $p = .013$), distr-elke ($z = -3.130$, $p = .002$) and cum-elke ($z = -2.215$, $p = .027$). No significant difference was found on the cum-alle condition.

3.3 Discussion truth-value judgment task

The first experiment demonstrated the judgments of Dutch adults and children on sentences with *alle* and *elke* in collective, distributive and cumulative situations. Adults show a sharp difference between *alle* and *elke* for the collective situation:

they reject *elke* more often than *alle*. In contrast to this finding, they allow both quantifiers for the distributive situation. Finally, they like *alle* better than *elke* in the cumulative situation. These results show that *elke* is more distributive to adults (Scha 1981; Van der Ziel 2012; Drozd et al. in preparation) and that *alle* is ambiguous (Gil 1982). Moreover, these findings are in line with the findings for Dutch (van der Ziel 2012; Drozd et al. in preparation).

While children performed adult-like on the distributive and collective interpretation, they performed different on the cumulative interpretation, where they accepted *elke* significantly more than adults. This indicates that children allow more distributivity in the cumulative situation than adults do. In the second experiment, the preference task, we will check whether these findings result in a preference for distributivity for both quantifiers. Furthermore, our results are in line with the results in Drozd et al. (in preparation) and Van Koert et al. (2015) for Dutch, because children in both studies know that *elke* corresponds to the distributive situation. The results demonstrated for children for the distributive situation are not comparable to the results found for English (Syrett & Musolino, 2013) and Serbian (Knezevic, 2014). The differences found in comparison to Syrett and Musolino (2013) can be due to the difference in language, where English asks for another interpretation than Dutch. Another explanation for the difference can be that they used a slightly different method than we used in this study. They placed the quantifier in the object position, where we placed the quantifier in the subject position. In comparison to Serbian it can be explained that Serbian is different from Dutch in the sense that Serbian has a distributive marker *po*. Translated to English this will sound like: *each boy is washing separately (po) a boat*. The study of Knezevic (2014) shows that children allow too many readings for the distributive marker *po*.

4. Preference task

In this task, we studied the preferences for collective, distributive and cumulative for sentences with *alle* and *elke*.

4.1 Method

4.1.1 *Participants*

The same adults and children participated in this experiment immediately after the first experiment.

4.1.2 *Materials*

We used stills of the movies from experiment 1. The stills are similar to the stills given in Figure 1, 2 and 3. The stills were presented simultaneously with the accompanying sentence that belonged to the set of stills.

4.1.3 *Procedure*

The participants were told that the computer wanted to know their preference for a collective, distributive or cumulative situation when they heard a test sentence. The three pictures were presented on the same page and the test sentence was played. The participants were asked to give their preference for one of the three pictures. The experimental leader wrote the preferences of the participants down.

4.2 Results preference task

The second experiment examined the preference of the participants for *alle* and *elke* for the collective, distributive and cumulative situations. In Figure 5 the preference results for the sentences with *alle* are displayed. The preferences of the quantifier *elke* can be found in Figure 6.

All within-group differences are evaluated with a paired samples t-test since the data are normally distributed and both groups consist of more than 20 participants. Adults have no significant preference for collective (40%) or distributive (60%) situations in sentences with *alle*. Children have a significant preference for the distributive reading (84%) for sentences with *alle* compared to the collective ($t(5) = 26.84$, $p < .000$) and cumulative reading ($t(5) = 30.13$, $p < .000$).

Differences between adults and children are evaluated with a paired samples t-test since the data are normally distributed and both groups consist of more than 20 participants. Children significantly prefer the distributive situation for sentences with *alle* in comparison to adults ($t(5) = -4.06$, $p < .010$). Adults, in comparison to children, significantly prefer the collective situation ($t(5) = -5.29$, $p < .003$).

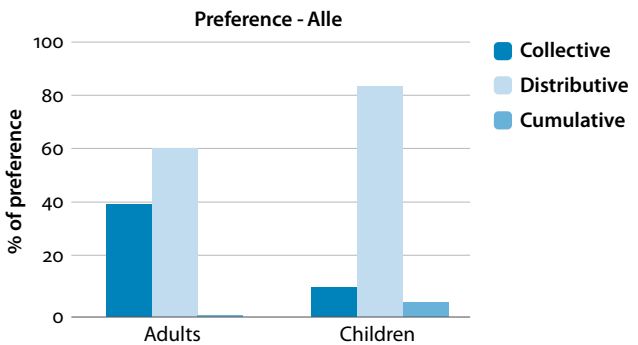

Figure 5. Preferences quantifier *alle*

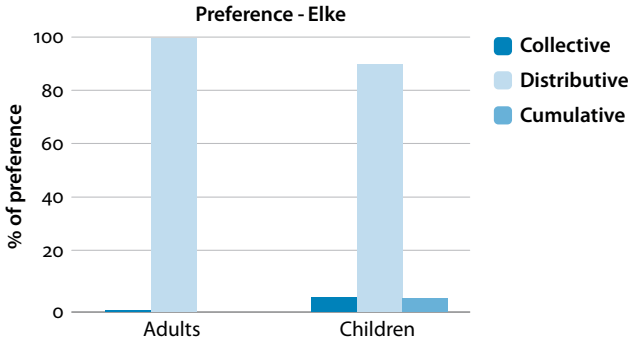

Figure 6. Preferences quantifier *elke*

In sentences with the quantifier *elke*, adults have a significant, 100% preference for the distributive interpretation. Children show approximately the same pattern as for the sentences with *alle*, where they significantly prefer the distributive situation. No significant differences were found between adults and children, i.e., they both have a strong preference for the distributive situation.

4.3 Discussion preference task

Adults do not show a strong preference for distributive or collective when using sentences with *alle*. In contrast, for *elke* they strongly prefer the distributive situation compared to the other two situations. The preferences of the adults fit the pattern that *alle* is ambiguous and *elke* more distributive. Dutch adults do not show the same preferences as English adults. The English adults in the study of Brooks and Braine (1996) showed a preference for collective situations in sentences with *all* and a preference for distributive in sentences with *each*. Adults in this study did not show an exclusive strong preference for collective in sentences with *alle*, but demonstrated a strong preference for distributive in sentences with *elke*. For both quantifiers, adults did not give a preference for cumulative. This could mean that cumulative is the least natural situation for adults.

On the other hand, children show a strong preference for distributive for both sentences with *alle* and *elke*. This is in line with Van Koert et al. (2015). They also showed that Dutch children, in comparison to English children, have a strong preference for distributive situations.

5. General discussion and conclusions

Children perform adult-like on the distributive and collective interpretation in the truth-value judgment task. However, they perform different on the cumulative condition, where they give significantly more yes-responses on sentences with *elke* than the adults, which shows that they allow more distributivity in this situation than adults do. The preference task demonstrated that children and adults differ in their interpretations. Children across the board, strongly prefer the distributive interpretation. Adults strongly prefer the distributive situation in sentences with *elke*, but did not show a preference for distributive or collective in sentences with *alle*.

For adults, the results found in the first experiment support the results in the second experiment: adults treated *elke* as the distributive quantifier and *alle* as the ambiguous quantifier in both experiments (Scha 1981; Roeper, Strauss & Pearson 2006). However, the child data showed a different pattern. While children performed adult-like on the distributive and collective interpretations for *alle* and *elke* on the judgment experiment, they showed a different pattern in the preference experiment. Children always preferred the distributive situation and not the collective. Children still have difficulties with restricting the quantifiers *alle* and *elke* to the correct domain (Van der Ziel 2012). A possible explanation could be found in how children see the world around them, i.e., a one-to-one pairing (man 1 – boat 1, man 2 – boat 2, man 3 – boat 3) might be cognitively easier for children than a one-to-more pairing (man 1 – boat 1, man 2 – boat 1, man 3 – boat 1). A possible other explanation for the strong preference of distributive readings in children, is provided by Van Koert et al. (2015). They claim that the syntactic clues of *elke* in Dutch lead the child to distributive readings at an early stage of the development.

This paper showed the interpretation of sentences with the Dutch universal quantifiers *alle* and *elke* in collective, distributive and cumulative situations in child and adult language. There is an interesting discrepancy between *alle* and *elke*: the first one allows for many more readings than the second one. This is too a large extent reflected in the results of this experiment. However, Dutch children do not have acquired the full range of restrictions of the Dutch quantifiers *alle* and *elke*, which might be due to the fact that they have a strong preference for distributivity in all situations.

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