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Shaped by context:

children's interpretation of Dutch universal quantifiers affected by pragmatics, semantics, and syntax

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Abstract

Universal quantifiers refer to a complete set of members, for instance "*all* animals", "*each* woman", or "*every* man". These English quantifiers can be translated in Dutch as *alle, elke,* and *iedere*. While these quantifiers differ in some ways, few have studied the common core for their interpretation: their universality. This was investigated in the present study with a truth-value judgement task and an act-out task for Dutch children (3;0 - 5;11). The influence of the pragmatic, semantic, and syntactic context on quantifier interpretation was investigated, as these are components that contribute to the equilibrium that is correct quantifier interpretation. A logistic mixed-effects regression was performed to assess this influence and that of quantifier (semantics), syntactic position (syntax), and age (developmental perspective), and their interaction with task type. The judgement task appeared to impose a lower threshold for children to correctly interpret the quantifiers, eliciting a higher number of universal interpretations than the act-out task. *Alle* elicited more correct responses than the other quantifiers, possibly due to its plural noun phrase and its facilitating syntactic position, indicating an equal contribution of semantic and syntactic context to the equilibrium of quantifier interpretation. An influence of age was found on the number of universal interpretations, indicating a learning curve within the age span of this study. These results highlight the value of using multiple experimental assessments to measure quantifier interpretation, since not all task types elicit the same responses. Researchers are encouraged to account for the influence of task types on their conclusions concerning children's quantifier knowledge.

1. Introduction

Universality is not an easy concept for children to comprehend. When universal quantifiers (*all*, *each*, *every*) are used in a sentence, children often struggle with their interpretation (e.g., Brooks & Sekerina, 2006; Slim et al., 2023; see Brooks & Parshina, 2019, for review). It appears that the fact that these quantifiers quantify over a complete set (e.g., *all women*) is not naturally understood. The present study examines children's ability to interpret Dutch universal quantifiers universally, i.e., to infer that they refer to the complete set, and investigates the influence of pragmatic, semantic, and syntactic factors on this interpretation. These factors include task-specific demands (pragmatics), the influence of the quantifier used (semantics), and that of the syntactic position of the quantifier (syntax). An equilibrium between these three factors should elicit a correct quantifier interpretation (Smits, 2010), which is why researching those factors is of great importance to better understand children's quantifier interpretation. This study contributes to the existing body of research on quantification in children and on the influence of the administered task on the display of children's ability to quantify and thus on the conclusions of researchers in the field.

This introduction begins with an examination of the terms 'universality' and 'quantification'. It then presents a review of the existing research on universal quantification. Subsequent sections discuss the potential influences of pragmatic, semantic, and syntactic factors. Finally, the specific research questions and hypotheses of this study are presented.

1.1. Universal quantifiers

In many languages, universal quantifiers are used to quantify over a complete set of certain members; they indicate that the person using the universal quantifier is talking about *all* members, or *each* or *every* member of the group. However, the specific meaning of these quantifiers is never explicitly taught to language users, sometimes resulting in incorrect interpretations. Before we dig into this problem, the two words that make up the term 'universal quantifier' need further explanation.

Firstly, universal quantifiers are quantity terms or **quantifiers**. These exist in many forms: numerical (*two*), existential (*some*), proportional (*most*), and universal. All these quantifiers refer to a certain number of set members (such as *two girls, some dogs,* or *most people*) and connect them to the predicate expression. For instance, in the sentence *Three girls are cycling*, the numerical quantifier 'three' specifies how many members of the set (*girls*) are doing what the predicate expresses (*are cycling*). The predicate expression shows the range of the quantifier's effect within the sentence and is called the scope of the quantifier (Ioup, 1975; Saeed, 2003). The noun phrase or NP (Leech, 1976) expresses the set and its members (*three girls*).

To define the meaning of quantifiers, semanticists use formal tools from predicate logic, which is a metalanguage for logical reasoning. In this metalanguage, quantifiers are represented as symbols in formulas that express their scope. For instance, the symbol for **universality** is ∀, used when expressing universal quantifiers (Gil, 1995; Saeed, 2003). These refer to the full set that is expressed by the noun phrase.

To illustrate this, consider the following formula:

$$\forall x \, (\text{cow}\,(x) \rightarrow \text{jumping}\,(x))^{1}$$

Literally translated, this means "For every thing *x*, if *x is* a cow, then *x* is jumping". In plain English, this means "Every cow is jumping", "Each cow is jumping" or "All cows are jumping". To express

[1] The NP is expressed by 'cow'; the predicate and its objects by 'jumping' and *x*, which in turn refers to the NP. The arrow represents entailment, expressing an 'if…then'- relationship between the NP and the predicate.

universality, the first part of this formula is essential: ∀*x* fixes the value of *x* as everything, the full set to which *x* belongs.

Although adults are able to interpret universal quantifiers correctly without this theoretical explanation, it has been evidenced that children systematically interpret these quantifiers incorrectly, up to the age of eight (Brooks & Sekerina, 2006; Slim et al., 2023; see Brooks & Parshina, 2019, for review). The question of where these issues originate remains unsolved but has been investigated in previous research. This study adds to that body of research by investigating the influences of the pragmatic, semantic, and syntactic contexts of the quantified sentence on children's universal interpretation of the Dutch quantifiers *alle* ('all'), *elke* ('each'/ 'every'), and *iedere* ('each'/ 'every'). The following sections discuss this previous body of research and link it to the specific research questions that will be investigated.

1.2. Previous research on children's issues with universal quantification

The reported problems that children might experience when interpreting quantifier words are mostly not related to their common core, i.e., universality. This is simply because studies tend to focus on participants' abilities to distinguish between universal quantifiers in terms of distributivity and collectivity, rather than on the common universal interpretation of the quantifiers (e.g., Brooks & Braine, 1996; Brooks & Sekerina, 2006; Syrett & Musolino, 2013).

'Distributive' universal quantifiers (*each, every*) allow a **distributive** interpretation of the quantified sentence, meaning that each member of the mentioned set performs the action of the predicate separately. For instance, the sentences *Each woman built a house* and *Every woman built a house* imply that each woman in the complete set of women built her own house. The sentence *All women built a house* can imply this as well but is generally interpreted **collectively**: all set members perform the action of the predicate together. Thus, in contrast to *each* and *every*, *all* does not force a distributive interpretation of the sentence, making it a 'non-distributive' universal quantifier.

Children's interpretation of (non-)distributive quantifiers has previously been studied (e.g., Brooks & Braine, 1996; Brooks & Sekerina, 2006; Syrett & Musolino, 2013). Brooks and Braine (1996), for instance, assessed four- to ten-year-old children's interpretation of universal quantifiers through two sentence-picture matching tasks, in addition to a picture selection task that assessed children's restriction of universal quantifiers to their NP. They found that children can easily restrict the quantifier to its NP but have a non-adult-like preference regarding distributivity: where adults usually prefer collective interpretations (e.g., all women building one house together in *All women built a house*), children prefer distributive ones (e.g., each woman building her own house in *All women built a house*). The study of Syrett and Musolino (2013) replicated this finding, specifically for *all*-statements, using a sentence-picture matching task as well. Although a distributive interpretation of *all* is not necessarily wrong (as *all* can be interpreted distributively as well), the non-adult-like preference indicates an underlying issue for children interpreting the linguistic information (Brooks & Braine, 1996).

Although interesting, the above studies did not investigate whether children struggle with the universal interpretation of universal quantifiers as well. In fact, the authors appear to assume that children can only experience problems with distributive interpretation and not with detecting the common core of these quantifiers. However, there are reasons to challenge this assumption. Corpus analyses of child-directed speech by Knowlton and Lidz (2021) and Knowlton and Gomes (2022) found that the English universal quantifiers *all*, *each*, and *every* are used distinctly in child-directed speech. The spontaneous detection of a common core of these separately used quantifiers by children thus seems unlikely, which may be the reason for children's inability to correctly interpret universal quantifiers. Issues with universal interpretation have been identified in previous research and a range of explanations has been offered (e.g., Barner et al., 2009; Ferenz & Prasada, 2002; Slim et al., 2023). These are discussed and linked to the specific research questions of the present study in the following section.

1.3. Influences on children's universal quantifier interpretation

This study focuses on children's ability to interpret universal quantifiers universally, i.e., to infer that they refer to the complete set, and investigates the influence of pragmatic, semantic, and syntactic factors on this interpretation. Those factors are components of Smits' **Equilibrium Hypothesis** (2010), that states that each of these components equally contributes to an adult-like understanding of quantification. Children pursue this equilibrium based on their knowledge of each of these components, and on inference of clues from the (linguistic) context. The following sections will discuss what problems children may experience in each of these fields. 1.3.1 discusses the implications of the pragmatic context in which children's knowledge of universal quantifiers is tested and how children may (incorrectly) interpret this context. These implications will be linked to the main research question of this study, regarding the influence of task-specific demands on children's universal quantifier interpretation. Assessing this influence is important to avoid conclusions unknowingly based on task performance that is not a display of the actual underlying process due to task-specific demands. 1.3.2 discusses semantics in the form of the specific universal quantifier used in a sentence and is linked to the sub-question of this study about influences of the used quantifier on universal quantifier interpretation. 1.3.3 discusses syntactics in the form of the position of the universal quantifier in the sentence, pertaining to the exploratory question about influences of this position on universal quantifier interpretation. The second and last exploratory question of this study looks at these results from a developmental point of view: do older children interpret more universal quantifiers correctly than younger children?

1.3.1. Pragmatics: the role of the used task in universal interpretation

Roughly, the experimental tasks used to assess children's problems when interpreting (universal) quantifiers can be divided into two categories: tasks that assess children's abilities to interpret universal quantifiers based on a given interpretation, and tasks where children need to generate an interpretation themselves, given a certain statement. A prominently used task in the first category is a **truth-value judgement task** (e.g., Barner et al., 2009; Brooks & Braine, 1996; Roeper & De Villiers, 1993; Smits, 2010; Syrett & Musolino, 2013), where the participant needs to judge if a given quantified sentence correctly describes a depicted situation. The aforementioned preference tasks (e.g., Brooks & Braine, 1996; Syrett & Musolino, 2013) that require the participant to select the interpretation that is most appropriate given the context, are part of this category. While the given interpretations in this latter task are all correct (i.e., a universal interpretation), one is clearly more suited than the other(s) in terms of distributivity. The other category contains **act-out tasks** (e.g., Ferenz & Prasada, 2002; Slim et al., 2023). In contrast to preference and judgement tasks, act-out tasks do not provide an interpretation. Participants are required to generate an interpretation of a given quantifier by acting out a situation described using the quantifier. For instance, they may be given objects and instructed to place "all" of them on a table.

Given the differences between these tasks, some have postulated that the type of task has a significant influence on the task results, and thus on researchers' knowledge of quantifier interpretation by children and adults (e.g., Skordos et al., 2022; Syrett & Musolino, 2013). Evidence from Syrett and Musolino (2013) supports this hypothesis: as mentioned in section 1.2, they administered a sentence-picture matching task and found that children prefer distributive interpretations where adults prefer collective ones. Nevertheless, the interpretation provided in their truth-value judgement task was correctly identified by the children. This suggests that children possess the knowledge of how to interpret universal quantifiers correctly – here in terms of distributivity and collectivity. The results of studies stating that children have trouble while interpreting universal quantifiers (see Brooks & Parshina, 2019, for review) might thus be related to the used task instead of children's knowledge. Related to the Equilibrium Hypothesis, this means that a different pragmatic context can influence children's interpretation of universal quantifiers.

The main research question of this study focuses on this potential influence of the administered task on (the display of) children's universal interpretation of universal quantifiers. Since a judgement task and an act-out task are used in this study, the possible influence of these task types on children's interpretation of universal quantifiers and thus on researchers' conclusions is discussed. Thereafter, a hypothesis to this main research question is formed.

Judgement tasks are used regularly to assess if children can judge correctly if a given interpretation fits the given situation. For instance, when a scene is depicted of a few people in a circle with a few people outside the circle with the sentence "All people are in the circle" or the question "Are all people in the circle?", the participant should respond "no". However, the phenomenon of quantifier spreading shows that children do not always judge a provided interpretation correctly. This term was introduced by Roeper and De Villiers (1993) but first investigated by Piaget and Inhelder (1974; Skordos et al., 2022). It entails that children often interpret universally quantified expressions symmetrically. To illustrate this point, consider the following example: Piaget and Inhelder (1974) presented a group of children with a set of red squares and a set of red and green circles in their experiment. This setup has been visually represented by Skordos and colleagues (2022, p. 2) in Figure 1. When asked whether all the squares were red, the children often answered "no" because some of the circles were also red. Thus, children's symmetrical interpretation of universal quantifiers entails that the predicate of the quantifier (here: *to be red*) should only apply to what the quantifier is referring to (here: *squares*) and not to anything else.

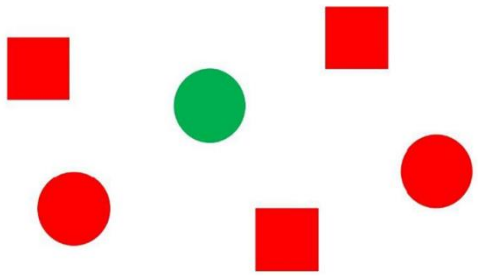

Fig. 1. Visual representation of stimuli from Piaget & Inhelder (1974) by Skordos et al. (2022).

A suggested explanation for quantifier spreading is the elicitation of an incomplete "Question Under Discussion" (QUD; Roberts, 2012; Skordos et al., 2022). A QUD contains alternative propositions related to the topic of the statement, to which the statement can be mentally compared. The elicitation of all propositions in a QUD necessary to eliminate all incorrect responses, results in a correct response. Using the situation depicted in Figure 1 as an example: comparing the statement "All the squares are red" to "*Some of* the squares are red" (not the case), "All the *circles* are red" (not the case), and "All the squares are *blue*" (not the case) results in a correct acceptance of the given statement. When one of these alternative statements is not elicited, there is a chance of answering incorrectly. If Piaget and Inhelder (1974) had asked whether *some* of the squares were red, the alternative statement elicited could have been "Some of the squares are *blue*". Since there are only red squares, the comparison of the question to the alternative statement would result in an affirmative response, while the response should have been "no".

Importantly, participants also need to be able to check if there are no squares left. In other words: the possibility of negating the statement posed should always be offered (Drozd, 2001; Freeman et al., 1982; Wason, 1965). Freeman and colleagues (1982, pp. 64-66) posit that, when presented with a universally quantified statement, the participant must "carry out an exhaustive search to check that no [set member] is missing". Experimental clues must always indicate the total size of the set for the participant to be able to do this. For the statement "All squares are red", the participant thus needs to check if there are any squares lying or depicted somewhere else than the group presented to the participant. This should be the case for some trials, so the participant knows a negation of the statement is possible. In addition, tasks should never include a yes/no question describing a statement that is clearly true or false (Crain et al., 1996). While their initial internal response might be correct, children may overthink the situation and elicit a different QUD than intended by the experiment, assuming that the experimenter has this particular QUD in mind as well. This may then result in an erroneous response.

These theories thus lead to the conclusion that children possess adequate knowledge of quantifier interpretation yet exhibit errors in pragmatically interpreting the task. To prevent this, the truth-value judgement task in the present study avoided most of the forementioned issues by continuously displaying all set members and creating a context in which the statements could be negated. More about this in the method section (2.4.2, procedure of the truth-value judgement task).

While incomplete QUDs are mostly argued to be the cause of incorrect responses in truth-value judgement tasks, they may also play a role in act-out tasks. When children are instructed to place *all* squares on a towel, for instance, they might compare this to the alternative statement: "Place all *circles* on the towel." When they consequently place squares on the towel, they may believe that to be the correct response, regardless of the quantification. Additionally, there appears to be even less of a basis for children on which to build their interpretation here, because of the need for spontaneous action and the lack of a given interpretation.

In addition to the issues already discussed, children may encounter another practical challenge here, namely the involvement of the production system. Since children need to act out a certain scene with objects, act-out tasks are hypothesized to not just involve the language comprehension system, but also the language production system. Thus, when comprehension is evaluated through an act-out task, the involvement of the production system could impede the detection of the comprehension effect (e.g., Ziegler & Snedeker, 2019). There is no consensus about the specific factors that contribute to this complication in an act-out task. Ziegler and Snedeker (2019) argue that participants may be repeating the test sentence internally while acting out the task in order to remember what they are supposed to do. In this manner, the involvement of the production system might push back the comprehension effect that needs to be detected. Additionally, assessing comprehension through this task relies on the participant's preparedness to create a scene based on only a sentence. This requires the participant to take the initiative and accept the fact that the answer could be wrong, which may be intimidating for young children.

This information leads to the following hypothesis: children may possess an adult-like representation of logical language, including quantifiers, which is why they respond more correctly in judgement tasks where the possibility of quantifier spreading is avoided. However, they may still have limited cognitive resources to 'convert' this representation into a correct production, which may explain the errors observed in act-out tasks (e.g., Gualmini, 2005; Gualmini, et al., 2003, Ziegler & Snedeker, 2019). Moreover, children's cognitive system may be less flexible than that of adults (e.g., Freeman & Stedmon, 1986). While adults are able to identify the relevant QUD to which the uttered statement should be compared, children may not know what QUD to compare it to. This may result in them being reluctant to answer or responding incorrectly. This is clearly a consequence of the demanding task context and not of their initial comprehension; they know which QUDs fit the situation, they are just not given the basis to select the specific QUD fitting the test sentence and are not flexible enough to do it themselves.

In conclusion, it is hypothesised that the judgement task will elicit more universal interpretations of the used universal quantifiers (*alle*, *elke*, *iedere*) than the act-out task. This would indicate that the task used to assess children's interpretation of universal quantifiers influences this interpretation and/or the display of it, which in turn influences our knowledge about children's abilities to interpret quantifiers.

1.3.2. Semantics: the role of the quantifier in universal interpretation

Slim and colleagues (2023) empirically tested the assumption of adequate knowledge of universality in children and found mostly differences in this interpretation depending on the quantifier used. In one of their experiments, 3- to 7-year-old children are asked to give toy items to an Elmo puppet. Universal quantifiers are used in these questions: they need to hand Elmo *all* toys, *each* toy, or *every* toy. The authors found that while children (from 4 years old) handed Elmo the full set of toy items when *all* and *every* were used, no children within the age restriction of the experiment consistently gave the full set to Elmo when prompted with *each*. This compelling evidence led to the sub-question of the study at

hand: is children's universal interpretation of universal quantifiers influenced by the used quantifier and if so, by which quantifier?

The results of Slim and colleagues (2023) match previous experimental evidence partly. It has been shown that children experience less difficulty with the universal interpretation of the non-distributive quantifier *all* than with the distributive quantifiers *each* and *every* (e.g., Gordon, 1982). An explanation for this is suggested by Ferenz and Prasada (2002): distributive quantifiers require a count noun and a singular expression of the associated NP, even though they quantify over more than one set member. Non-distributive quantifiers like *all* require either a count noun or a mass noun and a plural expression of the associated NP. Ferenz and Prasada (2002) argue that children may only pay attention to the plurality of the quantified noun and not to the quantifier itself, which leads to a universal interpretation of *all* because of the plurality of the NP (see also Gathercole, 1985). This theory can however not be applied to the observed correct interpretation of *every* by Slim and colleagues (2023). In turn, Slim and colleagues (2024) argue that *each* did not elicit as many accurate responses as *all* and *every* because of its highly distributive character (see also Knowlton & Gomes, 2022). They base this on another one of their findings: in an experiment where there are three fish with each a plate, the children were asked to give *each* fish fruit. Here, the response accuracy was much higher than in Slim and colleagues' (2023) give-a-quantifier task: children often placed a piece of fruit on each fish's plate. This may have happened because of the more pronounced distributivity of *each*, indicating each set member individually. When Elmo needed to be given *all/each/every* fruit, the more collective interpretation of *all* and *every* may have caused children to more easily interpret this as the complete set of fruit (Slim et al., 2024).

Although the studies of Brooks and colleagues (1998, 2001) did not concern universal interpretation, their results are linkable to this research question as well. They found that children distinguish moderately between *all* and *each*, linking more collective interpretations to the former than the latter in picture selection tasks. The fact that children selected much more collective pictures when prompted with *all* is explained by the authors as children using semantic clues to distinguish between these quantifiers. This leads to the following hypothesis: the used quantifier does influence universal quantifier interpretation, as children may infer the universality from semantic clues, like the plurality of the NP. According to previous evidence, *alle* may elicit more universal interpretations than *iedere* or *elke* in the present study.

1.3.3. Syntactics: the role of syntactic position in universal interpretation

In addition to the differences in interpretation that certain universal quantifiers elicit, they also differ in syntactic properties. These properties may influence their interpretation as well, leading to the first exploratory question of this study: does the syntactic position of a quantifier influence the universal quantifier interpretation? This question is labelled as 'exploratory' because of the lack of a consensus on this subject, as will be discussed in this section.

All English universal quantifiers can be used as a **determiner**, meaning they are placed before the NP (e.g., *All cows are jumping* or *Each/every cow is jumping*). However, only *each* and *all* can be used as **floating** quantifiers, meaning they syntactically behave as an adverb and are placed after the NP (e.g., *The cows are {all/each/*every} jumping*). As is visible in these example sentences, the plurality of the NP can change with the syntactic position of the universal quantifier. This specifically happens with the universal quantifier *each.* When determiner *each* is used, the predicate and NP are singular: *Each cow is jumping*. When floating *each* is used, however, these become plural: *The cows are each jumping*. This does not happen when *all* is used; in both syntactic positions, the predicate and NP stay plural. *Every* can only be placed in determiner position.

The body of hypotheses about children's usage of the syntactic component of Smits' Equilibrium Hypothesis (2010) (i.e., syntactic clues) contains more controversy than that about the semantic component. Authors have suggested that children interpret quantifiers in determiner position more easily than in floating position (e.g., Barner et al., 2009; Wellwood et al., 2016). Barner and colleagues (2009)

suggest that the issues with the latter can be explained by the larger distance between the universal quantifier and its NP: in determiner position, there is no distance between them, which might make it easier to connect them and interpret the universal quantifier. The research of Wellwood and colleagues (2016) adds that this may happen because of a "syntactic bootstrapping"-technique. They inferred from the results of their word-learning task that children use the syntactic position of a word to restrict its meaning. The syntactic environment of a determiner only allows a quantitative (i.e., numerical) meaning for the word in that position, never a qualitative one. Thus, if the language user knows this, they use this syntactic information to interpret the word in determiner position quantitatively. In the words of Wellwood and colleagues: "[…] when a novel superlative is used in a determiner position (e.g., *Gleebest of the cows are by the barn*; cf. *Most of the cows are by the barn*), knowledge of the syntax-semantics mapping for determiners constrains the possible space of meanings to those with quantity-based interpretations, and no further inference is required." (Wellwood et al., 2016, p. 264).

However, looking at the theory of Ferenz and Prasada (2002) mentioned in the previous section, there are arguments for a contrary hypothesis as well. If children only pay attention to the plurality of the NP, floating quantifiers seem more likely to be interpreted universally, because the NP is always plural. Determiner quantifiers, on the other hand, are less likely to be interpreted universally according to this theory, because the NP is singular. Note that this theory is only applicable to quantifiers that can appear in both syntactic positions, like the Dutch *elke* (more in 1.4.1).

Smits himself (2010) suggests that children do not use syntactic clues to restrict a quantifier to its domain, following Roeper and colleagues (2006). He found that children do not differentiate between subject and object quantification (i.e., sentences where the subject and the object are quantified, respectively), since they made many mistakes in the interpretation of these sentences, as evidenced by their faulty answers on questions about the sentences. Children did show comprehension of the semantic information and the pragmatic task context, indicating a greater contribution of semantic and pragmatic knowledge to the equilibrium that is adult-like quantification than of syntactic knowledge.

Since children appear to use semantic clues to infer quantifier meaning (Brooks and colleagues, 1998, 2001; Ferenz & Prasada, 2002; Smits, 2010), the hypothesis to this exploratory question is as follows: quantifiers in floating position are more likely to be interpreted universally than quantifiers in determiner position, as the NP of a floating quantifier is plural.

1.4. This study

The present study investigates the universal interpretation of Dutch universal quantifiers by children aged 3;0 to 5;11 years, using a truth-value judgement task and an act-out task. This universal interpretation will hereafter be called 'response accuracy' since a universal interpretation of a universal quantifier is an accurate interpretation. Primarily, the role of task-specific demands on children's response accuracy is investigated. In addition, possible differences in response accuracy depending on the universal quantifier used will be studied. The first exploratory question relates to the syntactic position of the quantifier and the second exploratory question focuses on the influence of age on quantifier interpretation. For this purpose, data from an ongoing study by Slim and Rowland (2024) was analysed.

1.4.1. Dutch universal quantifiers

There is no 1-to-1 translation of the discussed English universal quantifiers to Dutch, but the universal quantifiers are comparable. Table 1 contains Dutch translations of English universal quantifiers and example sentences per universal quantifier used in this study[2]. The **subject**, verb and *universal quantifier* in the example sentences are formatted as in this sentence to facilitate the translation.

[2] Slim and Rowland (2024) also investigate the universal quantifier *allemaal.* This complex quantifier can be compared to the existential quantifier 'some' when in determiner position but becomes a universal quantifier when

English universal quantifier	Dutch universal quantifier	English example sentence	Dutch example sentence
All	Alle	*All* **cows** are jumping.	*Alle* **koeien** springen.
Each (determiner)/every	Elke (determiner)/iedere[3]	*Each* **cow** is jumping. *Every* **cow** is jumping.	*Elke* **koe** springt. *Iedere* **koe** springt.
Each (floating)	Elk (floating)	**The cows** are *each* jumping.	**De koeien** springen *elk*.

Table 1. Universal quantifiers translated from English to Dutch.

The argument that children may experience difficulties interpreting floating quantifiers because of their long-distance dependency (Barner et al., 2009; see section 1.3.3) is applicable to Dutch universal quantifiers in floating position as well: the distance between the NP and the floating universal quantifier is even bigger here than in English. Ferenz and Prasada's (2020) theory of non-distributive quantifiers being easier to interpret applies to Dutch universal quantifiers as well. The distributive universal quantifiers *elke* and *iedere* can only be uttered with a singular count noun; *elke koe* ("each/every cow") is possible, but **elk water* (*"each water") is not. Non-distributive quantifiers such as *all(e)* do not strictly require count nouns, they can also be used with mass nouns (e.g., *Al het water*; "All the water"). When they are uttered with a count noun, however, this noun needs to be plural (e.g., *Alle koeien*; 'All cows'). Because of the presence of plurality in every context, Dutch non-distributive quantifiers seem to have the same interpretability as English non-distributive quantifiers. Dutch distributive universal quantifiers seem harder to interpret because of the singularity of the NP, just like the English distributive universal quantifiers.

1.4.2. Research questions and hypotheses

Slim and Rowland (2024) are assessing children's (age 3;0 to 5;11) universal interpretation of universal quantifiers through a truth-value judgement task and an act-out task at the Max Planck Institute in Nijmegen (MPI). Based on their data, this study will assess a main research question with a sub-question and two exploratory questions, pertaining to universal quantifiers *alle, iedere*, and *elke*. These questions investigate the influence of respectively the pragmatic, semantic, and syntactic context of the universal quantifier, three components that equally contribute to the equilibrium that is correct quantification, according to Smits (2010).

The **main research question** examines the influence of task-specific demands on the universal interpretation of universal quantifiers and is formulated as follows:

> Is there a difference in children's response accuracy (i.e., interpretations of universal quantifiers as universal) between the judgement task and the act-out task?

Since task-specific demands might influence children's interpretation of universal quantifiers, especially in terms of whether a possible interpretation is given or they have to generate one themselves, it is reasonable to expect that children will perform adequately on Slim and Rowland's judgement task, where an interpretation of the universal quantifiers is provided and the answer options are restricted, and worse on the act-out task, where free interpretation and spontaneous action are required. Thus, the **hypothesis to the main RQ** is as follows: task type likely influences response accuracy, with a higher response accuracy in the truth-value judgement task than in the act-out task.

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in floating position, comparable to 'all'. Because syntactic position is used as an independent variable in this study (see 2.1) and the syntax of *allemaal* implicates semantic changes, this universal quantifier is left out of the present study.

[3] *Iedere* can also be placed in floating position as *ieder*, but this is considered archaic and therefore not done anymore. Only *elke* will thus be analysed in the first exploratory question pertaining to syntactic position.

The semantic factor concerns the role of the different universal quantifiers (*alle, iedere*, and *elke*), which may differ between task types. This leads to the following **sub-question**: does the universal quantifier used influence universal quantifier interpretation? Previous research (e.g., Slim et al., 2023, see 1.3.2) responds affirmatively to this question and specifically leads to the following **hypothesis to the subquestion**: children are likely to interpret the universality of *alle* more easily than that of *elke* and *iedere.*

Exploratory question 1 is: does the syntactic position of the universal quantifier *elke* influence universal quantifier interpretation? As mentioned (section 1.3.3), there are many arguments for universal interpretation enabled by universal quantifiers in floating or in determiner position (e.g., Barner et al., 2009; Ferenz & Prasada, 2002; Smits, 2010; Wellwood et al., 2016). The hypothesis to this question is based on the hypotheses that children adequately use semantic cues to infer quantifier meaning (e.g., Smits, 2010; see 1.3.3) and specifically the theory of Ferenz and Prasada about plurality of the NP (2002): children might find the presence of a plural noun easier to universally interpret the universal quantifier. This is why the **hypothesis to exploratory question 1** entails that the universality of *elke* in floating position will likely be accurately interpreted more often than that of *elke* in determiner position.

A final interesting perspective on this subject is development: do older children within the age restriction of this study interpret more universal quantifiers universally than younger children? Or does this universal interpretation perhaps take place in one task but not in the other from a young age? This leads to **exploratory question 2**: does age influence response accuracy, and if so, is this effect alike in both tasks? The **hypothesis to exploratory question 2** includes the hypothesis to the main question (response accuracy is likely to be higher in the judgement task than in the act-out task from the age of three) and adds a developmental component to it: both performances are likely to improve with age. However, they may not improve at the same pace. If the youngest children already perform adequately on one task, this performance does not have much room left to grow. The performance on the other task may then improve at a faster pace because of the excessive room to grow. If young children perform similarly bad or adequate on both tasks, on the other hand, those performances may improve at a similar pace.

2. Methodology

2.1. Design

The study had a mixed design. The within-subject independent variables were Task (act-out/judgement), Quantifier (*alle*, *elke*, or *iedere*), and Syntactic position (the syntactic position of the UQ *elke)*. The between-subject independent variable was Age (3;0 to 5;11). The dependent variable was response accuracy (binary: correct (1) = universal interpretation, incorrect (0) = other response). Table 2 shows the independent variables per research question.

	Independent variable	**Dependent variable**
Main research question	Task type (act-out/judgement)	Response accuracy: universal interpretation of the UQ
Sub-research question	Quantifier (*alle*/*iedere*/*elke* (determiner)/*elke* (floating))	
Exploratory question 1	Age	
Exploratory question 2	Syntactic position of *elke* (determiner/floating)	

Table 2. Summary of the variables.

2.1.1. Test sessions

Adults completed both tasks in a single test session lasting approximately 45 minutes. Children performed each task in a separate session, each lasting twenty minutes to an hour depending on the

number of breaks. This was done to make sure their attention was maintained for each task. Both tasks assessed children's understanding of the Dutch UQs *elke*, *iedere*, and *alle*. *Elke* and *iedere* are distributive UQs, that emphasize the individual members of the referred set (like *every* and *each* in English), while *alle* is a non-distributive UQ (like *all* in English), that emphasizes the referred set as a group. The order of the test sessions in which the judgement and act-out task were performed was counterbalanced between participants.

2.2. Materials

2.2.1. Act-out task

Fig. 2. Materials for the act-out task set up at the start of a trial – view from participant chair (Slim & Rowland, 2024)

The act-out task involved a toy barn with three groups of six toy animals (sheep, pigs, and cows) and a toy field with troughs and fences in front of the barn (see Figure 2). Each trial contained a test and filler sentence. The test-sentence was always constructed as follows: "Nu gaan/gaat [quantifier] [animal] naar de wei" ('Now, [quantifier] [animal] go/goes to the field', determiner position) or "Nu gaan de [animal] [quantifier] naar de wei" ('Now, the [animal] [quantifier] go to the field', floating position). It was ensured that the animal was emphasized in the utterance, rather than the quantifier, to avoid revealing the objective of the study. The filler sentences were designed to fit every type of animal and contained eight actions: *springen* ('jump'), *liggen* ('lay down'), *rennen* ('run around'), *eten* ('eat'), *drinken* ('drink'), *rollen* ('roll around'), and *geluid maken* ('make a sound'). All test and filler sentences can be found in appendix 7.3.

These sentences were 'uttered' by a teddy bear containing an inserted speaker connected to the laptop on which the pre-recorded instructions and trials were played. This was done using the software *Presentation*, in which the experiments were programmed. The same sentences were recorded in a male and female voice. The gender of the voice was randomly assigned to the participants.

The test sentences contained quantifiers. The critical quantifiers were the universal *alle*, *iedere*, and *elke*, but the non-universal quantifiers *een* ('a'), *twee* ('two'), *de meeste* ('most'), *sommige* ('some'), and *een paar* ('a few') were also tested in non-critical sentences; they only introduced variation and were not analysed. *Allemaal* and *elke* were presented in determiner position and in floating position[4]. Together, these different quantifiers and positions add up to eleven different conditions. Since each condition was paired with each type of animal, this experiment consisted of a total of 33 trials.

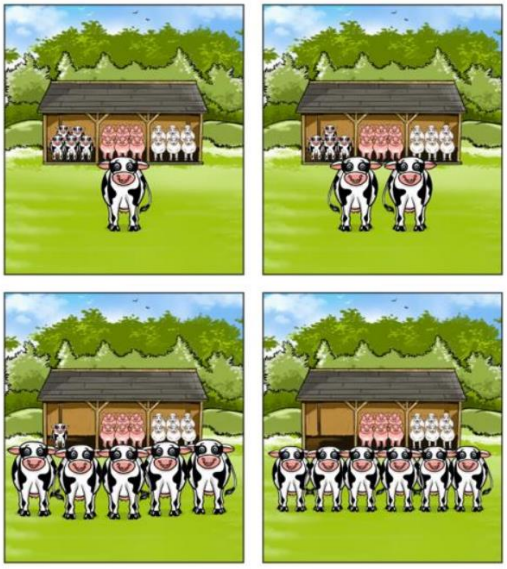

Fig. 3. The four possible depictions of cows in the field in the judgement task. Materials taken from Slim and Rowland (2024).

2.2.2. Truth-value judgement task

This task included two teddy bears: the farmer that was also used in the act-out task and his/her 'assistant', both with inserted speakers. It also involved a laptop facing the

[4] Recall that *allemaal* will not be analysed in the present study.

participant and the experimenter's laptop, connected through an internet cable. On both laptops, the experiment was carried out, again using the software *Presentation*. Each teddy bear's speaker was connected to a different laptop; that of the 'farmer' to the participant's laptop, that of the 'assistant' to the experimenter's laptop. Male and female voices were again randomly assigned to participants, but it was made sure that one of the teddy bears was male and the other female. The keypad of the participant's laptop was covered to prevent (accidental) key pressing. On that laptop, pictures were shown in which animals (sheep, pigs, cows) were depicted in the field and in the barn (Figure 3), while a sentence was 'uttered' by the assistant teddy bear. In the practice and filler items, these sentences were non-quantified and transitive (e.g., "Kijk, dit varken heeft een hoedje op.", 'Look, this pig is wearing a hat.'). The test sentences contained a quantifier (e.g., "Kijk, nu staan alle koeien in de wei.", 'Look, now all cows are in the field'). All sentences can be found in appendix 7.3.

The participant's responses were logged onto the laptop by the experimenter during the experiment. If the child refused to answer, the trial could be skipped without entering a response. These trials were not included in the analysis (more in section 2.5.2).

Similar to the act-out task, eleven different quantifier conditions were used in the truth-value judgement task, of which four are of importance to this study (*alle*, *iedere* (determiner), *elke* (determiner), *elke* (floating)). Unlike the act-out task, the judgement task consisted of 56 trials (44 test trials, 12 filler trials; see Appendices for all sentences).

2.3. Participants

The main participant sample consisted of 25 children with a mean age of 54.64 months (*SD* = 10.71). 15 whose parents identified them as male (M_{age} = 55.41, *SD* = 10.70) and 10 as female (M_{age} = 54.93, *SD* = 10.80). Each participant had completed trials of both tasks.

Both tasks were also administered to a group of 16 adults (M_{age} = 25.93 years, *SD* = 6.1 years), to assess if consistent universal interpretation is in fact an adult-like response. It was predicted that adult-like scores are indeed a consistent universal interpretation of the universal quantifiers. Fourteen adults self-identified as female (M_{age} = 25.79 years, *SD* = 6.5 years), one as male (29 years old) and one participant of 25 years old did not indicate a gender.

Children were recruited from the BRC (Baby and Child Research Centre) database, adults through that of the MPI. Inclusion criteria were clinically typical language development, clinically typical hearing, monolingual Dutch, and for children: three, four or five years old (3;0 – 5;11).

2.4. Procedure

2.4.1. Act-out task

First, the farmer teddy bear was introduced to the participant by the experimenter. The experimenter explained that the farmer needs help and asked if the child wants to help him/her. After a positive reaction, the farmer showed the farm and the animals to the participant. (S)he asked about the animals ("Weet jij welke dieren ik heb?", 'Do you know what animals I have?') and asked the child to point to the barn. This was done to make sure the child was familiar with all items of the set-up and could distinguish between them. The recordings of the farmer's speech contained no quantifiers and the experimenter did not use any quantifiers when introducing the task either.

Next, the farmer told the participant that the animals were going to play outside. The test-sentence was played ("Nu gaan/gaat [quantifier] [animal] naar de wei"), after which the child took what (s)he believed to be the correct number of animals out of the barn and placed them in the field, without any help from the experimenter. When the child was not reacting, the examiner was allowed to encourage him/her with sentences like "What do you think?" or "Go ahead". If the child did not hear or understand the uttered test or filler sentence, the experimenter repeated the sentence as often as necessary, using an intonation similar to the recording.

Once the animals were placed in the field, the filler sentence was uttered: "… om daar te gaan [action]", after which the researcher and the child used the toy animals in the field to act out the required action together. One filler sentence contained an action from the participant and was therefore formulated differently: "… en dan mag je aaien" ('and now you can pet them'), where the child and the experimenter petted the toy animals that were placed in the field. The filler sentences, the different types of animals and the non-universal quantifiers were only used to introduce variation in the task.

After that, the farmer instructed the participant to place the animals in the barn again ("En breng maar weer terug naar de schuur"; 'And bring them back to the barn now'). The experimenter was allowed to help the child put the animals back in the barn, since this was only a preparation for the start of the next trial, where the animals should all be in the barn again. It was important for the experimenter to not make any notes during the experiment, so the child received their undivided attention. The task responses were post-hoc (more in 2.5).

2.4.2. Truth-value judgement task

First, the two teddy bears were introduced to the participant as the farmer and his/her assistant, who is a farmer in training. The farmer said that the assistant still makes a lot of mistakes, so (s)he asked for the participant's help. After this introduction of the farmer in training, the pictures that would be depicted during the task were shown to the participant to introduce the different animals. These were presented in the same way as in the act-out task: questions were asked to make sure the participant could distinguish between the test items. These pre-recorded sentences did not contain quantifiers, and neither did the introduction by the experimenter.

Next, the farmer repeated that the assistant is not fully trained yet and still makes a lot of mistakes. The child was then instructed by the farmer to help the assistant by telling them if they are right or wrong. The child was also told that justification when wrong is necessary for the assistant to learn. Then, four practice trials were conducted, to which the participant needed to answer correctly before continuing to the task. If the participant responded incorrectly to one of the practice trials, four new practice trials were conducted. In these items, as in the test items, the assistant farmer uttered a sentence describing a depicted picture that either matched the description or did not. The test sentences (containing a quantifier) were accompanied by a picture where a certain number of animals is standing in the field, with or without some of the same type of animals still in the barn (Figure 3). The participant judged if the assistant's description matched the picture, while the experimenter logged the responses onto the laptop. If the answer was "no", the assistant asked "Waarom was dat fout?" ('Why was that wrong?') and the participant needed to explain the reason for his/her judgement. The experimenter was allowed to encourage the child if (s)he did not answer, with questions like "What do you think?" or "Is this right or wrong?". If the participant was reluctant to explain the reason for a judged mismatch, the experimenter often repeated the assistant's question: "Why was that wrong?". This response was, however, not logged onto the laptop (these were not used for the analysis, see section 2.5). After the response, the assistant thanked the participant, and then the next trial started with the depiction of a new picture.

As mentioned in section 1.3.1, quantifier spreading was avoided in this task and the quantified statement could always be negated. The problem of quantifier spreading that occurred during the experiment of Piaget and Inhelder (1964) – where children answered "no" to the question "Are all squares red?" when all squares were indeed red – occurred because other objects matched the predicate 'being red', rather than only squares. In the judgement task from this study, quantifier spreading would perhaps occur if there were other animals placed in the field than the set of animals from the test sentence. For instance, if "All the cows are in the field" was said and a picture of the field containing all cows and some pigs were depicted, a child might judge this statement as untrue because the predicate of 'being in the field' would also be applicable to the other animals in the field. Since a scene with more than one type of animal in the field was never depicted, it is likely that the problem of quantifier

spreading was eliminated. Additionally, the obligatory explanation of the child's judgement could provide the cause of an erroneous response.

As has also been pointed out in the introduction (section 1.3.1) that, when presented with a universally quantified statement, the participant must be able to determine if any set member is missing, inferring this from experimental clues (Drozd, 2001; Freeman et al., 1982; Wason, 1965). The judgement task of this study included such a clue: a barn in which the other animals and (if needed) part of the set of animals from the test sentence were constantly visible, indicating the total size of the group. This made the statement open to negation by the participant.

2.5. Analysis of the data

2.5.1. Interrater reliability

The video-recordings of the test sessions of the act-out task were coded post-hoc. Per trial was noted how many animals were placed in the field by one out of four raters. To assess interrater reliability, an independent rater rated a random sample of 10% of the responses. Interrater reliability was 100%.

2.5.2. Preprocessing

The eventual dataset for statistical analysis contained information on response accuracy (more below) of 24 children in every test trial of the judgement and act-out task[5]. One child's data was excluded as (s)he made too many errors during all practice trials of the judgement task. This child eventually responded correctly less than 25% of the time.

The information on response accuracy in the dataset entailed the number of animals that were placed in the field in the act-out task, later converted to a 'correct' when all six animals were placed in the field and an 'incorrect' when every other number of animals was placed in the field, making the dependent variable of response accuracy binary. Since there were no negative quantifiers involved (e.g., *none*), a 'zero response', where the participant placed no items in the field regardless of repetition by the experimenter, was interpreted as a misunderstanding of the task. These trials were not analysed.

The dependent variable of the truth-value judgement task was response accuracy as well. Children's correct answers ('yes' + match or 'no' + mismatch) were coded as 'correct' and the incorrect answers ('no' + match or 'yes' + mismatch) as 'incorrect' to make this variable binary as well. The explanation after a negative response was not included in the analysis. The adult dataset contained the same (preprocessed) variables for all 16 adults that participated in this study.

Trials where the coder had noted an unclear reaction were discarded in the eventual analysis. These trials included placing all animals in the field and then removing a few before the child was instructed to act out the filler sentence. When children made clear that they were not doing what the farmer asked, by saying "Or we could do this instead" or by answering "no" when the experimenter asked if they had done what the farmer said, the trial was not included in the analysis either.

2.5.3. Analysis

A logistic mixed effect regression was fitted in R *(*version 4.4.0., package *lme4*, Bates et al., 2015) to predict response accuracy: whether the universal quantifier is interpreted universally (dependent variable). The research questions were reworded in terms of these models. The different models, adapted to each research question (RQ), are summarized with their fixed effects in Table 3. Since the different types of animals were not relevant to the task, these were considered a random effect, along with participant. To assess if 'animal' was relevant to enter to the model as a random effect, model comparisons were made between a model containing only participant as a random effect and one containing participant and animal as random effects. The p-value of this comparison was .995, indicating no significant part of animal as a random effect. Only participant was entered as a random effect to each model.

[5] Test trials are trials using *alle, elke* (determiner and floating), or *iedere* (determiner) as a universal quantifier.

	Formulation	Fixed effects
Main RQ	Does task type predict the likelihood of response accuracy?	Task type (2 levels: act-out/judgement)
Sub-RQ	Does quantifier predict the likelihood of response accuracy? Is there an interaction of quantifier and task type?	- Quantifier (4 levels: *alle, iedere, elke (determiner), elke (float)*) - Interaction : Task type x Quantifier
Exploratory RQ 1	Does age predict the likelihood of response accuracy? Is there an interaction of age and task type?	- Age (in months; continuous) - Interaction: Task type x Age
Exploratory RQ 2	Does syntactic position predict the likelihood of response accuracy? Is there an interaction of syntactic position and task type?	- Syntactic position (2 levels: *elke (determiner), elke (float)*) - Interaction: Task type x Syntactic position

Table 3. Logistic mixed-effect models per RQ and their fixed effects.

If the effect of quantifier was found to be significant, post-hoc pairwise comparisons were conducted to identify the differences in response accuracy per quantifier.

3. Results

3.1. Adults

3.1.1. Adults versus children

The first analysis assessed whether the response accuracy differed between children and adults. Figure 4 illustrates the results in terms of the % accurate responses of children and adults. As predicted, an adult-like response entailed almost entirely universal interpretation of the universal quantifiers. Of all 322 elicited responses, only 5 were incorrect (i.e., not universally interpreted): once a mistake was made prompted with *alle*, twice with *iedere* and twice with *elke* in floating position. No mistakes were made when prompted with *elke* in determiner position. This indicated a 98% response accuracy rate. Since these responses are at ceiling, the adult data will not be further analysed.

To compare the results of adults and children, a Mann-Whitney U test was used, since assumptions of normality and homoscedasticity were violated. As predicted, the children produced significantly fewer accurate responses than the adults ($W = 125356$, $p < .0001$).

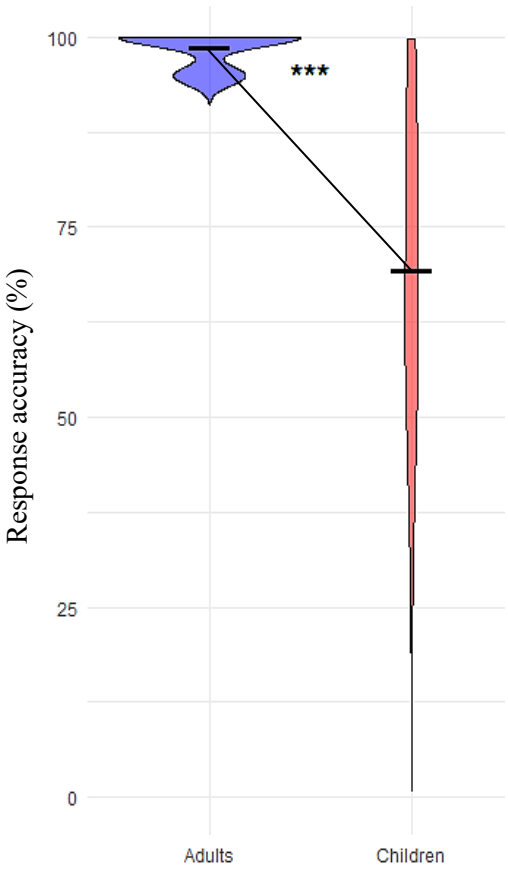

Fig. 4. Response accuracy per group. Mean response accuracy is indicated by a crossbar. Significant group mean difference is indicated with ***.

3.1.2. Predicted adult-like response accuracy

Based on the calculated adult-like response accuracy (98%), the age at which children would reach this accuracy could be predicted. A linear regression model was fit in R (R-package *dplyr*, Wickham et al., 2023; Figure 5). The coefficient estimate for age was 0.00724, indicating that for each one-month increase in age, response accuracy increased by 0.007% on average. Using the regression equation, a response accuracy of 98% was

predicted to be reached when a child is 94.53 months old. This is a rounded age of 7 years and 11 months, replicating previous findings of children up to eight years old not consistently interpreting universal quantifiers as universal (Slim et al., 2023; see Brooks & Parshina, 2019, for review).

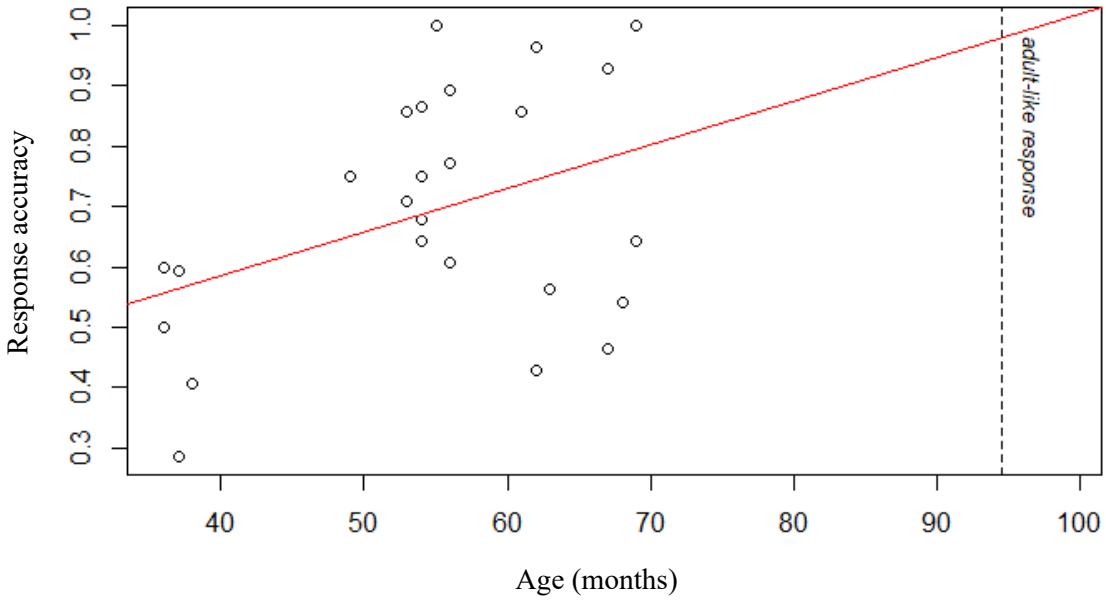

Fig. 5. Predicted adult-like response accuracy for children.

3.2. Children

Figures 6 and 7 depict children's response accuracy for all conditions per task. In Figure 6, the total percentage of universal interpretations of each subject is plotted per condition for the act-out task. This universal interpretation corresponds to the placing of six animals in the field. An adult-like response would thus elicit a low percentage for non-universal quantifiers[6] and a high percentage for universal quantifiers[7]. Figure 7, on the other hand, depicts the total percentage of accurate answers per condition in the judgement task. This means that an adult-like response would entail a high percentage in all (universal and non-universal) conditions. The percentages in both figures correspond to the dependent variable of 'response accuracy' in this study, since an accurate response is equal to a universal interpretation in the critical conditions.

The main topic of interest of this study is the possible influence of task-specific demands on response accuracy. The first analysis of the children's data assessed whether there was a difference in response accuracy depending on the administered task. Results from the mixed effect regression indicated a significant main effect of task type (χ^2 (1) = 5.3255, p = .027), with the judgement task eliciting the most accurate responses (see Figure 8). The odds for an accurate (i.e., universal) interpretation of the UQ increase 1.55 times when the judgement task is used, which makes this a small effect.

[6] here: *de meeste* ('most (of)'), *sommige* ('some'), *een paar* ('a couple of'), *twee* ('two'), *een* ('a'). Determiner *allemaal* belongs to this category as well but recall that this quantifier is not analysed due to its complexity.
[7] i.e., the critical conditions of this study.

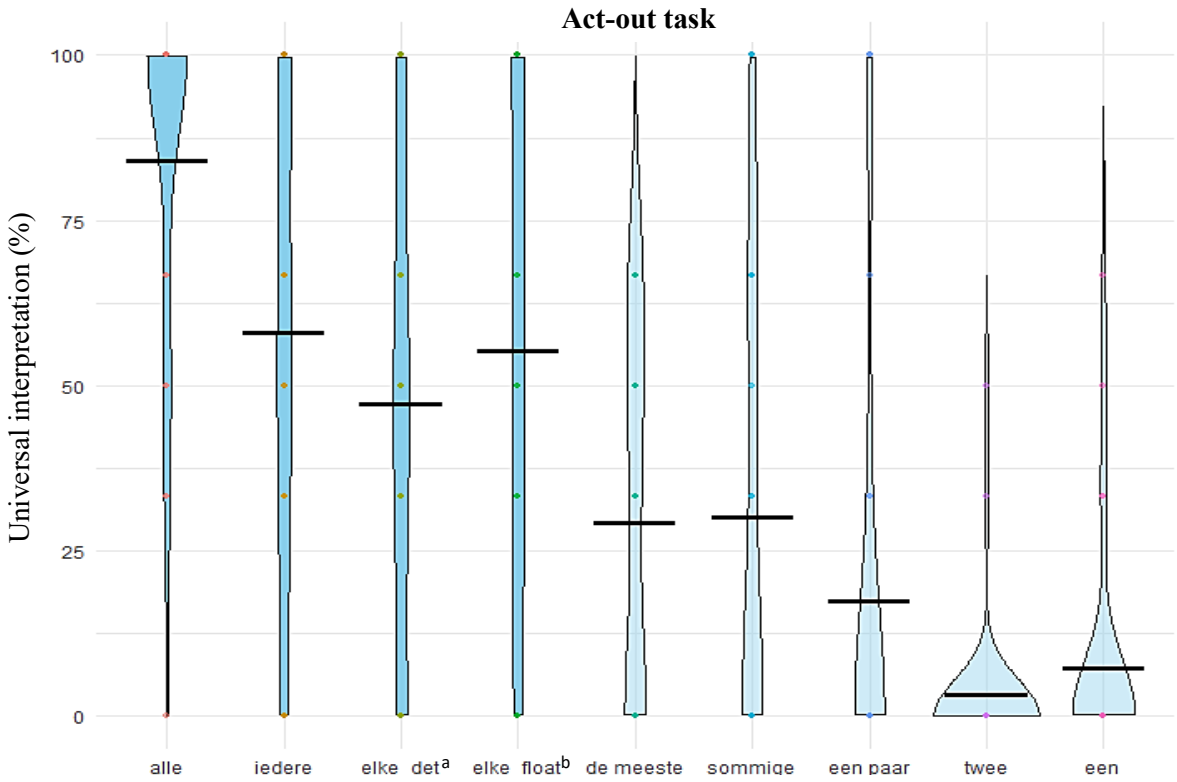

Fig. 6. Total universal interpretations (in %) of each subject per condition in the act-out task. Mean universal interpretation per condition is indicated with a crossbar. Critical conditions are coloured dark.
[a]*elke_det* corresponds to the condition of universal quantifier *elke* in determiner position.
[b]*elke_float* corresponds to the condition of universal quantifier *elke* in floating position.

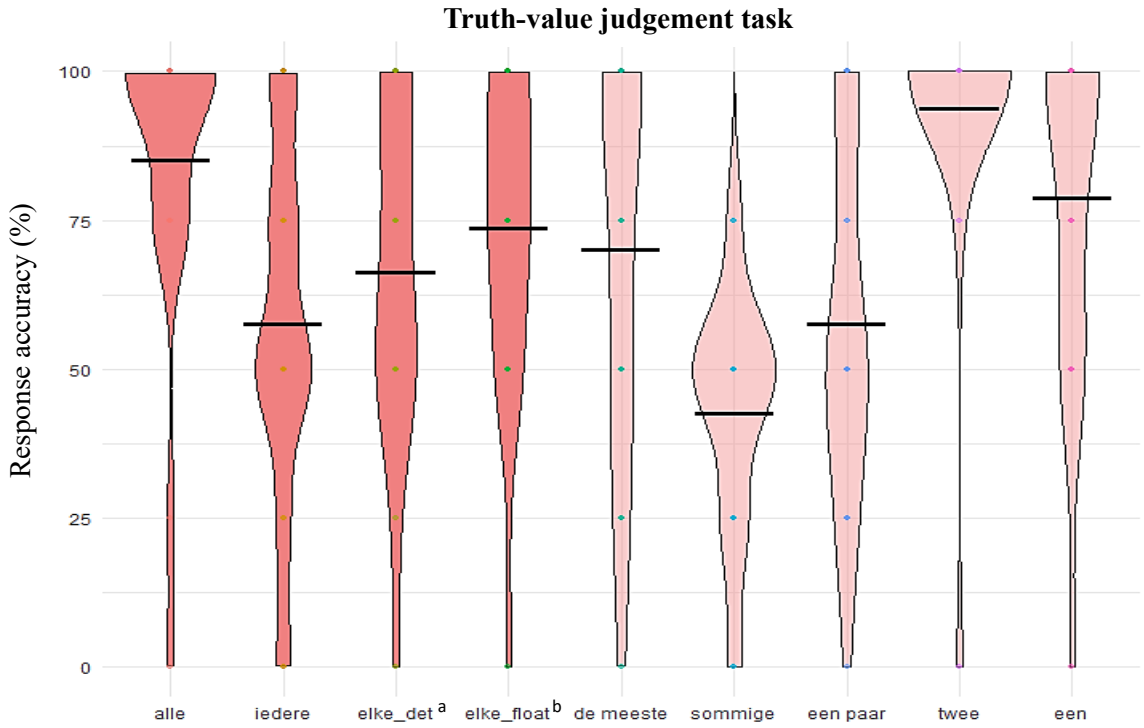

Fig. 7. Total response accuracy (in %) of each subject per condition in the act-out task. Mean response accuracy per condition is indicated with a crossbar. Critical conditions are coloured dark.
[a]*elke_det* corresponds to the condition of universal quantifier *elke* in determiner position.
[b]*elke_float* corresponds to the condition of universal quantifier *elke* in adverbial (floating) position.

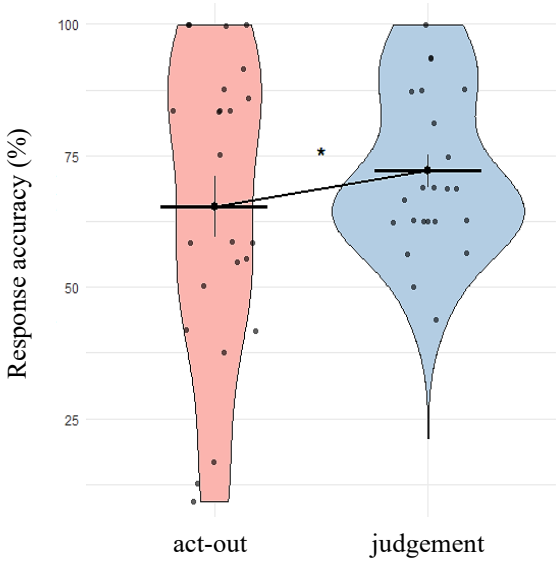

Fig. 8. Total response accuracy (in %) of each subject per task for critical conditions. Mean universal interpretation per task is indicated with a crossbar. Significant main effect of task type is indicated with *.

Next, the possible main effect of quantifier and the interaction between quantifier and task type were investigated, pertaining to the sub-question of the study. Figures 6 and 7 indicate a different response accuracy for each critical condition. A significant main effect of quantifier was indeed found (χ^2 (3) = 5.3255, p < .001), but no significant interaction between quantifier and task type. A post-hoc pairwise comparison with Holm correction to adjust for multiple comparisons (R-package *emmeans*, Lenth, 2022) demonstrated that there were significantly more accurate responses when *alle* was used (p < .001). There was no significant difference between the response accuracy when *iedere* and *elke* were used (Figure 9).

The first exploratory question of this study concerns the syntactic position of *elk(e)*, which can be placed before the NP (determiner) or in the adverbial position (floating). While Figures 6 and 7 indicate a difference in response accuracy between these syntactic positions, this difference appeared not to be significant (p = .15). Besides the absence of a main effect of syntactic position, no interaction with task type was found (p = .88).

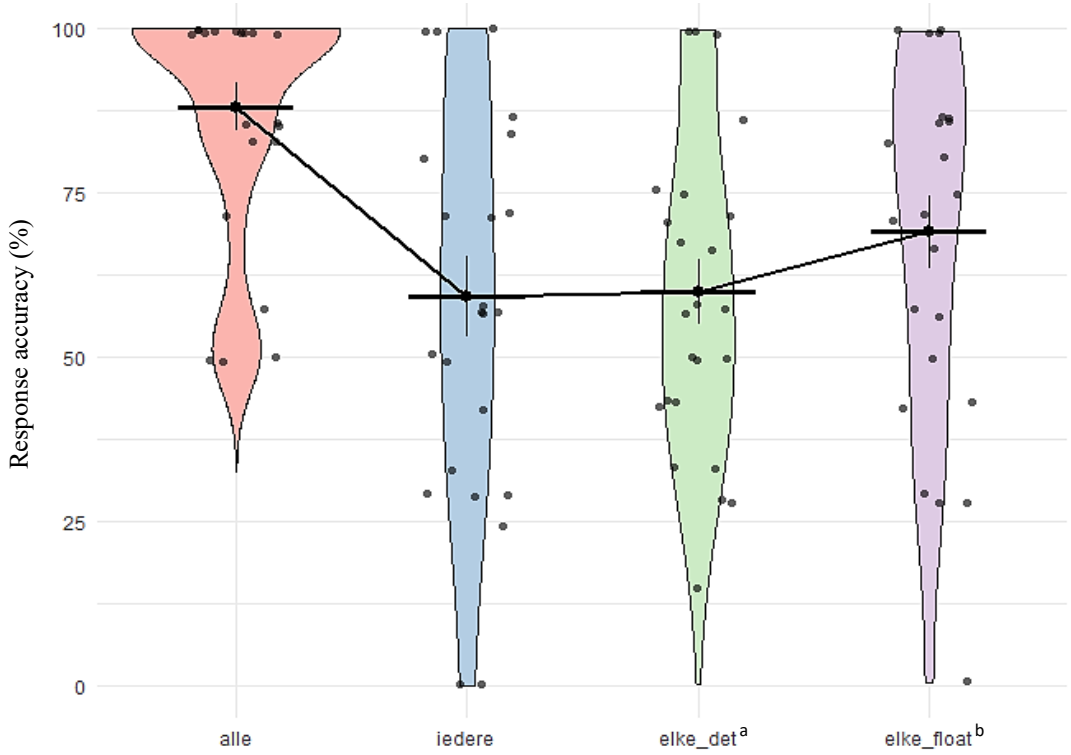

Fig. 9. Total response accuracy (in %) of each subject per critical condition. Mean universal interpretation per task is indicated with a crossbar.
[a]*elke_det* corresponds to the condition of universal quantifier *elke* in determiner position.
[b]*elke_float* corresponds to the condition of universal quantifier *elke* in adverbial (floating) position.

The last exploratory question pertained to the possible influence of age on response accuracy in both tasks. As predicted, a main effect of age was found (χ^2 (2) = 9.187, p = 0.01), but no interaction of age and task type. This indicates a similar effect of age on response accuracy in both tasks (Figure 10).

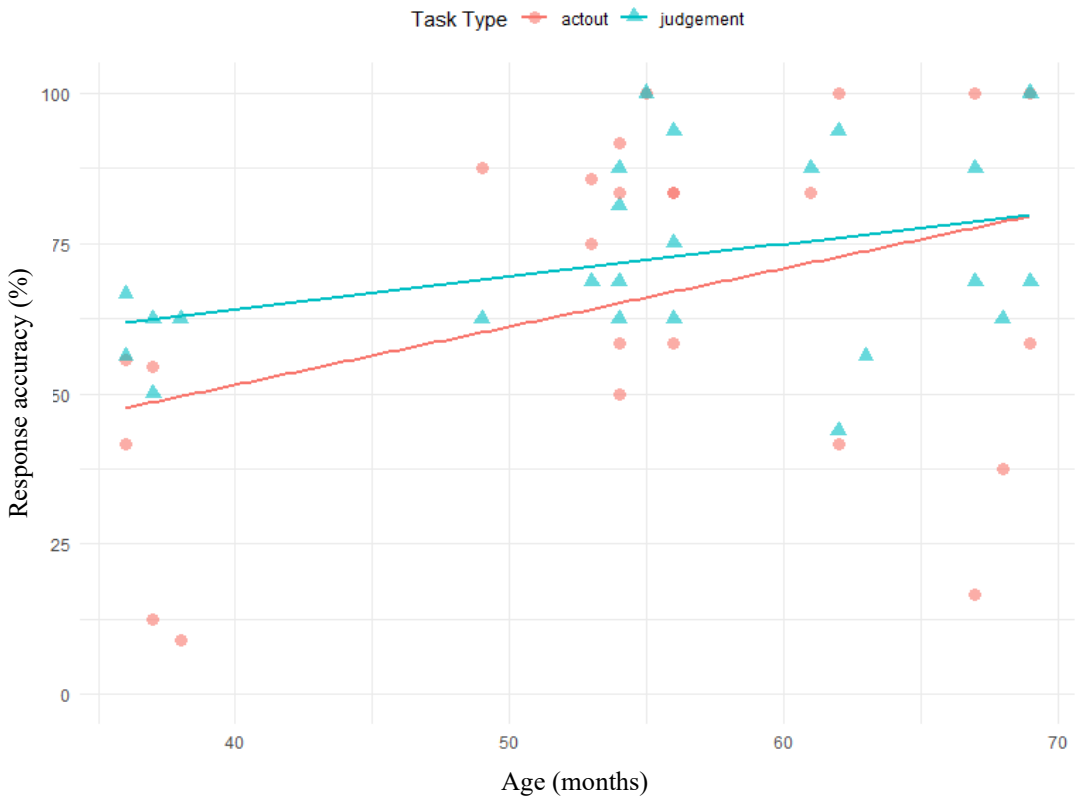

Fig. 10. Similar effect of age on response accuracy in both tasks.

To sum up, the hypotheses to the main research question and the sub-research question were affirmed: a main effect of task type and a main effect of quantifier were found. The post-hoc comparison for the sub-question pointed out that *alle* elicited significantly more accurate responses than the other quantifiers used, as was hypothesized as well. A main effect of age was also found, as was predicted for exploratory question 2. The hypothesis for exploratory question 1 was, however, rejected: while a significant difference between the syntactic positions of *elke* was predicted, no main effect of syntactic position was found. The lack of interactions with task type indicates a similar effect of quantifier and age in both tasks, with syntax not eliciting any effects in neither task.

4. Discussion

This study investigated children's universal interpretation of the Dutch universal quantifiers *alle*, *iedere*, and *elke* in an act-out task and a truth-value judgement task. It specifically concerned whether this interpretation is manipulated by task-specific demands (main RQ), the used quantifier (sub-RQ), syntactic position (exploratory RQ 1) and age (exploratory RQ 2). Since the main research question concerns the influence of task-specific demands, the interaction between this and every other predictor was also measured.

4.1. Pragmatics: task-specific demands

While the predicted developmental trend of universal quantifier interpretation has been confirmed by the main effect of age on response accuracy in this study, no interaction with task type was found, indicating a similar learning curve in both tasks (see Figure 10). However, response accuracy in the truth-value judgement task was found to be generally higher than that in the act-out task, indicated by

the main effect of task type (see Figure 8). The following sections discuss the role of task context in this finding (4.1.1) and potential influences of chance on the results (4.1.2).

4.1.1. Greater response accuracy in truth-value judgement task

The main effect of task type indicates a difference in response accuracy depending on which task was administered. The most accurate responses were observed in the judgement task. This finding confirms the main hypothesis of this study, which postulates that children are more likely to interpret the universality of universal quantifiers accurately when judging a given interpretation, rather than when they need to generate an interpretation themselves. This finding has potential implications for the field, as it suggests that the choice of task type to assess children's linguistic knowledge influences the display of that linguistic knowledge, as has been stated before (e.g., Gualmini, 2005; Gualmini, et al., 2003; Roberts, 2012; Skordos et al., 2022; Ziegler and Snedeker, 2019).

The truth-value judgement task thus elicited the most accurate responses, but what lies behind this result? The difficulty of the act-out task may have caused fewer correct responses in that task. Firstly, the act-out task contained many elements: a barn, 18 animals, the farmer bear, and a field with fences and troughs for the animals to 'drink' and 'eat' from. Children are especially distractable (Wetzel & Schröger, 2014); these different stimuli could have caused the child to get distracted from and eventually forget the goal of the trial.

Secondly, the elicitation of an unintended Question Under Discussion (QUD; Roberts, 2012) could have contributed to the issues as well. Recall that Roberts (2012) used this reason to explain quantifier spreading in children's responses in a judgement task. However, a QUD can just as well be elicited in an act-out task: by comparing the test sentence to the QUD, we know how many of which type of animal we need to place in the field. The intended QUD of this task contained a sentence with a different quantifier, so the participant would know how many animals to place in the field (e.g., not *some,* but *all* cows), and a statement with a different kind of animal, so the participant would know what kind of animal needed to be placed in the field (e.g., not all *pigs*, but all *cows*). Children, however, are challenged to elicit the correct QUD (Crain et al., 1996). Their QUD may have contained just a different animal and no different quantifier. For instance, if a child heard "Nu gaan alle koeien naar de wei" (*Now, all cows are going to the field*), (s)he might internally compare that sentence to "Now, all *sheep* are going to the field" and not to "Now, *some* cows are going to the field". Since there were only three kinds of animals, the probability of placing the right animal in the field was one in three, greater than the probability of placing the correct number of animals in the field (one in six; more in 4.1.2). Children might thus have elicited the 'easiest' QUD, the one to which there was a clear correct answer: no sheep or pig should be placed in the field, only the cow. They might not even have paid attention to the quantifier in the sentence since that was no important part of the QUD.

However, many of the older children repeated the used quantifier and the NP while placing animals in the field, indicating the use of the right QUD. In that case, the theory of Ziegler and Snedeker (2019) poses a different issue: the production system was clearly involved while creating the scene, potentially pushing back the comprehension effect. This repetition could also have distracted the children from their goal, together with the different elements mentioned above. Thus, even if the right QUD was elicited, the (internal) repetition of the test sentence or quantifier could still have rendered the comprehension effect less detectible and/or could have distracted children from their goal in the act-out task.

The judgement task also contained potentially distractible elements: the animals not included in the test sentence, depicted in the barn. An alternate QUD, based on the animal instead of the universal quantifier, could thus still be elicited. However, the clear involvement of one type of animal per trial, not only in the test sentence but also depicted in the field, made the elicitation of an unintended QUD less likely than in the act-out task. Another problem regarding the elicitation of an alternative QUD, pointed out by Crain and colleagues (1996), was avoided as well. When an experimenter asks children if *all* elements are in a location, children may expect the experimenter to have a different QUD in mind

because the question asked is too easy for the experimenter to not know the answer to. This issue was avoided by introducing the assistant bear in the judgement task: the narrative of the bear being new to the farm and still in training made the asking of the questions more believable.

In addition to this probable reduction of chances of constructing an alternate QUD, the truth-value judgement task also reduced the amount of distraction caused by the task design. As mentioned above, the act-out task involved many different elements, while the judgement task only involved a laptop and the two teddy bears. Lastly, the judgement task was constructed in such a way that the universally quantified statement could be negated, as is required to assess true knowledge of universal quantifiers (Drozd, 2001; Freeman et al., 1982; Wason, 1965), and the occurrence of quantifier spreading was unlikely in this experimental context (Piaget & Inhelder, 1964; Roeper & De Villiers, 1993). Both these points have already been discussed in the methodology section (2.4).

In sum, the judgement task imposed a lower threshold for a correct interpretation than the act-out task. In addition to the lowered possibility of eliciting a faulty QUD, the avoidance of quantifier spreading and the optional deniability of the test sentence, the judgement task was executed in a more controlled manner than the act-out task, without much room for children to divert from the goal. The environment was less distracting since this task involved only a laptop and the two farmer bears. The introduction of the assistant eliminated the problem of believability posited by Crain and colleagues (1996).

4.1.2. Potential influences of chance

Something else lowering the threshold for the truth-value judgement task was the higher probability of answering correctly in this task than in the act-out task. Even though the outcome variable of both tasks was binary (accurate or inaccurate), this was not clear for the children. While they could only answer with ‘yes’ or ‘no’ in the judgement task, giving them a 50% chance to be right, there were in fact six possible responses in the judgement task – the number of animals placed in the field (one to six) – which caused a probability of only one in six to respond correctly during this task. This could have led to guessing some of the responses. Because of the lower probability of answering correctly in the act-out task, the number of correct responses given by chance should be higher in the judgement task than in the act-out task. Therefore, the number of incorrect responses that were guessed should be lower in the judgement task than in the act-out task. This may have contributed to the difference in response accuracy between both tasks.

However, a contrary effect may have taken place in the act-out task, where the chance of answering correctly was only one in six or 16.7%. Because of this low success rate, children might have kept on placing animals in the field, expecting to learn from the adults in the room when they should stop or what they should do next. Participants indeed often looked at the experimenter or their guardian while placing animals in the field. Executing a task while looking for social cues from authority figures instead of basing the response on personal judgement is a common occurrence during development that child psychologists call “social referencing” (e.g., Feinman, 1992). This may have elicited more correct answers than if the children acted out of their own knowledge, since the placing of all the animals in the field may not have occurred out of a correct universal interpretation of the quantifier but out of waiting for a social cue. This accidental raising of the response accuracy in the act-out task may have cancelled out the forementioned raising of the response accuracy in the judgement task because of the higher success rate.

Thus, although some responses may have been guessed which may have accidentally raised the response accuracy on the judgement task, the response accuracy on the act-out task could have been raised as well, because of children’s apparent social referencing. This would keep the gap between response accuracy on both tasks as big as it would be without guessing. In conclusion, the higher response accuracy in the judgement task can still be regarded as an effect of task-specific demands.

4.2. Syntax and semantics

Recall that the Equilibrium Hypothesis (Smits, 2010) states that a balance of syntactic, semantic, and pragmatic components contributes to an adult-like understanding of quantification. Children would use their knowledge of these components and infer clues from the (linguistic) context to pursue this balance. As discussed in the previous section, the judgement task contained clear clues regarding pragmatics: children knew the intentions of the speaker (the assistant teddy bear) which could be connected to the situational context, the farm. The pragmatic context of the act-out task was also easy to understand, as the children were clearly instructed to help the farmer by placing the required number of animals in the field and further encouraged by the experimenter to do this. The linguistic context (the test sentence) was also easily connectable to the situational context since it only contained elements visible in the task setting: the animals and the field. The previous section already pointed out possible pragmatic issues, especially with the act-out task, that might have occurred during testing.

The contribution of syntactic and semantic components to the equilibrium is harder to assess. The answer to the sub-question of this study, regarding the influence of the specific quantifier on response accuracy, can be a good starting point here. The higher number of accurate responses when *alle* was used confirms the hypothesis to this sub-question, in line with previous research (Gordon, 1982; Slim et al., 2023). The hypothesis to this question was formed from a semantic point of view, based on Ferenz and Prasada (2002): when the NP of the sentence is plural, children interpret the quantifier as universal more easily than when the NP is singular. This would explain the gap between the high response accuracy when *alle* was used and the accuracy when the other universal quantifiers were used. However, if this were the reason for that gap, there should have been a difference between *elke* in determiner position and *elke* in floating position, since it requires a singular NP in determiner position but a plural NP in floating position. No difference in response accuracy was found between these two syntactic positions. This may indicate that children do not use syntactic information when restricting the domain of a quantifier, which has been posited before (Roeper et al., 2006; Smits, 2010), and thus that syntactic position is no predictor for universal interpretation of a universal quantifier, as is consistent with the results of this study.

However, the evidence for children's usage of syntactic position in quantifier interpretation listed in section 1.3.3 makes it unlikely that no syntactic information was used by the children within this age range to interpret the universal quantifiers (e.g., Barner et al., 2009; Wellwood et al., 2016). Indeed, previous studies have shown differences in children's interpretation of universal quantifiers in determiner position and those in floating position. Barner and colleagues (2009) found that the former was interpreted correctly more often than the latter and speculated that this happened because the quantifier and NP are placed right next to each other. Wellwood and colleagues (2016) added to this speculation that children may use a syntactic bootstrapping-technique to restrict their interpretation of a quantifier in determiner position to a quantitative one. But if this is true, then why was there no difference between response accuracy when prompted with determiner *elk* compared to floating *elk*?

An explanation can be found in the Equilibrium Hypothesis itself: the importance of the equal contribution of semantic, syntactic, and pragmatic properties of the universal quantifier. Many researchers propose a joint contribution of semantic and syntactic features to the correct interpretation of universal quantifiers, which children only learn at a developmental pace (e.g., Brooks and Braine, 1996; Ioup, 1975). While children may not have used syntactic information on its own to infer the universal interpretation of the universal quantifiers, it might have been a contributor to the high response accuracy for *alle*. If only the combination of semantics and syntax can cause the universal interpretation of universal quantifiers, the lack of a difference between the response accuracy for determiner *elk* and floating *elk* should not be surprising, especially for these fairly young children. Determiner *elk* only contains the syntactic property of position, while floating *elk* only contains the semantic property, a plural NP. *Alle*, in contrast, combines these two properties, resulting in an easier to interpret universality

and thus a significantly higher response accuracy. Since there was no interaction of quantifier and task type, the pragmatic components of each task (e.g., the realistic task context of the farm, the clear task instruction, the avoidance of quantifier spreading, the believability of the scenario, …) may have contributed equally to the general high response accuracy of *alle*.

Salient is that this finding partly contradicts the research of Slim and colleagues (2023), who also observed a high response accuracy (i.e., universal interpretation) for *all*, but *every* elicited a high response accuracy as well, while *each* did not. If the present study had replicated the finding of Slim and colleagues (2023), *alle* would have shared its first place in response accuracy with *elke* or *iedere*, which was not the case. It thus appears that Dutch and English cannot (fully) be compared with regard to universal quantifiers. Slim and colleagues (2024) argue that the English *each* is interpreted more distributively than *every* (see 1.3.2). Dutch quantifiers may thus differ from English quantifiers in distributivity, given that *elke* and *iedere* both elicited comparably lower response accuracy than *alle.* Be aware, though, that this hypothesis cannot be constructed for Dutch quantifiers without further research.

In conclusion, the judgement task may have maintained a greater equilibrium between semantics, syntax, and pragmatics than the act-out task, which may explain the significantly higher response accuracy in the judgement task. The specifically high response accuracy when the universal quantifier *alle* was used can be explained by the equilibrium between its semantic component (a plural NP) and its syntactic (determiner) position; both have been evidenced to facilitate universal quantifier interpretation in children (e.g., Barner et al., 2009; Ferenz & Prasada, 2002). Children appear to need more information than only from one component to interpret universal quantifiers, which is why no significant effect of syntactic position was found. The different results from Slim and colleagues (2023) indicate a difference between Dutch and English concerning the universal interpretation of universal quantifiers, which should be further investigated.

4.3. Limitations and future research

This study assessed children's universal interpretation of universal quantifiers through an act-out task and a truth-value judgement task. Both contained a large number of trials, to ensure that even after exclusion of skipped trials the task results could still be used for analysis. While they were administered in two different sessions and the child could take breaks during a test session, it still might have tired the children, perhaps leading to inattentiveness toward the end of the task. However, trials with an unclear reaction were eliminated from the eventual analysis. While it cannot be guaranteed that tiredness or inattentiveness may have influenced some trials, these trials should have been outnumbered by others that were not influenced by this.

Furthermore, the probability of answering correctly should be equal in both tasks to eliminate potential influence of guessing. The setting of the act-out task should also contain fewer distracting elements and only the elements necessary to create the situational context, perhaps simplified. This study avoided quantifier spreading by not including extra elements, which should happen more often in research of children's genuine knowledge of universal quantifiers. When a judgement task is administered, the possibility of denying the test statement should always be present, like it was in this study. Lastly, researchers should always be aware of the challenges children face to form a correct Question Under Discussion and all possible measures to avoid this should be taken (in this study, the assistant teddy bear and the lack of other animals depicted in the field avoided much of this problem in the truth-value judgement task).

This study has contributed to the body of research about the influence of task type on the task result. Future researchers are encouraged to use multiple different tasks to further assess knowledge of universal quantifiers. The demands those tasks impose should be studied separately or at least taken into account. This study also contributes to the small body of research on children's universal interpretation of universal quantifiers. Since children did not respond adult-like in both tasks, this has been proven to be an important part of the interpretation of universal quantifiers. Future research should focus more on

universal interpretation, rather than on just distributiveness. There still are many unanswered questions at this time that can only be further investigated when the field of focus widens from distributivity to universality and when task-specific demands are considered, by administering more than one task and by running models including task type as a predictor.

5. Conclusions

The present study showed that task-specific demands play a role in the display of children's knowledge of universality in interpreting universal quantifiers. The judgement task from this study imposed a lower threshold for children to correctly interpret the used universal quantifiers. The threshold imposed by the act-out task included a lower probability of success, which may have led to (unanswered) social referencing, and the construction of an unintended QUD. Issues that may occur during judgement tasks, like quantifier spreading or an un-negatable offered statement, were eliminated thanks to the farm context and the depiction of a barn and a field where animals could be depicted.

The higher response accuracy found for *alle* could be explained by its facilitating syntactic and semantic features compared to the other universal quantifiers, perhaps contributing more equally to the equilibrium proposed by Smits (2010) in his Equilibrium Hypothesis. This would also explain the lack of an effect of syntactic position, since determiner *elke* only gives children syntactic information and floating *elke* only provides semantic information (a plural NP), possibly creating an imbalance in the equilibrium. This imbalance may be corrected when children are older, since the effect of age in both tasks indicated a learning curve for response accuracy.

Future research should pay attention to task-specific demands when assessing children's interpretation of universal quantifiers and try to eliminate as many errors caused by these demands as possible. The use of multiple tasks to assess this interpretation is encouraged, since influences of each task can be better investigated in comparison to the response accuracy in another task, as was the case in this study. Lastly, the universal interpretation of universal quantifiers should be studied more often since lack of knowledge of their common core may be a cause in all reported problems with universal quantifier interpretation.

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7. Appendices

7.1. Declaration on plagiarism and fraud

Declaration on plagiarism and fraud

The undersigned,

First name, surname

Lena Grondelaers

Student number

s1128401

Bachelor's or Master's student

Master's student

Student at the Radboud University Faculty of Arts,

declares that the assessed thesis is entirely original and was written exclusively by themself. The undersigned indicated explicitly and in detail where all the information and ideas derived from other sources can be found. The research data presented in this thesis was collected by the undersigned himself/herself using the methods described in this thesis.

Place and date:

Nijmegen, 4/07/2024

Signature:

Radboud University

7.2. Declaration of consent

I, Lena Grondelaers, hereby grant permission for this dissertation to be stored in the Radboud University thesis repository. I understand that this will make my work accessible to the university community and, in some cases, to the public, in accordance with the policies of Radboud University.

I consent to the repository's use of this dissertation for academic and research purposes, subject to the copyright and intellectual property rights retained by me.

Signed,
Lena Grondelaers
04/07/2024

7.3. Information letter for guardians of participants

Baby & Child Research Center

INFORMATIEBLAD VOOR PROEFPERSONEN

In dit onderzoek gaan we ontdekken hoe kinderen woorden als *alle*, *elke* en *allemaal* leren. De betekenis van een woord zoals *hond* of *auto* kan duidelijk worden door naar een hond of een auto te wijzen. Dit is niet mogelijk voor woorden als *alle* en *elke*, wat ze moeilijk maakt om te leren. Dit zijn namelijk woorden met een abstracte betekenis. Toch zijn deze woorden heel belangrijk. Ze worden namelijk veel gebruikt in ons dagelijks leven, maar ook in situaties op school (bijvoorbeeld tijdens begrijpend lezen of bij het maken van rekenopdrachten).

Wij zullen bekijken hoe kinderen zulke woorden leren, door taalspelletjes te spelen met kinderen van 3 tot 7 jaar, waarin we het begrip van deze woorden spelenderwijs onderzoeken.

De studie wordt uitgevoerd door het Language Development Department onder supervisie van Prof. Dr. Caroline Rowland, Max Planck Instituut voor Psycholinguïstiek. Dit onderzoek is getoetst door de Ethiek Commissie Sociale Wetenschappen (ECSW) van de Radboud Universiteit Nijmegen.

Wat houdt de studie voor mij in?

De studie is voor kinderen tussen de 3 en de 7 jaar oud, en bestaat uit twee afspraken (sessies). Elke afspraak zal ongeveer 60 minuten duren. Op het moment van de afspraak wacht onze onderzoeker u en uw kind op bij de parkeerplaats van het BRC, locatie Wundtlaan 1 in Nijmegen. Samen met de onderzoeker lopen jullie naar de onderzoeksruimte via ons 'Elfjespad', waar uw kind naar elfjes en bosdiertjes kan kijken en zo alvast de onderzoeker kan leren kennen. Voordat het onderzoek begint, legt de onderzoeker stap voor stap aan u uit wat er gaat gebeuren. Tijdens het onderzoek zit u in de buurt van uw kind.

De onderzoeker zal in elke sessie een taalspelletje spelen met uw kind. Bij beide spelletjes zal uw kind een boer en een boerenknecht helpen op een speelgoedboerderij met dieren. Bij één van deze spelletjes is het buitenspeeltijd voor de dieren. De boer (een knuffel) zal aan uw kind vragen om de speelgoeddieren vanuit een stal in de wei te zetten. Bij het andere spelletje zal uw kind de boerenknecht helpen. Bij dit spelletje beschrijft de knecht plaatjes van de boerderijdieren. De knecht werkt nog niet zo lang op de boerderij, en maakt daarom veel fouten. Uw kind zal kiezen of de beschrijvingen wel of niet passen bij de plaatjes die hij/zij te zien krijgt.

We zullen de sessies op video opnemen, om deze later te kunnen analyseren. Na het onderzoek zal de onderzoeker met uw kind een vragenlijst doornemen m.b.t. de woordenschat van uw kind. Indien gewenst kan de onderzoeker dan ook verdere informatie over het onderzoek geven.

Krijg ik betaald voor deelname en zijn er mogelijke risico's?

Om u te bedanken voor uw deelname mag uw kind na afloop van beide afspraken een boekje uitkiezen of kunt u ervoor kiezen om een financiële vergoeding van €20,- te ontvangen. Bovendien hebben kinderen er meestal plezier in om aan de studie deel te nemen. Aangezien de studie inhoudt dat uw kind op een stoel zit en een spelletje speelt met speelgoed, zijn er geen risico's aan deze studie verbonden. Deelname is volstrekt vrijwillig en u kunt u zich op elk moment terugtrekken zonder een reden te geven en zonder dat dit verdere gevolgen heeft voor u of uw kind. Als uw kind niet wil deelnemen, zullen wij deze keuze respecteren, ook als u eerder toestemming heeft gegeven.

Wat gebeurt er met mijn gegevens?
We zullen de volgende (deels persoonlijke) data verzamelen in deze studie: video-opnames van de sessie; de reacties ('antwoorden') van uw kind; zijn/haar geboortedatum; geslacht. Als u na deelname besluit dat u de data vernietigd wilt hebben, neemt u dan alstublieft zo spoedig mogelijk contact met ons op, uiterlijk tot 1 maand na afronding van het onderzoek.

Alle verzamelde data worden bewaard op een server die met een wachtwoord beveiligd is, in een beveiligde omgeving op het Max Planck Instituut voor Psycholinguïstiek. De data zijn alleen toegankelijk voor werknemers met specifieke autorisatie. Onderzoeksdata (verzameld tijdens de studie) worden apart van persoonlijke data bewaard (bijvoorbeeld de naam van uw kind). De data worden zo snel mogelijk geanonimiseerd maar uiterlijk op het moment dat de dataverzameling gereed is. Als anonimisatie niet mogelijk is (bijvoorbeeld bij video-, audio-opnames en foto's), zullen we deze data op dezelfde manier behandelen als persoonlijke data, waarbij we extra beveiligingsmaatregelen nemen in overeenstemming met de Nederlandse wet.

Alle verzamelde data zullen alleen gebruikt worden voor wetenschappelijke doeleinden, en alleen beschikbaar zijn voor de onderzoeksgroep. Zij zullen overeenkomstig het EU regelement voor de gegevensbescherming van persoonlijke data (GDPR) handelen, ook als ze buiten de EU gesitueerd zijn. We hopen de onderzoeksdata te publiceren in 2024. Graag willen wij u vragen er rekening mee te houden dat wij onderzoeksdata niet kunnen vernietigen na publicatie van het onderzoek. Meer informatie over uw rechten en gegevensbescherming volgens de AVG vindt u op www.babyandchild.nl/privacybeleid.

Mocht u als bedankje een klein geldbedrag willen ontvangen, dan hebben wij ook uw contactgegevens, geboortedatum, IBAN en BSN nodig. Deze zullen door onze financiële afdeling verwerkt worden en staan los van uw onderzoeksgegevens. De verwerking van uw betaalgegevens is verplicht door de Belastingdienst. Deze gegevens worden 10 jaar bewaard.

Contactgegevens en klachten
Heeft u nog vragen? Bij vragen over de studie, gelieve contact op te nemen met de verantwoordelijke onderzoeker, dr. Mieke Slim via brc-afspraak@ru.nl. De onderzoeksassistenten van deze studie zijn Hanne van Uden en Lotte Arendsen. Voor overige vragen, suggesties of klachten kunt u contact opnemen met onze lab manager, Patricia Manko (brc@ru.nl; 024-3611203).

7.4. Consent form for guardians of participants

Baby & Child Research Center

Max Planck Instituut voor Psycholinguïstiek
Radboud Universiteit Nijmegen
Radboudumc

Baby & Child Research Center
Wundtlaan 1 (Max Planck Instituut voor Psycholinguïstiek)
6525 XD Nijmegen
024-361 1203
brc-afspraak@ru.nl

TOESTEMMING VOOR DEELNAME AAN ONDERZOEK [Helpen op de boerderij]

Ik stem in met deelname van mij en mijn kind aan een onderzoek van het Baby & Child Research Center. Hierbij verklaar ik dat ik naar tevredenheid ben geïnformeerd en dat ik de informatiebrief heb gelezen. Ik weet dat deelname aan dit onderzoek geheel vrijwillig is en ik op ieder moment zonder consequenties kan besluiten om zelf niet meer deel te nemen en om mijn kind niet meer deel te laten nemen. Ik heb begrepen dat de gegevens die tijdens het onderzoek worden verzameld alleen zullen worden gebruikt voor wetenschappelijk onderzoek. Gebruik voor niet-wetenschappelijke (bijv. commerciële) doeleinden is uitgesloten. Ik weet dat de verzamelde gegevens minimaal 10 jaar beschikbaar zullen zijn voor controle, hergebruik en replicatie. Ik weet dat de verzamelde gegevens beschikbaar kunnen worden gesteld voor gebruik van externe onderzoekers, maar alleen zonder alle gegevens die tot identificatie van personen zouden kunnen leiden. Ik weet dat tot de persoon herleidbare data alleen toegankelijk zijn voor het onderzoeksteam van het Baby & Child Research Center o.l.v. Dr. Sabine Hunnius. Dit onderzoek is getoetst door de Ethiek Commissie Faculteit der Sociale Wetenschappen (ECSW) van de Radboud Universiteit Nijmegen.

☐ *Ik geef toestemming voor het verzamelen, bewaren en gebruiken van de volgende (deels persoonlijke) gegevens: Geboortedatum, geslacht, antwoorden op vragen.

☐ *Ik geef toestemming voor het verzamelen, bewaren en gebruiken van de volgende persoonlijke gegevens: Audio- en video-opnames.

☐ *Ik geef toestemming voor het verzamelen, bewaren en gebruiken van de volgende bijzondere persoonlijke gegevens: Informatie over de taalontwikkeling en gezinssituatie van mijn kind

_____ Nijmegen, _____
Naam & achternaam van het kind datum

_____ _____
Handtekening ouder Naam & achternaam van de ouder

**Ik begrijp dat ik op alle bovengenoemde punten met een *sterretje* 'ja' moet antwoorden om aan het onderzoek deel te kunnen nemen.*

Indien van toepassing:

Hiernaast geef ik toestemming om de tijdens dit experiment opgenomen foto's, video- en/of geluidsopnames te tonen (svp aankruisen):

- ter illustratie van het onderzoek tijdens lezingen: □ JA □ NEE
- ter illustratie van het onderzoek in wetenschappelijke artikelen: □ JA □ NEE
- ten behoeve van onderwijsdoeleinden (aan studenten): □ JA □ NEE

7.5. Information letter for adult participants

MAX PLANCK INSTITUTE
FOR PSYCHOLINGUISTICS

Informatieblad voor proefpersonen: 'Helpen op de boerderij'

Afdeling: Language Development Department

Wat houdt het onderzoek in?
In deze studie, uitgevoerd door dr. Mieke Slim, bestuderen we de ontwikkeling van kindertaal. Het specifiekere doel is te bestuderen hoe kinderen Nederlandse zinnen begrijpen, en of ze daarin verschillen van volwassenen. Om deze vergelijking te maken zoeken we volwassenen die dezelfde taken (twee taalspelletjes) uit gaan voeren als de kinderen.

De studie wordt uitgevoerd door de Language Development Department onder supervisie van prof. dr. Caroline Rowland aan het Max Planck Instituut voor Psycholinguïstiek. De studie is via de lighttrack procedure aan de Ethiek Commissie Faculteit Sociale Wetenschappen (ECSW) van de Radboud Universiteit Nijmegen voorgelegd en de commissie heeft aangegeven geen bezwaar te maken.

Wat gebeurt er als ik meedoe?
In deze studie zult u twee taalspelletjes spelen, die ook aan de kinderproefpersonen gegeven worden. In één van deze spelletjes zal een "boer" (een teddybeer) opdrachten geven die u uit kunt voeren met speelgoeddieren. In de andere taak zal een "boerenknecht" plaatjes beschrijven, en is het uw taak om aan te geven of deze knecht het plaatje juist of fout heeft beschreven. Aan het einde van het experiment zult u een uitgebreidere beschrijving ontvangen over de doelen van deze studie.

Krijg ik betaald voor mijn deelname?
U zult €15 betaald krijgen voor deelname aan dit onderzoek. Het bedrag zal na voltooiing van het experiment worden overgemaakt op de rekening die u bij het instituut heeft opgegeven.

Wat zijn de risico's?
Er zijn geen risico's verbonden aan dit onderzoek.

Wat gebeurt er met mijn gegevens?
We zullen de volgende data verzamelen in deze studie:

Experimentele data: We zullen uw antwoorden in beide taalspelletjes opslaan voor latere analyses.

Persoonlijke data: We zullen de volgende persoonlijke gegevens verzamelen: geboortedatum, geslacht. Tevens zullen we een video-opnamen maken tijdens het experiment, om deze later te kunnen analyseren.

In het toestemmingsformulier wordt u gevraagd om toestemming te geven voor het verzamelen, gebruiken en bewaren van bovengenoemde (bijzondere) persoonsgegevens. Indien u hier niet mee instemt, kunt u niet deelnemen aan het onderzoek.

Alle data worden voor minimaal 10 jaar bewaard op een server die met een wachtwoord beveiligd is, in een beveiligde omgeving op het Max Planck Instituut voor Psycholinguïstiek. De data zijn alleen toegankelijk voor werknemers met specifieke autorisatie. Als u na deelname besluit dat u de data vernietigd wilt hebben, neemt u dan alstublieft zo spoedig mogelijk contact met ons op, uiterlijk tot 1 maand na afronding van het onderzoek. Onderzoeksdata (verzameld tijdens de studie) worden apart van persoonlijke data bewaard (bijvoorbeeld uw naam). Alleen middels een code of proefpersoonnummer is te achterhalen welke onderzoeksdata bij welke persoon hoort. De link tussen gegevens die u direct kunnen identificeren en de overige onderzoeksdata wordt opgeslagen in een sleutelbestand dat met een wachtwoord beveiligd is. De data worden zo snel mogelijk geanonimiseerd maar uiterlijk op het moment dat de dataverzameling gereed is. Als anonimisatie niet mogelijk is (bijvoorbeeld bij video-, audio-opnames en foto's), zullen we deze data op dezelfde manier behandelen als persoonlijke data, waarbij we extra beveiligingsmaatregelen nemen in overeenstemming met de Nederlandse wet. Alle verzamelde data zullen alleen gebruikt worden voor wetenschappelijke doeleinden. We hopen de onderzoeksdata te publiceren in 2025. Houdt u er rekening mee dat wij onderzoeksdata niet kunnen vernietigen na publicatie van het onderzoek.

Mocht u vergoeding willen ontvangen, hebben wij ook uw contactgegevens, IBAN en BSN nodig. Deze zullen door onze financiële afdeling verwerkt worden en staan los van uw onderzoeksgegevens. De verwerking van uw betaalgegevens is verplicht door de Belastingdienst en de gegevens worden 10 jaar bewaard.

Informatie over gegevensbescherming volgens de AVG

Verdere informatie omtrent uw rechten volgens de AVG vindt u onder www.mpi.nl/privacy (kopje '*Informatie over gegevensbescherming volgens AVG*' en '*Inzagerecht van toezichthoudende autoriteiten ter controle van het onderzoek*'). Onze Functionaris voor de Gegevensbescherming is mevrouw Heidi Schuster, van de Max Planck Society. Voor vragen over gegevensbescherming kunt u contact opnemen met privacy@mpi.nl (NL) of met datenschutz@mpg.de (DE of EN).

Kan ik mij op elk moment terugtrekken?

Deelname aan dit onderzoek is vrijwillig. U heeft het recht om te besluiten niet deel te nemen aan dit experiment. Als u besluit niet deel te nemen dan heeft dit geen verdere gevolgen. Als u besluit om deel te nemen dan heeft u het recht om op elk moment te stoppen zonder een reden op te geven.

Waar kan ik terecht met vragen?

Heeft u vragen over enig aspect van de studie? Stel ze gerust aan de proefleider, of vraag het naderhand aan de verantwoordelijke onderzoeker (dr. Mieke Slim, mieke.slim@mpi.nl). Voor overige vragen, suggesties of klachten kunt u contact opnemen met onze lab manager, Patricia Manko (brc@ru.nl; 024-3611203).

7.6. Consent form for adult participants

MAX PLANCK INSTITUTE FOR PSYCHOLINGUISTICS

Versie juni 2022

Toestemmingsformulier: 'Helpen op de boerderij'

Ik bevestig dat:

- ik naar tevredenheid over het onderzoek geïnformeerd ben
- ik de schriftelijke informatie op het informatieblad goed heb gelezen
- ik in de gelegenheid ben gesteld om vragen over het onderzoek te stellen
- mijn eventuele vragen naar tevredenheid zijn beantwoord
- ik goed over deelname aan het onderzoek heb kunnen nadenken
- ik een kopie van dit toestemmingsformulier en bijbehorend informatieblad heb ontvangen

Ik begrijp dat:

- ik het recht heb om mijn toestemming op ieder moment weer in te trekken zonder opgave van redenen en zonder dat dit nadelige gevolgen voor mij heeft
- ik het recht heb op vernietiging van mijn onderzoeksgegevens tot 1 maand na afronding van het onderzoek
- mijn persoonsgegevens worden verwerkt volgens het privacybeleid van het Max Planck Instituut voor Psycholinguïstiek (https://www.mpi.nl/page/privacy-beleid-proefpersonen)
- mijn persoons- en/of onderzoeksgegevens binnen dit onderzoek voor wetenschappelijke doelen worden verkregen en gedurende 10 jaar beschikbaar zullen zijn voor controle, hergebruik en replicatie
- mijn anonieme onderzoeksdata van dit experiment gedeeld kunnen worden met onderzoekers van andere afdelingen en/of instituten, echter alleen voor onderzoeksdoeleinden
- het ondertekende toestemmingsformulier met mijn persoonsgegevens gedurende 10 jaar wordt bewaard

Ik geef toestemming om:

	JA	NEE
• de (bijzondere) persoonlijke data die tijdens dit experiment worden verzameld te verwerken (zie informatieblad): geboortedatum, geslacht, video- en geluidsopnames.	☐	☐

Daarnaast geef ik toestemming om de tijdens dit experiment gemaakte (identificeerbare) audio- en/of video-opnames:

	JA	NEE
• te delen met andere onderzoekers/ onderzoeksgroepen buiten deze studie	☐	☐
• te gebruiken voor onderwijsdoeleinden (bijvoorbeeld in een hoorcollege/ werkgroep) (bewaartermijn 5 jaar)	☐	☐
• te gebruiken voor andere educatieve doeleinden (bijvoorbeeld op een conferentie/ workshop).	☐	☐

Hierbij stem ik volledig en vrijwillig toe om deel te nemen aan de studie "Helpen op de boerderij"

Handtekening deelnemer: _____

Naam deelnemer: _____

Datum: _____

Naam en handtekening experimentleider: _____

7.7. Stimuli

All materials from Slim and Rowland (2024).

7.3.1. Act-out task: test sentences

Condition	Sentence
alle	Nu gaan alle koeien naar de wei
	Nu gaan alle schapen naar de wei
	Nu gaan alle varkens naar de wei
iedere	Nu gaat iedere koe naar de wei
	Nu gaat ieder schaap naar de wei
	Nu gaat ieder varken naar de wei
elk (determiner)	Nu gaat elke koe naar de wei
	Nu gaat elk schaap naar de wei
	Nu gaat elk varken naar de wei
elk (float)	Nu gaan de koeien elk naar de wei
	Nu gaan de schapen elk naar de wei
	Nu gaan de varkens elk naar de wei
allemaal (determiner)	Nu gaan allemaal koeien naar de wei
	Nu gaan allemaal schapen naar de wei
	Nu gaan allemaal varkens naar de wei
allemaal (float)	Nu gaan de koeien allemaal naar de wei
	Nu gaan de schapen allemaal naar de wei
	Nu gaan de varkens allemaal naar de wei
een	Nu gaat een koe naar de wei
	Nu gaat een schaap naar de wei
	Nu gaat een varken naar de wei
twee	Nu gaan twee koeien naar de wei
	Nu gaan twee schapen naar de wei
	Nu gaan twee varkens naar de wei
een paar	Nu gaan een paar koeien naar de wei
	Nu gaan een paar schapen naar de wei
	Nu gaan een paar varkens naar de wei
sommige	Nu gaan sommige koeien naar de wei
	Nu gaan sommige schapen naar de wei
	Nu gaan sommige varkens naar de wei
de meeste	Nu gaan de meeste koeien naar de wei
	Nu gaan de meeste schapen naar de wei
	Nu gaan de meeste varkens naar de wei

7.3.2. Act-out task: filler sentences

Om daar te gaan liggen!
Om daar te gaan eten!
Om daar te gaan drinken!
Om daar geluid te gaan maken!
Om daar te gaan rollen!
Om daar te gaan rennen!

Om daar te gaan springen!
En dan mag je aaien!

7.3.3.Truth-value judgement task: practice sentences set 1

Dit schaap is bellen aan het blazen
Deze schapen zijn aan het touwtjespringen
Dit varken heeft een hoedje op
Deze koeien zijn aan het voetballen

7.3.4. Truth-value judgement task: practice sentences set 2

Dit varken draagt een rugzak
Deze koeien gooien met een bal
Deze varkens rollen in de modder
Deze koe heeft strepen

7.3.5. Truth-value judgement task: test sentences

Condition	**Sentence**
alle	Kijk, hier zijn alle koeien in de wei
	Kijk, hier zijn alle schapen in de wei
	Kijk, hier zijn alle varkens in de wei
iedere	Kijk, hier is iedere koe in de wei
	Kijk, hier is ieder schaap in de wei
	Kijk, hier is ieder varken in de wei
elk (determiner)	Kijk, hier is elke koe in de wei
	Kijk, hier is elk schaap in de wei
	Kijk, hier is elk varken in de wei
elk (float)	Kijk, hier zijn de koeien elk in de wei
	Kijk, hier zijn de schapen elk in de wei
	Kijk, hier zijn de varkens elk in de wei
allemaal (determiner)	Kijk, hier zijn allemaal koeien in de wei
	Kijk, hier zijn allemaal schapen in de wei
	Kijk, hier zijn allemaal varkens in de wei
allemaal (float)	Kijk, hier zijn de koeien allemaal in de wei
	Kijk, hier zijn de schapen allemaal in de wei
	Kijk, hier zijn de varkens allemaal in de wei
een	Kijk, hier is een koe in de wei
	Kijk, hier is een schaap in de wei
	Kijk, hier is een varken in de wei
twee	Kijk, hier zijn twee koeien in de wei
	Kijk, hier zijn twee schapen in de wei
	Kijk, hier zijn twee varkens in de wei
een paar	Kijk, hier zijn een paar koeien in de wei
	Kijk, hier zijn een paar schapen in de wei
	Kijk, hier zijn een paar varkens in de wei
sommige	Kijk, hier zijn sommige koeien in de wei

	Kijk, hier zijn sommige schapen in de wei
	Kijk, hier zijn sommige varkens in de wei
de meeste	Kijk, hier zijn de meeste koeien in de wei
	Kijk, hier zijn de meeste schapen in de wei
	Kijk, hier zijn de meeste varkens in de wei

7.3.6. Truth-value judgement task: filler sentences

Deze koe speelt met een vlieger
Dit schaap heeft een gele vacht
Deze varkens zijn aan het zwaaien
Deze schapen zijn aan het tafeltennissen
Deze koe is aan het skateboarden
Dit varken is helemaal vies
Dit schaap heeft rode sokken aan
Deze koeien zijn lekker aan het slapen
Deze varkens graven een gat
Deze schapen hebben het heel erg koud
Deze koeien liggen lekker op een kleedje
Deze schapen zijn heel erg moe

7.7. R-script for logistic mixed effect regression

```
library(tidyverse)

library(here)

library(dplyr)

library(readxl)

library("Matrix")

library("lme4")

library("lmerTest")

library("lattice")

library("sjPlot")

library("memisc")

library("car")       # for Anova()

library("carData")

library("effects")   # for allEffects() and plot(allEffects())

library("multcomp")  # for glht()

library("performance") # for R2

library("jtools")    # for summ function for easy output

library("Matrix")
```

```
library("ggeffects")

library("xfun")

library(openxlsx)


#Prepare dataset

FINAL <- read.csv("//data.mpi.nl/collaborations/ld-
p2_helpenopdeboerderij/03-raw_data/03-
analysis_scripts/LG/LG_FINAL.csv", sep=";")

FINAL <- FINAL %>%

  mutate(Condition = case_when(

    Condition == "elk (determiner)" ~ "elke_det",

    Condition == "elk (float)" ~ "elke_float",

    TRUE ~ Condition

  ))

FINAL$Condition <- factor(FINAL$Condition, levels = c("alle",
"iedere", "elke_det", "elke_float"))

FINAL$Task <- factor(FINAL$Task, levels = c("actout", "judgement"))


#Models for main and sub RQ

contrasts(FINAL$Condition) = contr.sum(4)

fit3 <- glmer(Accuracy ~ Task*Condition + (1|Subject), contrasts =
list(Condition = "contr.sum", Task = "contr.sum"), family= binomial,
data=FINAL)

fit2 <- glmer(Accuracy ~ Task+Condition + (1|Subject), contrasts =
list(Condition = "contr.sum", Task = "contr.sum"), family= binomial,
data=FINAL)

fit1 <- glmer(Accuracy ~ Task + (1|Subject), contrasts =
list(Condition = "contr.sum"), family= binomial, data=FINAL)

fit0 <- glmer(Accuracy ~ 1 + (1|Subject), family= binomial,
data=FINAL)


#Main RQ: Does task type predict the likelihood of response
accuracy?

anova(fit0, fit1)

summary(fit1)

anova(fit1)
```

```
plot(allEffects(fit1))

AIC(fit1)

r2(fit1)

plot_model(fit1, show.values = TRUE, value.offset = .4)


#Sub-RQ (pt 1): Does quantifier predict the likelihood of response
accuracy?

anova(fit1, fit2)

summary(fit2)

anova(fit2)

plot(allEffects(fit2))

AIC(fit2)

r2(fit2)

plot_model(fit2, show.values = TRUE, value.offset = .4)


#Sub-RQ (pt 2): Is there an interaction of quantifier and task type?

anova(fit2, fit3)

summary(fit3)

anova(fit3)

plot(allEffects(fit3))

AIC(fit3)

r2(fit3)

plot_model(fit3, show.values = TRUE, value.offset = .4)

#In a nicer table:

tab_model(fit3, show.se = TRUE, show.ci = TRUE, show.p = TRUE)


#EQ 1 (pt 1): Does syntactic position predict the likelihood of
response accuracy?

  #new dataset with 2 levels (elke det and elke float)

EQ2_data <- subset(FINAL, Condition != "alle")

EQ2_data <- subset(EQ2_data, Condition != "iedere")

EQ2_data <- droplevels(EQ2_data)

  #models with new dataset
```

```
fit0a <- glmer(Accuracy ~ 1 + (1|Subject), family = binomial, data =
EQ2_data)

fit1a <- glmer(Accuracy ~ Condition + (1|Subject), contrasts =
list(Condition = "contr.sum"), family= binomial, data=EQ2_data)

anova(fit0a, fit1a)


summary(fit1a)

anova(fit1a)

plot(allEffects(fit1a))

AIC(fit1a)

r2(fit1a)

plot_model(fit1a, show.values = TRUE, value.offset = .4)


#EQ 1 (pt 2): Is there an interaction of syntactic position and task
type?

  #new model with EQ2 dataset

fit2a <- glmer(Accuracy ~ Condition*Task + (1|Subject), contrasts =
list(Condition = "contr.sum", Task = "contr.sum"), family= binomial,
data=EQ2_data)

fit2b <- glmer(Accuracy ~ Condition+Task + (1|Subject), contrasts =
list(Condition = "contr.sum", Task = "contr.sum"), family= binomial,
data=EQ2_data)

fit1a <- glmer(Accuracy ~ Condition + (1|Subject), contrasts =
list(Condition = "contr.sum"), family= binomial, data=EQ2_data)

fit0a <- glmer(Accuracy ~ 1 + (1|Subject), family = binomial, data =
EQ2_data)


anova(fit2a, fit2b, fit1a, fit0a)


summary(fit2a)

anova(fit2a)

plot(allEffects(fit2a))

AIC(fit2a)

r2(fit2a)

plot_model(fit2a, show.values = TRUE, value.offset = .4)
```

```
#EQ 2 (pt 1): Does age predict the likelihood of response accuracy?

  # new model

fit4 <- glmer(Accuracy ~ Age_months+Task + (1|Subject), contrasts =
list(Task = "contr.sum"), family= binomial, data=FINAL)


summary(fit4)

anova(fit4)

plot(allEffects(fit4))

AIC(fit4)

r2(fit4)

plot_model(fit4, show.values = TRUE, value.offset = .4)


#EQ 2 (pt 2): Is there an interaction of age and task type?

fit5 <- glmer(Accuracy ~ Age_months*Task + (1|Subject), contrasts =
list(Condition = "contr.sum"), family= binomial, data=FINAL)

anova(fit4, fit5)


summary(fit5)

anova(fit5)

plot(allEffects(fit5))

AIC(fit5)

r2(fit5)

plot_model(fit5, show.values = TRUE, value.offset = .4)


anova(fit0, fit1, fit4, fit5)
```

7.9. GDPR-measures of the MPI

GDPR Induction for Newcomers at MPI

The General Data Protection Regulation (GDPR) came into effect on 25 May 2018. This privacy legislation has implications for everyone who collects, stores, shares and processes personal information about another person at any point in time.

1. General introduction

1.1 Organizational structure

Every organization is obliged to have a data protection officer who concerns themselves with GDPR practices at their organization's level. As the MPI is part of the Max Planck Society (MPG), we report back to MPG and implement the rules as prescribed by MPG.

The **Data Protection Officer** for all MPI's is Heidi Schuster, supported by a legal team. Each MPI has their own **Data Protection Coordinator** to make sure those rules are implemented. At our MPI that is Patricia Manko (deputy Annelies van Wijngaarden), supported by the Data Protection Committee DPC.

Information about guidelines and rules for our MPI can be found on Maxintra: https://maxintra.mpi.nl/data-protection.
General information about Data Protection MPG wide can be found on the MAX pages (intranet pages MPG): https://max.mpg.de/Zentrale-Beauftragte/Datenschutz.
For any questions regarding privacy issues, please send an email to privacy@mpi.nl.

1.2 Legal bases for processing personal data

According to GDPR, an organization needs a legal basis for being allowed to process personal data. In case of MPI we make use of the following three:

Consent, performance of a contract, legitimate interest.

1. *Consent*: The data subject has given permission for the organization to process their personal data for one or more processing activities (e.g. informed consent in research, but also for recording events, stimuli recordings etc.).
2. *Performance of a Contract*: The data processing activity is necessary to enter into or perform a contract with the data subject (e.g. processing your CV, salary, pension etc. at MPI).
3. *Legitimate Interest*: Also known as balancing of interest. Is this processing activity necessary for the organization to function? Does the processing activity outweigh any risks to a data subject's rights and freedoms? (e.g. withdrawal of consent in finished research project; always contact privacy@mpi.nl for this)

1.3 What is personal data?

Definition of personal data according to GDPR:
"Personal data can be any information relating to an *identified* or *identifiable natural person* ('data subject'). "

- *Identified natural person*: The person can be clearly determined from the data available
- *Identifiable natural person*: The person can be identified, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person.

*"Personal data is any data which can be **traced back** to a person, such as their name, age, email address, IP address, data that contains audio or video recordings of a person, high-resolution fMRI scans, genetic data."*

General personal data (all data a person produces)

- name and surname;
- home address;
- email address such as name.surname@company.com;
- identification card number;
- location data (for example the location data function on a mobile phone);
- an Internet Protocol (IP) address;
- a cookie ID;
- the advertising identifier of your phone;

Sensitive personal data

Sensitive personal data are special kinds of personal data which need a high level of protection, because a data leak could cause the person involved harm on many levels. When processing these kinds of data, some additional measures need to be taken. Please contact privacy@mpi.nl for help

- racial or ethnic origin (NOT nationality)
- political opinions
- religious or philosophical beliefs
- trade union membership
- health
- sex life
- genetic data
- biometric data for the purpose of uniquely identifying a natural person

1.4 Data breach

A data breach is a security breach leading to the destruction, loss or alteration of personal data, or to the unauthorized disclosure of, or access to personal data. At MPI,

that personal data can concern your own personal data, as well as that of colleagues, externals and participants.

Examples:

- loss/theft of an external hard drive (USB stick, SSD cards etc.) with work-related information
- loss/theft of PC/laptop/phone with work-related information
- being hacked
- phishing mail attack
- writing down passwords, losing them
- not using bcc in an open email list
- *...*

Why report this?

As company we are legally obliged to report data breaches to the authorities within a limited amount of time, within 72 hours of the breach. If we do not report there is a high risk of being fined.

If you suspect a data breach, we need to inform the legal team of the MPG, who will run an internal assessment to determine whether the violation is likely to pose a risk to the rights and freedoms of the individuals concerned. If there is indeed a risk the MPG will file a report to the supervisory authority.

In addition, if the risk for the rights and freedoms of the concerned individuals is high and if none of the legally standard exceptions apply, we will also have to inform them of the breach.

What to do?

In case of a breach contact data-breach@mpg.de and privacy@mpi.nl right away (within 72 hours of the breach!). It will help if you already fill in the data breach notification form on Maxintra: https://maxintra.mpi.nl/data-protection/data-breach.

1.5 Rights of the data subject

In addition, according to GDPR (https://gdpr-info.eu/chapter-3/; articles 12-23), every data subject has specific rights concerning their personal data. Every entity processing personal data, is legally obliged to accommodate these inquiries by the data subject within in a short amount of time:

- Right to revoke consent (Informed consent)
- ***Right to information*** (what data is stored where, how long..etc)
- Right to correction
- Right to deletion
- Right to data portability (receive a digital copy)
- Right to file a complaint with the supervisory authority

Please always contact privacy@mpi.nl if a data subject expresses the wish to act upon the rights described above.

Right to information (art.13 GDPR)

Some of the above described rights require the data subject to take action, but the right to information is actually a right in which we proactively have to provide information to the data subject. The following information **always** has to be provided when processing personal data:

- Identity and contact details of the controller and the data protection officer
- Purpose of the processing
- Legal basis of the processing
- Recipients
- Storage period, or the criteria used to determine that period;
- Details of intended transfers into third countries (outside EU/EEA)
- Comments on all other rights of the data subject
- When collecting data from third parties: source of data

Examples

- Study information sheets and informed consent procedures
- All online registration procedures (signing up for studies, newsletters, event registrations, making an account on platforms etc.)
- Website information (privacy policy)
- Video surveillance information
- Guest contracts
- Job applications
- ...etc.

Please ask privacy@mpi.nl for the most recent templates.

2. Index of Procedures

According to GDPR, every organization is required to document all data processing activities carried out in the organization. At MPI, this is done in the Index of "Data Processing Procedures (hereafter, the Index)". Every employee who is, or is planning to process personal data that does not fall under the categories already in the Index, has to schedule an appointment with the Data Protection Coordinator of the Institute. Please contact privacy@mpi.nl to assess whether the planned data processing activity is new.

3. Personal Data & Research

3.1 Participant data

As mentioned earlier ("*What is personal data?*"), some types of research data falls under the category of personal data, meaning that if combined, it contains identifiable information about a participant. However, some types of data are personal by nature (audio, video, imaging data). Here a list of types of data one usually encounters in research that fall under either of these categories:

- contact data of participants (should only be kept in our participant database)
- audio recordings
- video recordings
- genetic data (sensitive personal data)
- imaging data (fMRI head scans etc.)
- health information (sensitive personal data)
- birth dates

Examples for online studies

- IP addresses, contact data, financial information for payment, questionnaires containing health related data (speech, hearing etc.)
- and more: if you are uncertain, please contact privacy@mpi.nl

Sensitive personal data of participants

In addition to "ordinary" personal data, there is also "special" personal data as mentioned above, for example, information concerning someone's political preferences, race, health or sexual orientation. If you are currently processing or plan to collect this kind of sensitive information please contact privacy@mpi.nl.

3.2 Stimulus recordings

When video- and or audio recording an individual (e.g. employee, colleague, external person) you will need their written consent to use the recordings. Contact privacy@mpi.nl for a template consent form.

3.3 Research tools

As company we are legally obliged to enter into an agreement with a software or service provider in case personal data processing is involved. Please use the software MPI provides, as this software or services have already been approved. You can find a list here, as well as request form: https://maxintra.mpi.nl/TG/software.
Furthermore, we also have a list of tools for online experiments:
https://maxintra.mpi.nl/research/exp/expfac/online_experiments

3.4 Recruitment

When recruiting participants who are not already in the MPI participant database, always contact: privacy@mpi.nl. There are rules, guidelines and templates. E.g.

- TG can create a specific project-related email address (e.g. *projectname*@mpi.nl); it is prohibited to create private recruitment mailboxes for anything related to research (e.g. NEVER use any other email provider than our own!)
- We have a corporate identity for flyers and posters; always use these for recruitment Please contact our Communications team for help and questions

communications@mpi.nl ;https://maxintra.mpi.nl/operations/information-from-a-to-z/corporate-identity

Rules

- Never take any personal data out of the institute. All data should be kept in the designated infrastructure provided by MPI and should not leave the MPI servers. Please contact helpdesk@mpi.nl if you have questions about the infrastructure of your department or group
- Never copy any parts of personal data onto external data storage devices (USB, hard drives, personal laptops, home devices etc.). if, for any reason you have to export personal data, contact privacy@mpi.nl
- If you have personal information on paper, this should be a kept in a designated locker, email privacy@mpi.nl for help
- Personal data on paper should be destroyed by using a GDPR proof shredder (black shredder in the basement, or room 265 (check settings))
- Always use the approved research tools on Maxintra; it is also not allowed to put any personal information from participants on insecure websites (like Google).
- Delete any data that you do not need anymore right away

Links and official GDPR text

Legal text

https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32016R0679&from=EN#d1e40-1-1

Q&A European commission

https://ec.europa.eu/info/law/law-topic/data-protection/reform/what-personal-data_en

https://ec.europa.eu/info/law/law-topic/data-protection/reform/what-constitutes-data-processing_en