**RESEARCH**

# Acquisition of quantifier raising of a universal across an existential: Evidence from German

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Our paper reports an act out task with German 5- and 6-year olds and adults involving doubly-quantified sentences with a universal object and an existential subject. We found that 5- and 6-year olds allow inverse scope in such sentences, while adults do not. Our findings contribute to a growing body of research (e.g. Gualmini et al. 2008; Musolino 2009, etc.) showing that children are more flexible in their scopal considerations than initially proposed by the Isomorphism proposal (Lidz & Musolino 2002; Musolino & Lidz 2006). This result provides support for a theory of German, a "no quantifier raising"-language, in terms of soft violable constraints, or global economy terms (Bobaljik & Wurmbrand 2012), rather than in terms of hard inviolable constraints or rules (Frey 1993). Finally, the results are compatible with Reinhart's (2004) hypothesis that children do not perform global interface economy considerations due to the increased processing associated with it.

**Keywords:** quantifier raising; language development; inverse scope reading; German language; interface economy

## 1 Introduction

This paper contributes to our understanding of the grammatical and cognitive factors that underlie pre-schoolers' and adults' interpretation of quantifier scope, and its implications for our theoretical understanding of language development.

We will investigate here quantifier raising, as involved in sentences with an indefinite subject and a universal object as the classic example discussed by Hirschbühler (1982) in (1). In such sentences, inverse scope is easily obtained: each building sported its own flag. Overt scope between the indefinite and the universal gives a somewhat unexpected reading that a single flag was hanging in front of the buildings in question.

(1)     An American flag was hanging in front of every building.

It has been established in the 70s and 80s that such inverse scope readings must be accounted for by a covert syntactic movement operation (or its equivalent in related frameworks) – quantifier raising, henceforth QR. It was shown that QR is island-sensitive and it may give rise to semantically distinct readings (see Reinhart 2006 for an overview of the history of QR).

Reinhart (2006) generalised the idea, originally raised by Fox (1995), that even though QR is a covert syntactic operation, its application is restricted by interface considerations. Her position was also qualitatively different from Fox's (2000) position in that she claimed that the question whether an instance of QR was licit cannot be decided locally (see

also Reinhart & Szendrői 2003 for discussion). Rather, a *global* comparison of competing derivations is necessary. This is what she called reference set computation, see (2). In a reference set, utterances are represented as ordered pairs of their syntactic derivation, $D_i$, and their semantic interpretation, $I_j$. The members of a reference set always have identical interpretations. As a result of the comparison between the different members, ones with no covert syntactic operations are favoured over ones with covert syntactic operations.

(2)     Reference set: $\{<D_1, I_1>, <D_2, I_1>, <D_3, I_1>, …\}$
        Interface economy: $<D_i, I_1>$ is excluded as a violation of interface economy if an alternative derivation, $<D_j, I_1>$, exists which employs no covert syntactic operation, like QR.

Let us now turn to German. At first sight it appears that German is qualitatively different from English in that it does not allow inverse scope by QR at all. This was indeed proposed by, for instance, Frey (1993). As (3a) and (3b) illustrate, a universally quantified object cannot take scope over an existential subject in embedded clauses, or in V2 clauses, respectively (taken from Krifka 1998: 77).[1]

(3)     a.     WEIL   mindestens   ein   Student   jeden   Roman   gelesen   hat
               since   at.least      one   student   every   novel    read      has
               'since at least one student read every novel.'          ∃›∀; *∀›∃

        b.     Mindestens   ein   Student   HAT   jeden   Roman   gelesen.
               at.least       one   student   has   every   novel    read
               'At least one student read every novel.'          ∃›∀; *∀›∃

Bobaljik & Wurmbrand (2012) proposed a different explanation for the lack of availability of inverse scope in sentences like (3). In the spirit of Reinhart's (2006) interface economy, they proposed that a soft constraint called *Scope Transparency (ScoT)* prevents scope reversal at LF by QR:

(4)     *Scope Transparency (ScoT)*:
        If the order of A and B is A›B at LF, then A›B at PF.

Just like Reinhart's reference set computation, this constraint will favour a variant of the utterance that has overt scope over one that has inverse scope. They argue, since in German, unlike in English, objects can scramble over subjects, a derivation that expresses distributive scope and shares the same numeration is actually available in overt syntax. This blocks the application of covert scope reversal in German.

(5)     [jeden Roman]   hat   mindestens   ein   Schüler   $t_{DP}$   gelesen
        [every novel]    has   at.least      one   pupil     $t_{DP}$   read
        'at least one pupil read every novel.'          ∀›∃

So, QR is more restricted in German than it is in English. It is disallowed in cases the overt scrambling variant of the utterance is available. However, if an independent syntactic constraint blocks overt scrambling, inverse scope can be obtained, just like in English.

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[1] Note, however, that this is only true under neutral intonation, as indicated. Inverse scope is possible under what Krifka (1998) has called the rise-fall contour characteristic of clauses involving contrastive topics. We will put such data on the side here.

In addition, Szendrői (2012) argued that not only the scrambling variant can act as a blocker, but also the passive variant of actives sentences. She showed that the passivisability of a particular sentence influences the availability of the inverse scope reading obtained by quantifier raising. In particular, her findings showed that in a forced choice study, participants considered the inverse scope reading obtained by quantifier raising in a higher proportion of cases if the sentence in question did not have a passive variant (due to the fact that the verb in question was non passivisable). We will return to the question of passives as blockers in the Discussion.

Let us now turn to the availability of inverse scope readings in child language. In a series of experiments Musolino (1998), Lidz & Musolino (2002) and Musolino & Lidz (2006) have found that children are reluctant to assign inverse scope to utterances involving a quantifier (existential, numeral or universal) and negation, such as (6). In all these cases the preferred, or often the only interpretation children assigned were the overt scope readings, as indicated. In other words, children show a strong preference for scopal relations at LF that are isomorphic to the c-command relations in surface syntax. Consequently, this has been termed, the Isomorphism Effect.

(6)     a.    The detective didn't find some guys.          neg > exist
        b.    The Smurf did not catch two birds.           neg > num
        c.    Every horse didn't jump over the fence.      univ > neg

This Isomorphism preference on the part of children, can then be thought of as a strong manifestation of Bobaljik & Wurmbrand's (2012) *ScoT*. It is possible that children fail to access the inverse scope reading because they simply do not consider the possibility that a pair of quantificational elements may take scope in a way that is not reflected by their surface syntactic relation.

But there are findings that cast doubt on this literal interpretation of the Isomorphism Effect in children's interpretation of doubly quantified sentences. Gualmini et al. (2008) were the first to notice that information structuring can alleviate children's reluctance to assign inverse scope in sentences like (6). They argued that children can indeed access inverse scope if the reading with inverse scope provides an appropriate answer to what they called the "question under discussion". In particular when the expectation is built up that the Troll should deliver all the pizzas, and he ends up delivering two, but loses two, children were no longer unable to access the inverse scope reading of *The Troll didn't deliver some/two pizzas*. In the experiment with *some*, children's inverse scope responses jumped from 50% in Musolino (1998) to 90% in Gualmini's (2004) experiment. In the experiment with *two*, children's inverse scope responses jumped from 50% in Musolino (1998) and 33% in Lidz & Musolino (2002), to 75% in Gualmini's (2004) experiment.

Gualmini et al. (2008) argued that this substantial improvement occurred because the expectations of the situation make the question "Will the Troll deliver all the pizzas?" highly accessible, and the inverse scope reading (i.e. two/some pizzas were not delivered) is a more appropriate answer to this question than the overt scope reading (i.e. the Troll didn't deliver any/(at least) two pizzas). So, children do appear to consider inverse scope when the information-structure requirements of the story require them to do so.

But these experiments all involved scopal ambiguities with negation. There are two reasons why this is important to note. On a theoretical level, it is not clear that such sentences involve the syntactic operation of quantifier raising of the lower quantifier over the higher one. In the case of existentials, such as (6a), Reinhart (2006) has explicitly argued that no quantifier raising is involved. Rather, wide scope of indefinites utilises a different theoretical construct in the semantic computation: choice

functions. So, these experiments do not tell us whether children can entertain inverse scope by quantifier raising. Crucially, there is in fact independent supporting evidence for the availability of the QR operation in antecedent contained deletion, where it is syntactically necessary, but it is not motivated by the necessity to derive a different scopal reading (Syrett & Lidz 2009).

So, in this paper we sought to find out if children can entertain inverse scope when it is obtained by quantifier raising. If we find that they do, that would support the availability of quantifier raising in their grammar (Syrett & Lidz 2009), and demonstrate their ability to use it to derive inverse scope. This result would not be compatible with Musolino & Lidz's (2002) and Lidz & Musolino's (2006) *Observation of Isomorphism*, found in some earlier studies for scopal relations involving negation, but it would support Gualmini et al.'s (2008) position that inverse scope is generally available in child language.

We performed our study in German, a language that hardly ever allows inverse scope by quantifier raising. It has been proposed by Frey (1993) that in German a hard inviolable constraint blocks the availability of quantifier raising in such examples, with the effect that inverse scope is not available to native speakers. In contrast, Bobaljik & Wurmbrand (2012) and Reinhart (2006) argued that quantifier raising is available as an operation, but its application is blocked if an alternative derivation is possible without covert movement. Since in German an overt scrambling structure (or a passive) is almost always available, inverse scope by quantifier raising will be effectively blocked for German adult speakers. As a result, it is almost impossible to make empirical predictions that distinguish Frey's hard constraint view from Bobaljik & Wurmbrand's soft constraint view (although see Bobaljik & Wurmbrand 2012 for some compelling examples).

But we may be able to make differing predictions for children. Reinhart (2004) presented a compelling case for a special status of interface economy in children. Specifically, she proposed that pre-schoolers find it hard to carry out cross-derivational comparisons. They would need to create an alternative derivation (i.e. the passive alternant or the scrambling one), compare it with the inverse scope reading of the original derivation and exclude inverse scope on those grounds. She conjectured that their immature working memory capacity makes it impossible for them to carry out this computation. There are other areas where pre-schoolers behave differently from adults. For instance, they are reluctant to perform scalar implicatures, and entertain the logico-semantic reading instead (Chierchia et al. 2001; 2004; Noveck 2001; Papafragou & Musolino 2003; Pouscoulos et al. 2007; Foppolo et al. 2012; Huang, Spelke & Snedeker 2013; but cf. Katsos & Bishop 2011). In judgment tasks involving the operator *only* and marked focal stress, they resort to a default interpretation ignoring the stress shift (Gualmini et al. 2003; Costa & Szendrői 2004; Szendrői 2004). Reinhart (2004) proposed that all these areas require comparisons with alternative derivations, which she argued would be too taxing for pre-schoolers. Although it is not entirely clear what is precisely too taxing for pre-schoolers, retrieving the alternatives, keeping the target utterance and alternatives in their working memory, or comparing them, the evidence overwhelmingly supports the generalisation that pre-schoolers normally do not engage in cross-derivational comparisons even if they appear to be able to do so in some specific experimental setups (e.g. Katsos & Bishop 2011).

As for the status of QR in children, in our view, Reinhart drew the wrong conclusions, because they were based on false premises. Specifically, Reinhart (2006: 105) regarded QR as an "illicit operation". For this reason, she proposed that children will not consider it unless they are forced to do so by context. Consequently, she expected that children would initially only entertain overt scope, which was supported by initial evidence in the area (cf. the early Isomorphism view, Lidz & Musolino 2002; Musolino & Lidz 2006). But if one regards QR as a simple grammatical movement operation, albeit a covert one, then

there is no reason to expect that it would be absent from children's grammar. In fact, the Continuity Assumption (Crain 1991, 2002) would dictate that if children are able to apply a movement operation to obtain scope reversal overtly, they will also apply it covertly sometimes, just like adults do. So, on this view, one would expect that QR is available in child language from an early age. As already noted, there is in fact independent supporting evidence for the availability of the QR operation in antecedent contained deletion, where it is syntactically necessary, but it is not motivated by the necessity to derive a different scopal reading (Syrett & Lidz 2009).

If so, this would mean that faced with inverse scope obtained by QR, young children would fail to perform the interface economy computations that would (potentially) exclude such utterances. Consequently, it follows that the prediction based on Reinhart's (2004) proposal is that children should initially fail to exclude the inverse scope reading that adults disprefer. So, on this view, it is expected that German (and English) children should allow QR to apply more freely than German (or English) adults do – the direct opposite of the original Isomorphism idea. In contrast, on Frey's hard constraint view, children are supposed to behave like adults and reject inverse scope, as there is ample evidence in their linguistic input showing that inverse scope is disallowed in German (under neutral intonation).

## 2 The experiment

Our research question was the following. Given that children have quantifier raising as a syntactic operation in their grammatical inventory (Syrett & Lidz 2009), can they use it to derive inverse scope? We tested children and adults in German, where Frey argued for a blanket ban on inverse scope by quantifier raising, while the prediction based on Bobaljik & Wurmbrand (2011) and Reinhart (2004) is that children will be more flexible than adults, and will allow inverse scope by quantifier raising.

### 2.1 The task

We chose to perform an act out task. The advantage of this task is that it gives direct confirmation of the availability of a particular reading. Specifically, for our example test item in (7), if the child acts out a scenario where the giraffes are fed by different zookeepers, we have strong evidence that they entertain the inverse scope reading. The disadvantage of this task is that it potentially underestimates the availability of inverse scope for children. First, if the child entertains both the overt and the inverse scope reading for our test sentences, there may be independent reasons why (s)he chooses to act out the overt scope reading. So, we cannot strictly speaking conclude anything from overt scope act outs with regard to the availability of the inverse scope reading. Second, given that our test sentences involve an existential subject and a universal object there is in fact an entailment relation between the overt scope reading and the inverse scope reading. (This is not the case for experiments testing sentences involving negation. This is specific for our test sentences.) Specifically, children might have the inverse scope reading in mind and yet perform an act out involving a single zookeeper. This, of course, is the act out that is also consistent with the overt scope construal of the test item. So again, we might underestimate children's willingness to entertain the inverse scope reading.

(7)     Test item:          A zookeeper fed every giraffe.
        Overt scope:        There is a zookeeper that fed every giraffe.
        Inverse scope:      For every giraffe there is a zookeeper that fed it.

Given that psycholinguistic experiments have shown that adults rarely entertain inverse scope in null contexts (see Anderson 2004 and references therein), we designed a scenario that would support the inverse scope reading of our test utterances. We relied on two

factors. First, as Gualmini et al. (2008) identified, children entertain inverse scope with respect to negation if the reading with inverse scope provides an appropriate answer to the *Question Under Discussion* (QUD), while the reading with overt scope does not. For our test items, exemplified in (7), this meant that the question under consideration should be something like (8b) rather than (8a).[2]

(8)     a.    Who fed the giraffes?
        b.    Did every giraffe get fed?

The second factor concerned topic-focus alignment. Saebo (1988) showed that if QR involves movement of a focal constituent across topic, it is ruled out. So, there is no inverse scope reading available in a sentence like (9a). In contrast, quantifier raising of a topical element across a focal one is easy to obtain, as in (9b). For this reason, we made sure in the context story preceding the test sentences that the object quantifier *every giraffe* or at least the group of giraffes was the discourse topic in our scenarios.

(9)     a.    Q: How many meetings did the candidates attend?
              A: $[SEVERAL]_{Topic}$ candidates attended $[EVERY]_{Focus}$ meeting.
        b.    Q: How many candidates attended the meetings?
              A: $[SEVERAL]_{Focus}$ candidates attended $[EVERY]_{Topic}$ meeting.

## 2.2 Participants

Our experiment involved native speakers of German: 20 5-year olds (15 females, mean age: 5;3, age range: 5;1–5;7), 20 6-year olds (10 females, mean age: 6;4, age range: 6;1– 6;11) and 10 adults (8 females; mean age: 23;3, age range: 22–26). The participants were all monolinguals and the adults had no linguistics training. Both children and adults were recruited at the University of Potsdam from the participant pool of the BabyLAB of the Department of Linguistics. One additional 6-year-old participant turned out to be bilingual and was therefore excluded.

## 2.3 Materials

We performed an act out task involving the test condition (n = 6), the control condition (n = 3) and fillers (n = 3). An example of an instruction for the test items is given in (10), while the test item itself is given in (11). A female native speaker experimenter presented the instructions in a neutral, but natural intonation. The test items were pre-recorded with the prosody as indicated, with main stress falling on the lexical item in capitals. So all participants heard the same intonation. A different number of toys were used for the subject (i.e. 4 zookeepers) and the object (i.e. 3 giraffes) in order to avoid a potential exhaustive pairing strategy by the participants (Drozd 2001).

(10)    *Example of Condition ACTIVE*:
        In dieser Geschichte habe ich dir Giraffen mitgebracht. Die Giraffen sind sehr hungrig. Aber alles wird gut, denn hier kommen ein paar Tierpfleger!
        'In this story, there are some giraffes. [experimenter places 3 giraffes on table] The giraffes are very hungry. But all is well, because some zookeepers arrive.' [experimenter places 4 zookeepers on table]

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[2] We note that it is never possible to fully determine the Question Under Discussion by controlling the discourse context. For instance, we cannot exclude the possibility that children considered the QUD to be something like 'What happened with the zookeepers and the giraffes?'. Our hope was to build a discourse context that diminishes the likelihood that participants consider the QUD in (8a).

(11)    Ein Tierpfleger füttert JEDE Giraffe.
        'A zookeeper feeds EVERY giraffe.'

The control condition involved similar instructions, but the control items were different, e.g. (12). They involved passive sentences, e.g. (13). The use of passive sentences was motivated by the fact that such sentences easily receive a distributive scopal interpretation (see Kurtzmann & MacDonald 1984 for experimental data on English) with the universal taking scope over the existential in the *by*-phrase. But this distributive reading arises without quantifier raising. Since adults are known to predominantly reject the distributive interpretation for active sentences, we decided to include passive controls to provide an opportunity for them to assign a distributive interpretation to some experimental items. We had no reason to think children would behave differently from adults on these utterances.

(12)    *Example of Condition PASSIVE:*
        In dieser Geschichte habe ich dir ein paar Windräder mitgebracht. Die
        Windräder sind leider kaputt gegangen. Aber alles wird gut, denn hier
        kommen ein paar Frauen!
        'In this story, I have some pinwheels. [experimenter places 3 pinwheels
        on table] The pinwheels are broken. But all is well, because some ladies
        arrive.' [experimenter places 4 ladies on table]

(13)    Jedes Windrad   wird   von   einer   FRAU   repariert.
        Every pinwheel  is     by    a       lady    repaired
        'Every pinwheel is fixed by a LADY.'

Our fillers involved simple SVO structures and involved no quantificational elements. We would have excluded any participants with less than two correct fillers, but all participants performed at ceiling on the fillers. An example is given in (14) and (15).

(14)    *Example of Filler:*
        In der nächsten Geschichte haben wir ein paar Ponys. Den Ponys ist sehr
        langweilig. Aber alles wird gut, denn hier kommen ein paar Hunde!
        'In this story, I have here some ponies. [experimenter places 3 ponies on
        table] The ponies are bored. But all is well, because some dogs arrive.'
        [experimenter places 4 dogs on table]

(15)    Der große weiße Hund spielt mit den Ponys.
        'The big white dog plays with the ponies.'

Two of three fillers singled out a specific individual to be used for acting out the event, thus we countered the potential contextual bias that the children might be tempted to act out the experimenter's instructions with more toys, simply because more than one toy was presented to them as potential actor.

### 2.4 Procedure

The items were presented in a within subject design, with all participants seeing all items. The test, control and filler items (n = 12) were pseudo-randomised and two lists were created to control for order effects. The experiment started with a warm up phase where the experimenter explained the task and presented the child with a practice item, which was similar to our fillers. Here the child was explicitly encouraged to manipulate the toys and act out the experimenter's instruction sentence. If it seemed like the child was

comfortable with the task, the experimenter moved on to the test phase. In the test phase, each response was noted down by the experimenter and subsequently coded. The experimental sessions were also video recorded to allow for precise coding of responses.

## 2.5 Results

### 2.5.1 Coding

Let us use our example test item, *A zookeeper fed every giraffe*, to explain our coding. If participants acted out a scenario which involved one single zookeeper and (s)he fed all the giraffes, the response was coded as an overt scope response (O). If more than one zookeepers were involved in the feeding events of the giraffes, then the response was coded as a distributive response (D). (Recall that in the test items, the distributive reading corresponds to inverse scope, while in the controls it is overt scope.) Since there were no incorrect responses (i.e. neither D nor O) the coding yielded a binary dependent variable.

### 2.5.2 Statistics

Figure 1 plots the proportion of distributive responses. The data were analysed using a generalised linear mixed-effects (LME) model in R (R Core Team 2016) with the package lme4 (Bates et al. 2015).

The model we fitted followed the recommendation by Barr et al. (2013) to specify a maximal random effects structure for confirmatory hypothesis testing. Therefore the model contained three random components: two random intercepts (for participants and for items) and an individual adjustment of the condition effect for each participant (random slope). See Appendix 1 for the full model output including the model specification in R. The contrast for Age was set up such that the 6-year-old children are considered as "baseline" in order to be able to compare their performance to that of 5-year-old
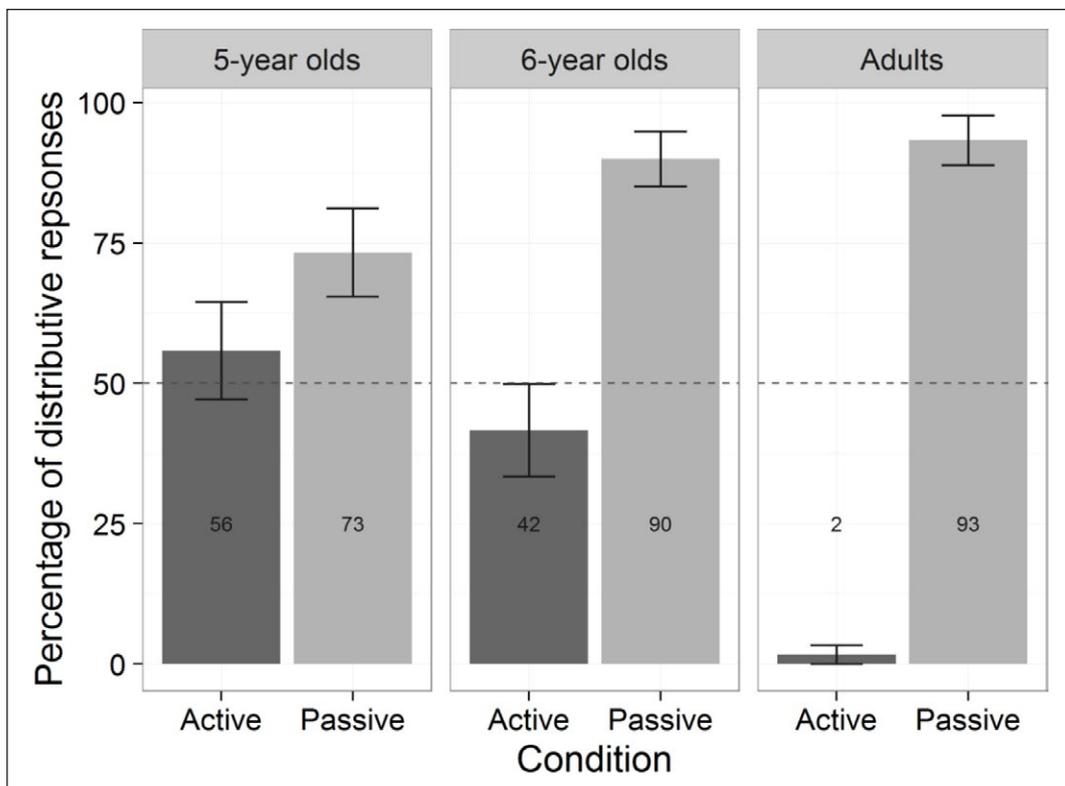


**Figure 1:** Percentage of distributive responses for our test (active) and control (passive) items for 5- and 6-year-old and adult participants (whiskers: +/− 1 standard error).

| Effect | Effect size [log odds] | Effect size [percent] | Standard error | z-value | p-value | Significance level |
|---|---|---|---|---|---|---|
| 6yo: Active (Intercept) | –0.6513 | 42% | 0.6771 | –0.962 | .3361 | |
| 6yo: Passive vs. Active | 4.1199 | 48% | 1.0629 | 3.876 | .0001 | *** |
| Active: 5yo vs. 6yo | 1.2358 | 14% | 0.9279 | 1.332 | .1829 | |
| Active: Adults vs. 6yo | –5.4081 | –40% | 1.6666 | –3.245 | .0012 | ** |
| 5yo vs. 6yo for Passive vs. Active | –2.8607 | –31% | 0.9812 | –2.915 | .0036 | ** |
| Adults vs. 6yo for Passive vs. Active | 5.9567 | 43% | 1.9608 | 3.038 | .0024 | ** |
| *post hoc:* 5yo: Passive vs. Active | 1.2592 | 17% | 0.8183 | 1.539 | .1238 | |

**Table 1:** Output of the statistical model. For each effect the effect size in log odds (from the model) and in percentages are given along with the standard error, z- and p-values and the significance level (* < .05, ** < .01, *** < .001).

children and to that of adults. The contrast for Condition was set up such that ACTIVE (test items) was the 'baseline'.

Because the model uses a binomial link function, the estimates are given in log odds, as illustrated in Table 1. To relate the estimates to the figure we also report the percentage values. The amount of distributive responses for ACTIVE in 6-year-old children is with 42 percent not significantly different from chance, i.e. 50 percent ($p = .336$). The 5-year-old children do not differ from the 6-year olds in the number of distributive responses for ACTIVE ($p = .183$). In contrast, adults give significantly less distributive responses in active sentences than 6-year olds do ($p < .001$). Both groups of children provide significantly more distributive responses in the ACTIVE condition than the adults.[3]

Looking at the factor of Condition for 6-year olds, their proportion of distributive responses to PASSIVE vs. ACTIVE significantly increases ($p < .001$). Compared to this change, the increase in distributive responses to PASSIVE vs. ACTIVE by 5-year-old children is significantly smaller ($p < .01$) whereas that for adults is significantly larger ($p < .01$). So both older age groups, 6-year olds and adults, gave significantly more distributive responses in PASSIVE compared to ACTIVE with the difference between both conditions being even larger in adults than in 6-year olds. For 5-year olds the increase is smaller than in 6-year-old children. However, the model's contrast specification does not allow us to evaluate whether the size of the increase itself is significantly different from zero in 5-year olds. Therefore, we ran another model with a different contrast coding (but the same parameters, see output in Appendix 2). This post hoc comparison revealed that 5-year olds did not give significantly more distributive responses in PASSIVE compared to ACTIVE ($p = .124$).

## 2.6 Discussion

We found that adult participants did not consider the distributive scope reading for our ACTIVE condition. This result is in line with both Frey's hard ban on quantifier raising in German and Bobaljik & Wurmbrand's soft constraint view. Under this latter view, the overt scrambling version (or the passive variant) of the test sentence acts as a blocker, so inverse scope by quantifier raising is ruled out for the ACTIVE items.

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[3] For information, the distribution of individual response patterns was as follows: 25% of 5-year-olds gave 0 or 1 distributive scope responses for our 6 test items, 30% gave 2–4, and 45% gave 5 or 6. The distribution of responses for 6-year olds was 42%, 26% and 31%, respectively. This is not a clearly bimodal pattern.

At the same time, we also found that both 5-year olds and 6-year olds sometimes assign a distributive scope reading for our ACTIVE items, indicating that they allow quantifier raising to take place in such doubly quantified utterances. This finding supports Gualmini et al.'s view that children can entertain inverse scope readings at least in favourable pragmatic contexts, and go against the Observation of Isomorphism (Lidz & Musolino 2002; Musolino & Lidz 2006).

An alternative interpretation of our findings, suggested to us by an anonymous reviewer, is to propose that the discourse context may have forced a distributive scope interpretation for some children despite the fact that distributive scope by quantifier raising is normally unavailable to them. Specifically, the last phrase of the context contains a plural indefinite *ein paar Tierpfleger* 'some zookeepers', and multiple instances of zookeepers are presented to the child. Although we cannot exclude the possibility that these factors may facilitate a distributive reading, we do not think that they invalidate the results for the following reasons.

As far as the presence of multiple zookeepers is concerned in the visual context, we would like to emphasise that we had fillers where the context was the same and the test sentence itself referred to a single individual from that group. This means that children were exposed to the idea that not all the toys on the table must be used for acting out the test sentence. Note also that we do not see how an experimental task that is investigating whether children ever assign a distributive reading could be designed where children are not exposed to multiple potential actors (i.e. zookeepers). So, it seems to us that this issue is to some extent unavoidable.

As far as the presence of a plural indefinite *ein paar Tierpfleger* 'some zookeepers', in the last phrase of the discourse context is concerned, note that the first word of the instruction itself is a singular indefinite, *ein Tierpfleger* 'a zookeeper'. In German, the default interpretation of sentence-initial indefinite singular subject is specific (Diesing 1992). So, just as much as one can claim that a plural indefinite in the context could have induced a distributive interpretation, one can also claim that the indefinite singular subject in the test sentence itself can be seen to have induced an overt scope interpretation, with the noun phrase *ein Tierpfleger* 'a zookeeper' referring to a specific member of the group of zookeepers. It is indeed possible that these factors contributed to whether children chose to act out the distributive reading or the overt scope one, but crucially, it is clear that for such factors to have played a role, the children must have had both readings available to them in the first place.

If children's actions had been forced by the mention of a plural indefinite (*some zookeepers*) despite the fact that they do not have inverse scope by quantifier available to them, then one would have expected that at least some of the children would have acted out the event using more than one zookeeper, but still using a collective action (i.e. the zookeepers as a group feeding the giraffes). No child ever produced such an actout. The children who used more than one zookeeper all acted out the action distributively (i.e. individual zookeepers feeding different giraffes). So, we can conclude that their actouts are actual reflections of a genuine ability to assign inverse scope to our test sentences.

As a final point, we would like to mention that one advantage of our task was that children actually had to act out the events corresponding to their interpretation of the test sentences. This is different from a TVJT or a picture selection task where there are always potential irrelevant reasons why a child might "accidentally" give the correct response, and thus appear to be entertaining the inverse scope reading, while they do not actually do so. In our task, we can be sure that their interpretation was indeed as we assume, because they acted it out themselves.

So, we conclude that our findings indicate that children showed unadultlike scopal flexibility and revealed an ability to assign inverse scope by quantifier raising, supporting Gualmini et al.'s view that children can entertain inverse scope readings at least in favourable pragmatic contexts, and going against the Observation of Isomorphism (Lidz & Musolino 2002; Musolino & Lidz 2006).

In addition to demonstrating children's ability to assign inverse scope by quantifier raising, children's response pattern also presents supporting evidence in favour of Bobaljik & Wurmbrand's (2012) soft constraint view for quantifier raising in German. Both 5- and 6-year-old children entertained the distributive scope reading in ACTIVE items about half the time. Crucially, at least for 6-year-olds, this is clearly a specific reaction to ACTIVE items potentially involving inverse scope by quantifier raising, because they treated PASSIVE control items differently. Facing our results, a proponent of Frey's hard constraint account would have to posit that the hard constraint ruling out QR in German is not yet learnt by 5- and 6-year-old children. Learning such a constraint at such an advanced stage of language acquisition would be fairly implausible. If such a constraint *could* be learnt, it should not be hard to learn it given the overwhelming evidence in its favour in adult language – adults almost never use inverse scope in German. But note that since the resulting adult grammar is less permissive than the posited child grammar, the state-of-affairs represented by our findings constitutes a Subset Problem (Borer & Wexler 1987). As a result, a learning account would have to also explain how children overcome the learnability problem presented by the lack of negative evidence. In other words, how do children come to realise that inverse scope is *not* available in adult German grammar? Thus, overall, both our empirical findings and the theoretical learnability argument favour the position that 5- and 6-year-old children are aware of the soft interface economy constraints governing the scope shifting operation QR, but they fail to compute them.

We follow Reinhart's (2004) proposal that children fail to rule out the inverse scope reading obtained in ACTIVE sentences by quantifier raising, because they are too young to generally engage in cross-derivational comparisons.[4] Although this is consistent with our findings, we should also consider an alternative explanation, namely that children fail to exclude the inverse scope reading in ACTIVE items because of an immature grammar regarding potential blocker items, such as scrambling or passives. This view would still favour Bobaljik & Wurmbrand's soft constraint view over Frey's hard constraint one, but the inability to apply blocking would be attributed to the unavailability of a blocker, rather than to the inability to perform the computation. As far as passives are concerned, other studies indicated mastery of the passive in German by Age 5, while long passives in English did not reach the same level until Age 6 (Aschermann et al. 2004), suggesting that the children we tested should have already mastered the passive.

In this regard children's performance on our PASSIVE control condition is potentially relevant. It is only possible to interpret a passive sentence like our *Every giraffe was fed by a zookeeper* distributively if one syntactically integrates the *by*-phrase, since it is the entity in the *by*-phrase (i.e. zookeeper) which is distributed over, as shown in the paraphrased LF representation given in (16).

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[4] Note that the age at which children start to engage with cross-derivational comparisons varies slightly for different areas of the grammar. It seems earliest in accidental co-reference of pronouns, where they start to behave in an adultlike fashion from Age 6 (see Conroy et al. 2009 for a review). For scalar implicatures, adultlike performance is earlier with numerals than with quantifiers like *some* (Huang, Spelke & Snedeker 2013). It seems that for quantifier raising the age is relatively late; comparable to the findings with scalar implicatures with quantifiers. These differences are presumably due to additional features of these areas over and above the ability to engage in cross-derivational comparisons.

(16)    For every x, if x is a giraffe, then there exists y, where y is a zookeeper and
        x is fed by y.

So, we can conclude that children who entertained the distributive reading in our PASSIVE condition were certainly able to construct passive syntax (with A-movement and the *by*-phrase). (It is possible that the others were too, but they did not demonstrate their syntactic knowledge in this experiment.) This was the case for the majority of our 6-year olds, while there was only a numerical tendency in 5-year olds (=73%, see Figure 1). So, at least for 6-year olds, we can conclude that they are in command of passive utterances, so to the extent that passives are appropriate blockers for inverse scope in actives, they should be able to use them if they engage in cross-derivational comparisons.

One could further argue that passives do not act as blockers for active sentences with inverse scope, as Bobaljik & Wurmbrand (2011) did, because the two utterances do not share the same numeration (i.e. lexical array). In that case, the burden of adjudication between the alternative explanations falls on children's acquisition of scrambling structures. The literature on OVS order in German is mixed. Several studies show early, frequent, productive occurrence of OVS orders in young children. For instance, this was demonstrated from CHILDES data of a child aged 2;1–2;6 by Poeppel & Wexler (1993) (see also Weissenborn 1990). Comprehension data, however, reveals that children have problems distinguishing OVS utterances from SVO ones for much longer, with some indications that OVS is in place by Age 5 (Grünloh et al. 2011), or by Age 6 (Schipke et al. 2012), while some studies finding unadultlike comprehension in certain case up to Age 7 (Dittmar et al. 2008). It should be noted that these comprehension studies are of limited relevance as they are on sentences with contrastive focus on the object, which is not our concern here. In any case, early, productive use of OVS scrambling structures, we think, is indicative of the children being in command of the syntax of scrambling. Late comprehension findings might mask that either because they involve contrastive focus, which is independently known to be associated with unadultike comprehension (Gualmini, Maciukaite & Crain 2003; Snedeker & Yuan 2008) or for other reasons (Sauermann & Höhle 2016). So, overall, it is unlikely that children were more permissive regarding inverse scope than adults because of the unavailability of appropriate blocker structures.

Let us now briefly turn to participants' performance on our PASSIVE controls. First, considering Kurtzmann & MacDonald's (1993) findings for English, one would expect that German adults and children would allow both the wide scope indefinite reading and the distributive scope reading for PASSIVE items. For this reason, it was somewhat surprising that both adults and 6-year-olds (with 5-year-olds showing a numerical tendency in the same direction) had a clear preference for the distributive scope reading. Note, however, that an act out task is not suitable for testing whether a speaker allows both readings: if they have a preference for one reading, that would be the one selected, even if they allow the other reading in principle. Post hoc judgments obtained from adult native speakers revealed that the accentuation pattern we used (with accent on the nominal element i.e. *FRAU* in (13)) clearly favours a distributive scope reading. This may well have been a contributing factor as to why the majority of our participants assigned a distributive scope reading to the PASSIVE items. 5-year olds' different performance, then could either be due to their potentially insufficiently stable knowledge of passives, as discussed above, or to their relative difficulties using prosodic information for disambiguation (Gualmini, Maciukaite & Crain 2003; Snedeker & Yuan 2008).

To sum up, we found evidence that 5- and 6-year-old children allow quantifier raising to derive distributive scope in doubly quantified utterances. Our results thus favour Gualmini et al.'s (2008) position that inverse scope, and its underlying mechanisms, such as quantifier

raising, is available to children, over the Observation of Isomorphism (Mussolino & Lidz 2002; Lidz & Mussolino 2006). In addition, the results provide support for Bobaljik and Wurmbrand's economy-based account of QR for German, which purports to account for the lack of inverse scope in German by the soft interface constraint *ScoT*, which penalises non-transparent scope. In their terms, our results indicate that children initially fail to apply *ScoT* in the case of QR (or they do not have the appropriate blockers available to them). Crucially, an alternative account that rules out the existence of inverse scope by QR in German by a hard constraint (e.g. Frey 1993) would face more questions in the light of our data.

## 3 Conclusion

We have seen that German 5- and 6-year olds allow inverse scope interpretations in universal object existential subject sentences, where adults reject it. The results of our act out task contributed to a growing body of research (e.g. Gualmini et al. 2008; Musolino 2009 etc.) showing that children are more flexible in their scopal considerations than initially proposed by the Isomorphism Hypothesis (Lidz & Musolino 2002; Musolino & Lidz 2006). The results also support a theory of German, a 'no QR'-language in terms of soft violable constraints (Bobaljik & Wurmbrand 2011), or global economy terms (Reinhart 2006), rather than in terms of hard inviolable constraints or rules (Frey 1993). Finally, the results are compatible with Reinhart's (2004) hypothesis that children do not perform global interface economy considerations due to the increased processing associated with it.

## Abbreviations

∀›∃ = the universal quantifier takes scope over the existential, ∃›∀ = the existential quantifier takes scope over the universal, neg > exist = the negation takes scope over the existential, neg > num = the negation takes scope over the numeral, univ > neg = the universal quantifier takes scope over the negation, QUD = Question Under Discussion, ScoT = Scope Transparency (soft constraint proposed by Bobaljik & Wurmbrand 2012)

## Additional Files

The additional files for this article can be found as follows:

- **Appendices.** Model output including the model specification for R of both statistical analyses. DOI: https://doi.org/10.5334/gjgl.261.s1
- Open file-repository containing raw/additional materials. DOI: https://doi.org/10.7910/DVN/D6XN9S

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## Competing interests

The authors have no competing interests to declare.

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