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BRIEF RESEARCH REPORT

Ditransitive structures in child language acquisition: An investigation of production and comprehension in children aged five to seven

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Abstract

The aim of the present study was to investigate the acquisition of ditransitive structures beyond production. We conducted an elicitation task (production) and a picture-sentence matching task measuring accuracy and response times (comprehension). We examined German five-to seven-year-old typically developing children and an adult control group. Our data showed quasi-perfect performance in comprehension in adults and in those children who had already mastered ditransitives productively. However, children who had not yet mastered the production of ditransitives showed comprehension abilities preceding production abilities. Unlike adults, in the comprehension task children did not react explicitly before the end of the auditory stimulus.

Keywords: ditransitives; production-comprehension asymmetry; language acquisition; case marking

Introduction

Adult native speakers display a quasi-perfect symmetry between competences in producing and comprehending their mother tongue (Hendriks & Koster, 2010). In language acquisition, there is robust evidence for comprehension of a particular linguistic phenomenon preceding its consistent production (Benedict, 1979; Clark, 1999; Clark & Hecht, 1983; Fenson, Dale, Reznick, Bates, Thal, Pethick, Tomasello, Mervis, & Stiles, 1994). For German language acquisition, research shows that functional categories such as determiners and prepositions are successfully recognized by infants during their first year of life (Höhle & Weissenborn, 2003), whereas these categories are not consistently produced before the age of three (Grimm, Müller, Hamann & Ruigendijk, 2011). This production-comprehension asymmetry has recently been challenged by the findings of a

'reverse asymmetry' in various languages – that is, higher production compared to comprehension levels (Hendriks & Spenader, 2006; Johnson, de Villiers & Seymour, 2004; Pérez-Leroux, 2005; Ünal & Papafragou, 2016), and symmetrical acquisition of both modalities (Ruigendijk, Friedmann, Novogrodsky & Balaban, 2010). Thus, the precise relationship between comprehension and production is still a matter of debate (Azpiroz, Allen, Katsika, & Fernandez, 2019).

Regarding language production, the acquisition process is shaped by phases of non-target-like production (Kauschke, 2012). For diagnostic purposes (e.g., the assessment of developmental language disorders, DLD), it would be valuable to investigate the individual comprehension competences within these non-target-like production phases to evaluate whether knowledge about a particular structure has already been built, although this knowledge may not yet have been transferred to a correctly produced output.

The present study focuses on comprehension and production of ditransitive structures, because long phases of non-target-like production have been documented (Schönenberger, Sterner, & Ruberg, 2011; Scherger, 2015) and comprehension has rarely been investigated so far. In German, ditransitives are characterized by verbs (such as *geben* [to give], *schenken* [to donate/to gift]) selecting a nominative (NOM) subject (SUBJ), a direct object (DO) marked for accusative (ACC), and an indirect object (IO) marked for dative (DAT). Case marking is encoded morphologically, mostly on the determiner, which allows for a relatively free word order (see Example 1).

(1) a. Ich gebe dem Kind die Puppe
I give the-IO-DAT child the-DO-ACC puppet
I give the child the puppet

b. Ich gebe die Puppe dem Kind
I give the-DO-ACC puppet the-IO-DAT child
I give the puppet to the child

Example (1a) illustrates IO-DO word order, which is the most frequent order in child-directed speech (Sauerman & Höhle, 2018) and often the more acceptable word order for adults (Pechmann, Uszkoreit, Engelkamp & Zerbst, 1996). Drenhaus (2004) found word order effects on ditransitive case marking by children aged three to six. They were able to repeat only IO-DO sentences with correct word order and case marking, but not DO-IO. This preference for IO-DO structures was confirmed in cross-linguistic acquisition studies (e.g., for Russian and Ukrainian, see Mykhaylyk, Rodina & Anderssen, 2013).

In languages with more transparent case marking paradigms than German, like e.g., Turkish (see Aksu-Koç, 2010; Rothweiler, Chilla & Babur, 2010), case marking is acquired relatively fast by ages two to three. However, in case systems like e.g., Russian (Janssen, Meir, Baker & Armon-Lotem, 2015) or German (Schulz & Grimm, 2019), case marking is a late acquisition phenomenon. Within the generative paradigm, Woolford (2006) divided case marking in three subcategories: structural, lexical and inherent markings, comprising ditransitives as non-structural and inherent. Scherger (2015, 2018) found that German children reached mastery around age seven with inherent case markings, whereas children aged four showed more difficulties with inherent > lexical > structural markings. However, to date, due to different methodologies used in various studies, no consensus has been reached for age of mastery in German, ranging from 4;6 to nine years in different studies (Grimm & Schulz, 2016; Scherger, 2021; Schmitz, 2006; Ulrich, Berg, Penke, Lüdtke & Motsch, 2016; Ulrich, Thater & Mennicken, 2021).

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Compared to German ditransitives in production, much less is known about comprehension. So far, case marking and word order have been studied only in less complex structures. Dittmar, Abbot-Smith, Lieven, and Tomasello (2008) showed that two- and five-year-old children relied on word order only and did not use case marking to correctly interpret causative sentences. Conversely, seven-year-old children already behaved like adults by relying on case markers over word order when both cues conflicted. Consistent with these findings, Schipke, Knoll, Friederici, and Oberecker (2012) and Brandt, Lieven, and Tomasello (2016) found that only six-year-old children are able to use case marking to some extent for comprehension, whereas younger children fail to do so, relying on word order over case marking in object-initial sentences. For our purposes, therefore, it seems reasonable to examine children from the age of five. Cross-linguistically, the IO-DO preference found in production was reproduced in comprehension (for Japanese, see Sugisaki & Isobe, 2001).

With respect to predictive processing, Altmann and Kamide (1999) were the first to demonstrate anticipatory eye-movements in adults triggered by the verb. Another trigger has shown to be case marking. When hearing the case-marked first nominal phrase (NP), adult native speakers of German anticipated the second NP (Kamide, Scheepers & Altmann, 2003). Regarding German ditransitives, Schlenter (2019) found German adults to anticipate the second object. Mani and Huettig (2012) have shown children by the age of two to be able to anticipate, e.g., the object of a cake, when hearing "the boy eats__". However, a relatively high productive vocabulary size turned out to be a prerequisite for anticipatory eye-movements (see also Borovsky, Elman, & Fernald, 2012, for English children). In the same vein, it has been found for Turkish children that they were able to use nominative and accusative case marking predictively in transitive sentences by the age of four (Özge, Kornfilt, Münster, Knoeferle, Küntay & Snedeker, 2016; Özge, Küntay & Snedeker, 2019). To our knowledge, up to date, there are no studies on predictive processing in children using case marking cues in German ditransitives.

To summarize, the acquisition of comprehension of ditransitives is not yet fully understood. The comprehension of German ditransitives in children has not been investigated – a gap which we attempt to fill.

Research questions

Our main research question was whether comprehension precedes production in the acquisition process of five- to seven-year-old monolingual German children. Therefore, performance in an elicitation task (production) and a picture-sentence matching task (comprehension) was compared in children and young adults. The following research questions (RQs) are of particular interest:

RQ1: Are monolingual German children between age five and seven able to produce ditransitive target-like structures?
RQ2: How accurate are the comprehension abilities regarding ditransitive structures in these children?
RQ3: Is there a production-comprehension asymmetry at this age regarding ditransitive constructions?
RQ4 (provided that comprehension is target-like): Are participants able to anticipate the meaning of the sentence after hearing the first case marker on the direct/indirect object?

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Considering previous findings on the production of dative case marking in ditransitive structures (Scherger, 2015), we expected the younger children in our sample (age: 5-6) to show non-target-like production patterns. Children around the age of seven may have already mastered the production of ditransitive structures. Thus, we hypothesized that not all of the children by the age of five are productively on target yet (**H1**).

According to previous results concerning comprehension preceding production in language acquisition, we expected comprehension to be more advanced compared to production. We expected children to master comprehension of ditransitive structures between age five and seven (**H2**) resulting in comprehension > production performance (**H3**).

Regarding RQ4, in line with previous findings (Mani & Huettig, 2012; Schlenter, 2019), we expected adults and children to anticipate the second object in ditransitives (**H4**).

Methods

Participants

Forty-five TD monolingual German speakers participated in this study. Three children had to be excluded owing to technical problems (*dropout rate* = 6.6%). The final sample consisted of 16 children (8 males) aged 5;9-7;6 (*median* = 6;6 years, *SD* = 0.6) and 26 adults (7 males) aged 19-48 (*median* = 21 years, *SD* = 7.5). Children were recruited from a kindergarten and a primary school's first grade in Lower Saxony, Germany. The children's parents completed a background questionnaire including information on the socio-economic status (SES). All adults were university students and participated voluntarily, optionally receiving a course credit. All participants or their legal guardians provided written informed consent in keeping with the European General Data Protection Regulation.

To exclude children with intellectual and/or language impairments, we conducted a language assessment test (*Sprachstandserhebungstest für Kinder im Alter von 5–10*, SET 5–10, subtests 1, 3, 5, 7, 8; Petermann, 2018), a language assessment screening (non-word repetition task; Grimm & Hübner, in press), and a non-verbal intelligence test (Colored Progressive Matrices [CPM]; Bulheller & Häcker, 2002). Adult participants performed a multiple-choice test and two cloze tests[1] targeting lexical, semantical, syntactical, pragmatical and orthographical knowledge. Furthermore, we controlled for working memory abilities in all participants by assessing forward and backward digit spans (Wechsler Intelligence Scale for Children [WISC V]; Petermann, 2017).

Procedure and stimulus material

We developed an elicitation task for production and a picture-sentence matching task with similar items for comprehension. We especially controlled for animacy and semantic constraints by excluding [-animate] and [+human] objects. Both direct and indirect objects were restricted to animals, so that participants could not use semantic cues for the assignment of thematic roles. Only definite nouns were included in the picture-sentence matching task, because we did not want to cumulate two different

[1]Adaption from the University of Kassel, Germany. Each text contained about 70 words. Every second word's second half was truncated.

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discourse entities that are acquired in a distinct manner (Schulz, 2007; van Hout, Harrigan, & de Villiers, 2010). To control for auditory length, we excluded animal names of more than two syllables. The subject was kept consistent (1st person singular). In the comprehension task, we further controlled for gender by excluding feminine gender, because of the strong masculine nominative bias of the form *der* (which is also feminine dative), to avoid confusions in interpretations. Masculine gender was excluded, because of the low auditory discriminatory potential between accusative *den* and dative *dem*. For not confounding interpretations of phonetic and grammatical processing, we only included neuter nouns. Since reference expression (pronouns vs. full lexical phrases) influences the word order (Sauerman & Höhle, 2018), we excluded pronouns. Finally, to avoid a verb bias, we included only two verbs (*jemandem etwas geben* and *jemandem etwas schenken* 'to give/ to donate something to somebody') that were most likely to be acquired semantically at the age of testing. In order to not confound semantical and structural acquisition, we limited item construction to these two verbs.

Production: Elicitation task

To elicit ditransitive constructions, participants played a card game with three stuffed animals of various genders (*der* Hund-MASC 'the dog', *die* Schnecke-FEM 'the snail', and *das* Schaf-NEUTR 'the sheep'). The game consisted of 27 pictures of various animals. The child/adult participant had to give each animal on the picture to one stuffed animal recipient, while describing his/her action by producing sentences like *Ich gebe das Pferd dem Schaf* 'I give the horse to the sheep'. In order to clarify the task, the experimenter provided two examples prior to the task using IO-DO-sentences beginning with "ich schenke […]" ('I give […]'). In the rare cases in which participants did not produce full sentences on their own, the experimenter intervened with a reminder of the sentence beginning. Since participants were free in their productions, both word orders DO-IO (example 2a) and IO-DO (example 2b) were produced.

(2) a. *Ich schenke* *die Maus* *dem Schaf*
I give the-DO-ACC mouse the-IO-DAT sheep
I give the mouse to the sheep
b. *Ich schenke* *dem Hund* *die Schlange*
I give the-IO-DAT dog the-DO-ACC snake
I give the dog the snake

Comprehension: Picture-sentence matching task

All stimuli were presented on a standard 24" flat-screen desktop computer with Windows 10, 1366*768 pixels resolution, and 60 Hz frame rate. A video, constructed in Microsoft PowerPoint 2016, containing auditory sentence recordings of a male voice, was used for stimulus presentation. All participants were seated at 60 cm viewing distance in front of the monitor, head fixed on a chin-headrest. We presented videos displaying two pictures (size: 408*491 pixels, 100 pixels apart, placed in the middle of the screen on a grey background; see Figure 1). We also tracked eye movements (not reported here). Participants were asked to press one of two buttons on a standard keyboard to choose between left and right as soon as

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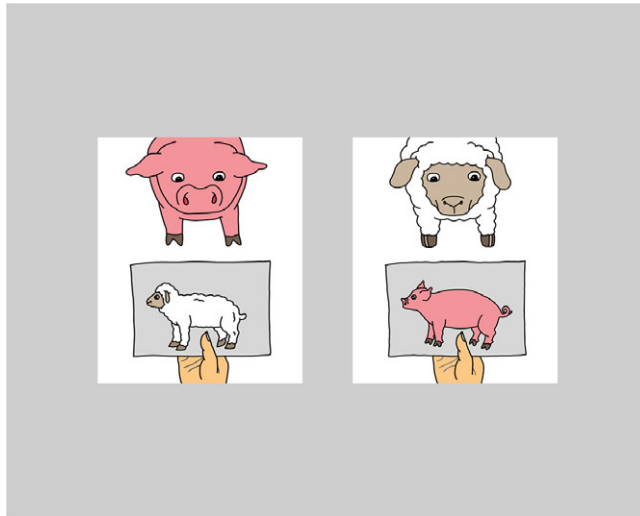

Figure 1. Exemplary item of the picture-sentence matching task. *Ich gebe dem Schwein sicherlich das Schaf,* 'Certainly, I give the sheep to the pig'.

they understood which picture matched the auditory input. The instruction was the same for children as for adults being told to respond as quickly as possible.

For the comprehension task, we added an adverb between the indirect and direct object to provide time to parse the first object and react before hearing the second object (example 3, Figure 1).

(3) *Ich gebe* *dem Schwein* *sicherlich* *das Schaf*
I give the-IO-DAT pig certainly the-DO-ACC sheep
Certainly, I give the sheep to the pig

The experiment contained 58 items for adults and 50 for children. Among those, 20 were ditransitive experimental trials, 30 were unrelated fillers (e.g., *die Katze schläft*, 'the cat is asleep'; *das Dreieck ist blau*, 'the triangle is blue'). For adults, we added 8 ditransitive trials with masculine gender objects (not analyzed here). For children, we extended the response duration by 2 s (i.e., an inter-item interval of 6.5 s). In total, the comprehension task lasted 10 min for adults and around 9 min for children.

Prior to the proper experiment, participants performed four practice trials. The experiment was run with two different lists of pseudorandomized items. The production task was conducted prior to the comprehension task in order to avoid priming effects. Overall, each test session lasted about 60 min for adults and, owing to the more extensive language assessment, 2 x 45 min for children.

Data analysis

For the analysis of the elicitation task, target-like accusative case markings and target-like dative case markings were counted separately to calculate absolute and relative scores. Moreover, word orders (IO-DO, DO-IO) were analyzed separately.

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On average, 3.2% (25/770 in children) and 1.8% (23/1288 in adults) of all produced objects were built with pronouns. Because pronouns have been shown to be acquired earlier than full DPs (Jaeger & Tily, 2011; Scherger, 2016; Tracy, 1990), and to keep the analysis consistent with the one of the comprehension task comprising full lexical DPs only, pronouns were excluded from analysis. Furthermore, we excluded realizations of IOs by prepositional phrases (PP, see Example 4), since these structures do not mandatorily require a dative case marking. The insertion of a preposition within a ditransitive structure changes the licensing of case markings from the inherent v^o to the lexical P^o, going beyond the focus of our study.

(4) *Ich gebe* *das Pferd* *an den Hund*
I give the-DO-ACC horse to the-IO-ACC dog
I give the horse to the dog

Trial removal rates due to PPs were 16.1% in children and 2.6% in adults. Moreover, utterances including verbs other than *geben/schenken* (to give) were excluded from analysis (4 utterances in children, 2 utterances in adults). The remaining amount of analyzed utterances was 903 (309 in children; 594 in adults).

RTs were recorded via the annotation capture plugin of the eye-tracking software Pupil Labs[2] and were operationalized as the interval between auditory presentation of the first case marking and button press for the matching picture.

To assess the relative number of predictions, we followed Schlenter (2019, p. 2) in her assumption that "only effects visible prior to the onset of the critical perceptual input are taken as effects of prediction" in contrast to later effects that may reflect rapid integration rather than prediction. Therefore, we defined the time between the onset of the first object's article and the onset of the second object as the critical window (Figure 2). Responses were marked as *prediction* when the response was made BEFORE auditory onset of the second case marking.

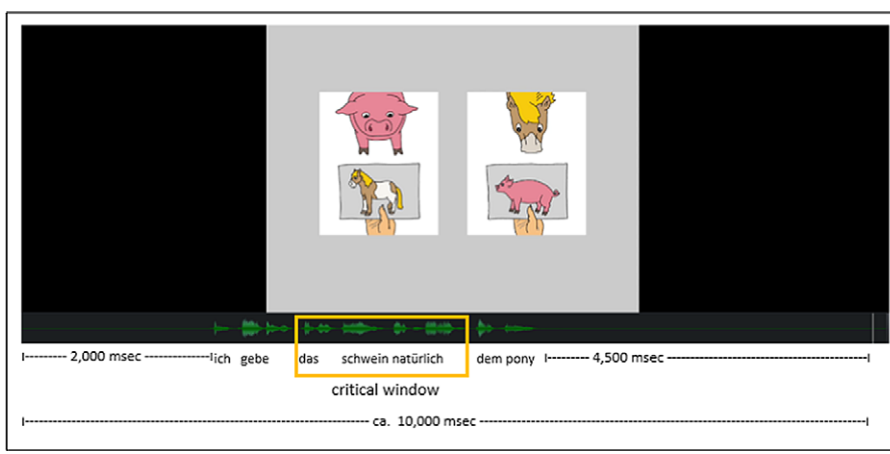

Figure 2. Critical window for anticipating the second object in the exemplary item *Ich gebe das Schwein natürlich dem Pony* 'of course, I give the pig to the pony'.

[2]See https://pupil-labs.com (access date: 2021-09-22).

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Statistical analysis

Data were statistically analyzed using SPSS 24.0.0 for Mac OS (International Business Machines Corp., Armonk, New York, USA) and R for Windows OS (R Core Team, 2017, Version 3.6.3) for the regression analysis (using the package relaimpo; Grömping, 2006). We employed a mixed design with between-subjects factor Group {children, adults} and within-subjects factor Word Order {IO-DO, DO-IO}. RTs and accuracy scores (in percentages) served as dependent variables. For production data, we computed 2 x 2 repeated-measures analyses of variance (ANOVA) with Case {ACC, DAT} as a within-subjects factor and Group {children, adults} as a between-subjects factor. This means that we used either mean RT or the percentage of correct case markings for conditions child-+ACC, child+DAT, adult+ACC, adult+DAT. For comprehension data, we computed a 2 x 2 ANOVA with Word Order as a within-subjects factor and Group as a between-subjects factor. Effect sizes were reported as partial eta squared (η_p^2) for ANOVAs. In a subgroup of children, non-parametrical tests were used for comparison of the means.

Results

All children scored within the normal range in the SET 5–10, with *T*-values between 40 and 80 (*mean* = 57.8, *SD* = 11.2), within normal intellectual ability ranges in the CPM with percentiles between 31 and 100 (*mean* = 55.8, *SD* = 21.4). In adults, German proficiency levels were consistently above 90% (i.e., advanced level). As expected, and most likely due to neurocognitive maturation, digit spans were significantly higher for adults, who scored between 5 and 10 in forward digit spans (DS-FW, *mean* = 6.5, *SD* = 1.1) and between 4 and 8 in backward digit spans (DS-BW, *mean* = 6.1, *SD* = 1.2), than for children (DS-FW: $t(40) = 5.87$, $p < .001$; DS-BW: $t(40) = 8.64$, $p < .001$). Children scored between 3 and 6 in DS-FW (*mean* = 4.7, *SD* = 0.7) and between 2 and 5 in DS-BW (*mean* = 3.2, *SD* = 0.8).

Production

A 2 x 2 repeated-measures ANOVA revealed main effects for Group ($F[1, 40] = 19.33$, $p < .001$, $\eta^2_p = .326$) and Case ($F[1, 40] = 10.98$, $p = .002$, $\eta^2_p = .215$). Most importantly, there was an interaction effect between both factors ($F[1,40] = 15.88$, $p < .001$, $\eta^2_p = .284$). Adults showed no difficulties in producing target-like utterances, mastering accusative markings by 100% (*SD* < .01) and overall dative markings by 99.4% (*SD* = 1.7). This applied for both word orders (DO-IO and IO-DO; see Table 1). However, children showed difficulties with dative case (*mean* = 68.3%, *SD* = 33.2), but not with the accusative (*mean* = 98.8%, *SD* = 2.6). This applied for both word orders. Differences between adults' and children's production were not significant with respect to the accusative ($t(40) = 1.78$, $p = .095$), but significant regarding the dative ($t(40) = 3.30$, $p = .005$).

At this stage of language acquisition, children demonstrated consistent overgeneralizations of the accusative (see Example 5).

(5) a. *Ich schenke* *die Giraffe* *den Hund*
I give the-DO-ACC giraffe the-IO-ACC dog
I give the giraffe to the dog
German target sentence: *ich schenke die Giraffe dem Hund*

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Table 1. Results of the elicited productions (raw scores and percentages correct), divided in overall correct accusative markings and overall correct dative case markings, as well as separate outcomes of the word orders

	IO-DO				DO-IO							
	ACC		DAT		ACC		DAT		Overall correct accusative		Overall correct dative	
Participants	raw	%	raw	%	raw	%	raw	%	raw	%	raw	%
Children	13.2	99.4	9.6	68.8	12.2	98.9	7.8	67.3	25.4	98.8	16.2	68.3
Adults	9.4	100	9.4	100	15.4	100	14.5	98.9	24.8	100	23.8	99.4

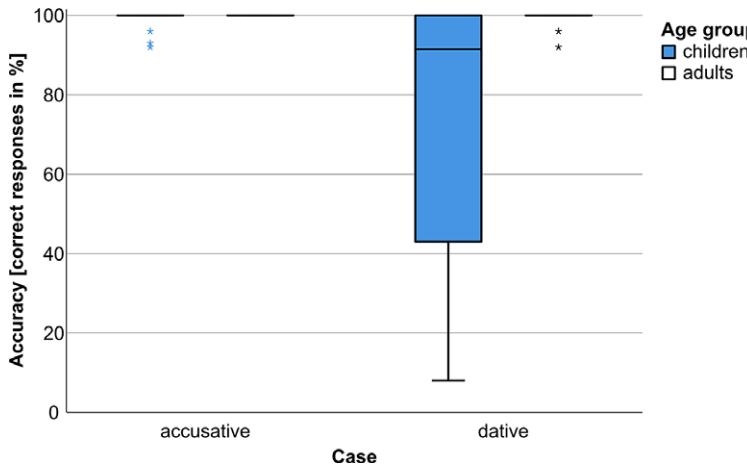

Figure 3. Target-like dative case markings produced by children ($N = 16$) and adults ($N = 26$), split by case. The thick line within the boxplot(s) represents the median.

In sum, as depicted in Figure 3, all children had mastered accusative case marking in ditransitives, whereas there was high variability regarding dative case marking. Adults showed ceiling effects for both.

Comprehension

With respect to comprehension, we identified two children as outliers. Both displayed clear response strategies. Whereas one child consistently interpreted the first object as DO, the other child interpreted the first object as IO, resulting in 100% correct answers in one order and 0% correct in the other. We therefore excluded them from statistical analysis.

A 2 x 2 repeated-measures ANOVA revealed a significant main effect of Group ($F[1, 38] = 31.79$, $p < .001$, $\eta^2_p = .456$) and of Word Order ($F[1, 38] = 4.631$, $p = .038$,

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Table 2. Accuracy in the picture-sentence matching task for comprehension assessment

	IO-DO			DO-IO			Accuracy total		
Group	mean (%)	SD	range (%)	mean (%)	SD	range (%)	mean (%)	SD	range (%)
Children	87.8	13.7	60.0–100	79.1	14.5	50.0–100	83.3	11.9	63.0–100
Adults	97.3	0.06	80.0–100	97.3	0.05	80.0–100	97.3	0.04	90.0–100

$\eta^2_p = .109$). Moreover, a significant interaction effect was observed ($F[1, 38] = 8.60$, $p = .006$, $\eta^2_p = .185$). In contrast to adults, some children showed difficulties with correctly identifying the picture that matched the heard sentence. As Table 2 shows, children performed lower on non-default DO-IO items (*mean* = 79.1% correct selections, *SD* = 14.5) than on default IO-DO (*mean* = 87.8%, *SD* = 13.7, Wilcoxon-test: $z = 2.27$, $p = .023$). As Figure 4 shows, children's overall performance on correctly selecting the matching picture (*mean* = 83.3%, *SD* = 11.9) was less accurate than that of adults (*mean* = 97.3%, *SD* = .04; $t(38) = 4.21$, $p = .001$).

Regarding RTs, a 2 x 2 repeated-measures ANOVA showed main effects of Group ($F[1, 38] = 83.51$, $p < .001$, $\eta^2_p = .687$) and Word Order ($F[1, 38] = 5.27$, $p = .027$, $\eta^2_p = .122$) but no interaction ($F[1, 38] = 1.29$, $p = .262$, $\eta^2_p = .033$). On average, adults reacted about 1.7 s faster than children, and participants responded faster to IO-DO word order than DO-IO, independent of group (see Table 3 and Figure 5).

Regarding anticipation ability, as expected, adults not only responded faster than children on the first case-marking cue they heard, they also responded even before hearing the second case marking in 65.0% of all trials (*SD* = 34.2%), indicating anticipation. In contrast, children responded only after hearing the second object.

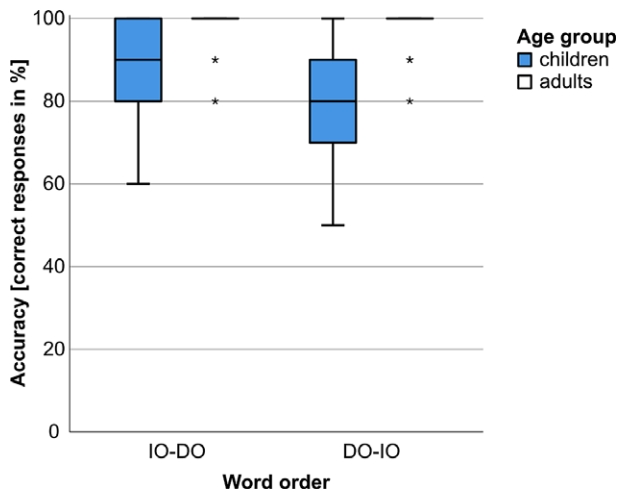

Figure 4. Overall comprehension accuracy in children ($N = 14$) and adults ($N = 26$), split by word order.

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Table 3. Response times (in s) in the picture-sentence matching task

	IO−DO			DO−IO			RTs total		
Participants	mean	SD	range	mean	SD	range	mean	SD	range
Children	3.394	0.558	2.546−4.217	3.431	0.617	2.166−4.629	3.438	0.514	2.484−4.794
Adults	1.631	0.537	0.781−2.578	1.775	0.597	0.943−2.843	1.700	0.561	0.852−2.681

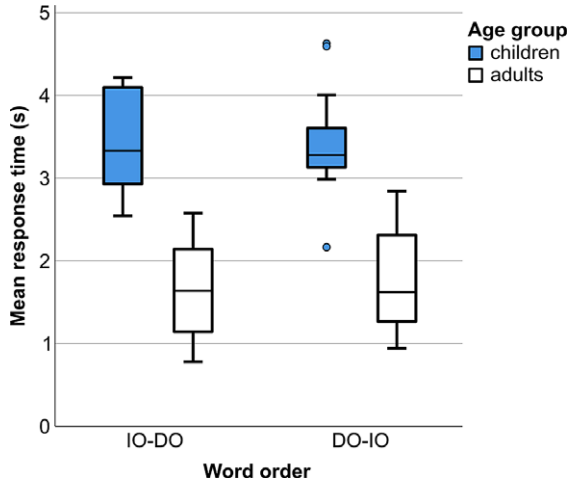

Figure 5. Overall response time (in s) for the comprehension task in children ($N = 14$) and adults ($N = 26$), split by word order.

Production-comprehension (a)symmetry on an individual level

To investigate the production-comprehension (a)symmetry, we compared means of comprehension and production. Since every child had mastered the accusative case marking, we only included the dative in the production performance for this analysis. On average, comprehension accuracy in children (*mean* = 83.3%, *SD* = 11.9) was not significantly above their production levels (*mean* = 68.3%, *SD* = 33.2, Wilcoxon-test: $z = 0.35$, $p = .727$).

Besides overall production and comprehension accuracy in ditransitives, it is of particular interest to compare these abilities in different word orders. A closer exploratory look into the data revealed that most of the variance could be explained by children who had not yet mastered dative production. We therefore split the group of children into those who had already mastered ditransitives in production ($N = 8$ scored > 90%) and those who had not ($N = 6$). Importantly, some five-year-old children outperformed some of the seven-year-olds. Thus, the grouping cannot be attributed to age alone. Figure 6 shows comprehension and production abilities in children. Those who have already mastered production do not show differences between comprehension and production abilities, neither in IO-DO (Wilcoxon-test: $z = 1.83$, $p = .068$) nor in DO-IO (Wilcoxon-test: $z = 1.48$, $p = .138$).

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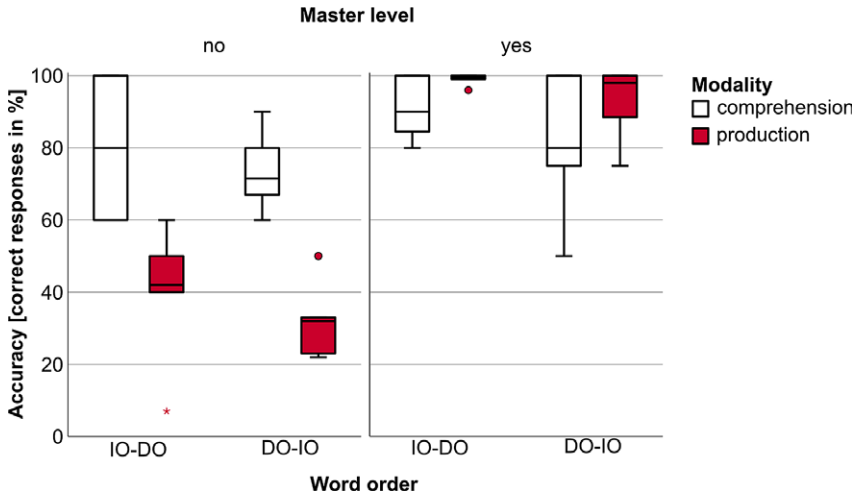

Figure 6. Comprehension and production abilities in word orders IO-DO and DO-IO. The left panel shows six children who had not yet mastered dative case production, the right panel shows eight children who had already mastered it (total $N = 14$).

However, children who had not yet mastered production ($N = 6$, with $N = 2$ outliers excluded, one male) showed differences between comprehension (mean = 80.0%, SD = 16.3) and production (mean = 41.0%, SD = 17.3) in IO-DO (Wilcoxon-test: $z = -2.02$, $p = .043$) and in DO-IO (comprehension mean = 73.4%, SD = 9.6; production mean = 31.5%, SD = 9.2; Wilcoxon-test: $z = 2.03$, $p = .042$). Overall, comprehension abilities were significantly better than production abilities, as supported by a bootstrapping comparison of the means ($N = 1{,}000$ samples, 95%-*CI for the population difference* = [0.17, 0.47], $p = .019$).

Analysis of potential confounding factors for the production of ditransitives

To determine influencing factors and their relative importance for the variability in children's production performance, a mixed-effects regression was calculated. We investigated the explanatory factors comprehension (picture-sentence matching accuracy), age, SES (parents' years of education), and working memory (digit spans), on the response variable production accuracy. Neither the model ($p = .228$, $R^2 = .38$, $R^2_{adjusted} = .15$), nor any predictor reached significance (comprehension: $\beta = 0.97$, $t = 1.921$, $p = .081$, working memory: $\beta = -0.02$, $t = 0.22$, $p = .825$, age: $\beta = 0.01$, $t = 0.72$, $p = .488$, and SES $\beta = 0.04$, $t = 1.12$, $p = .284$). Nevertheless, the four variables explained 37.7% of the productive variance. Comprehension, by far, was the factor with the highest weight; it explained 22.8% of the production variance.

Discussion

This study aimed at illuminating the relationship between comprehension and production abilities regarding ditransitive structures in children between five and seven

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years. Regarding PRODUCTION, performance for dative production was significantly less accurate in children, with accusative production close to ceiling, while adults performed at ceiling regarding both cases. This supports earlier findings showing that accusative is acquired prior to dative in German (Clahsen, 1982; Eisenbeiss, Bartke, & Clahsen, 2006; Scherger, 2015, 2016; Tracy, 1986). Here, half of the tested children had not reached 90% accuracy in dative case production. While neither SES nor working memory nor age explained the variance in production performance, high comprehension ability appears to be the likeliest prerequisite, as was reflected by the highest predictive value of this factor. Note, however, that the regression model's output was not significant, which is why this nominal finding can only be taken as tentative evidence.

It has been argued that dative case marking is subject to language change (DuBois, 2013; Yager, Hellmold, Joo, Putnam, Rossi, Stafford & Salmons, 2015). It is up to future research to identify influencing input factors rather than ascribing the development of case marking abilities to age and maturation alone.

Regarding COMPREHENSION, the investigated children showed an average accuracy of 83.3%, which is below our expectation of performing at ceiling. While adults performed at ceiling in both word orders, children performed less accurately in DO-IO order. This is in line with findings on Japanese (Sugisaki & Isobe, 2001) and could be explained by IO-DO being the preferred word order in child-directed speech (Sauerman & Höhle, 2018). Our findings suggest that the age of five to seven represents a developmental stage during which the comprehension ability for IO-DO word order has already been mastered by most children, while non-canonical DO-IO structures are still more difficult to comprehend. Cross-linguistically, this is in line with the reported preference of IO-DO structures in production studies (Mykhaylyk et al., 2013).

With respect to the RELATION OF PRODUCTION AND COMPREHENSION, we found children to produce some correct ditransitive structures prior to complete mastery of comprehension. This finding agrees with Clark and Hecht's (1983) assumption that comprehension does not need to be fully mastered prior to the start of the productive development. In our data, the difficulties attested in comprehension could be due to task demands. While the act of pointing is not problematic in this procedure, in line with Brandt-Kobele and Höhle (2010), we suggest that storing visual and linguistic information simultaneously, evaluating both information, and finally deciding are additional demands that presumably are not yet fully established in children. This argument is supported by the fact that the prefrontal cortex and its executive functions, including working memory and decision making, are not fully developed until early adulthood (Amlien, Fjell, Tamnes, Grydeland, Krogsrud, Chaplin, Rosa, & Walhovd, 2016; Moriguchi & Hiraki, 2013). It should be noted that the children in Brandt-Kobele and Höhle's study were three to four years old. Our study showed that the described additional requirements of the picture-sentence matching task may still have been too demanding for the ages five to seven. Nevertheless, as the general task demands were held constant across our experimental conditions, the within-group differences cannot be solely explained by age-related neural development. It could also be that the inherent structural complexity of ditransitives masks the children's ability to decode case markings. Therefore, future research should contrast the comprehension within transitive and ditransitive structures within an individual.

In sum, the assumption of a comprehension-production asymmetry can neither be confirmed nor rejected based on our data. Since the age of mastery of dative case marking is still under debate, choosing an appropriate age span for the present study was not easy. Our exploratory analysis of the subsample of six children who had not yet mastered both modalities suggests comprehension preceding production for ditransitives. This would be in line with research stating that comprehension precedes production (Clark & Hecht, 1983; Fenson et al., 1994).

Regarding PREDICTION, only adult speakers predicted upcoming input explicitly. This evidences the incrementality of language processing, "that comprehending utterances involves the continuous mapping of incoming items onto mental representations under construction" (Kamide, 2008, p. 648). The investigated children did not respond prior to the second case-marked object. Although this could be taken as evidence for lower predictive ability, the slow RTs in our children could also be explained by the developmental stage of their central nervous system. While the precentral gyrus, which is responsible for the execution of voluntary movements, should already have reached maturity by this age, the prefrontal regions, which are responsible for decision making and keeping the task and current auditory stimulus active, are still underdeveloped (Amlien et al., 2016; Gogtay, Giedd, Lusk, Hayashi, Greenstein, Vaituzis, Nugent, Herman, Clasen, Toga, Rapoport & Thompson, 2004). Besides these executive functions, coordinating the decision making and the response preparation are involved as potentially challenging requirements. Studies employing measurements with higher temporal resolution did report anticipatory abilities and incremental parsing in children age 4 to 5 (Huang, Zheng, Meng & Snedeker, 2013; Omaki & Lidz, 2015; Özge et al., 2016). Thus, the conclusion of an overall absence of predictive abilities based on the current operationalization of prediction (button press) would be too narrow. More implicit measures, such as glances towards the target, could reveal covert predictive behavior.

Concluding remarks and limitations

Our data indicate a production-comprehension symmetry in adult native speakers and children who already mastered ditransitives in German productively, and a production-comprehension asymmetry in children who had not yet reached mastery of ditransitives in production. Production does not precede comprehension of ditransitives. Moreover, our findings contribute to cross-linguistic research, as Turkish children do not seem to have long-lasting difficulties with comprehension (Özge et al., 2016), in contrast to German children who struggle with comprehension up until the age of seven in our study, perhaps because of the fusional German morphology in which case interacts with gender. Therefore, the acquisition of ditransitives seems to be language-specific. For future research, the comprehension and production abilities in impaired language acquisition would be of interest as well as the development of comprehension measures that allow for differentiation between DLD and TD, even though children of both populations show similar difficulties in production by this age.

We are aware of the fact that small samples can distort the results, because outliers have a greater influence in small samples or may not even be discoverable as such (e.g., Leppink, Winston, & O`Sullivan, 2016). However, statistical significance reached with small samples should not be underestimated, as such findings can be due to large true effects in the population (Friston, 2012). We would therefore like to highlight the

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differences between comprehension and production in the subsample of children, who had not yet mastered production. At the same time, we emphasize the need to replicate our findings with a larger sample size and with other verbs as well as masculine and feminine gender.

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