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Ina Lehmkuhle* and Josefin Lindgren

# Connectives in written narratives by German-speaking children in fourth grade and adults

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**Abstract:** Connectives are a central means for creating a coherent discourse. The relationships between specific connectives, coherence relations and syntactic relations are complex for children to acquire. In this paper, we systematically compare the use of clause-initial connectives in written narratives by German-speaking children in fourth grade (10-year-olds, $N$ = 32) and adults ($N$ = 52). The overall use of connectives, the types of syntactic relations and coherence relations expressed and the connective types used as well as the relationships between syntactic relations, coherence relations and connective types are analysed. The results show that the groups expressed coherence relations with connectives equally often. Additive relations were the most frequent in both groups, but the children expressed temporal relations more often than the adults, who showed a larger diversity in the types of coherence relations. There was no difference in the overall use of subordination and coordination, but the adults expressed temporal relations more frequently with subordination. The children used adverbs to a greater extent than the adults. The connective *da* 'then' played an important role in the children's expression of temporal relations, whereas the adults used a wider variety of different connectives to express different types of temporal relations. The results suggest that children in the fourth grade have not yet fully acquired an adultlike use of connectives in written narratives.

**Keywords:** coherence relations; connectives; German; primary school children; written narratives

## 1 Introduction

Connectives are a central means for creating a coherent discourse. They explicitly mark semantic relations – called coherence relations – between clauses. Using a

***Corresponding author: Ina Lehmkuhle**, Osnabrück University, Osnabrück, Germany,
E-mail: ina.lehmkuhle@uni-osnabrueck.de. https://orcid.org/0000-0003-0028-7972
**Josefin Lindgren,** Uppsala University, Uppsala, Sweden, E-mail: josefin.lindgren@nordiska.uu.se. https://orcid.org/0000-0003-3995-8315

wide range of specific connectives in different syntactic constructions to mark different types of coherence relations contribute to making a text or a piece of oral discourse both engaging and easy for the reader/listener to follow. In order to be able to present a variety of content in different oral and written contexts – something that is crucial for success at school and for participation in society at large – children have to learn how to use connectives appropriately. To provide children with support in their process of developing oral and written language skills, we thus need to know how they acquire and use connectives. The interplay between specific connectives, coherence relations and syntactic relations is complex and therefore not easy to acquire, meaning that this process extends well beyond the early childhood and continues throughout the school years. When specific coherence relations are first acquired and expressed by young children in spontaneous speech has been investigated for a relatively large number of different languages. In contrast, how primary school children learn to handle this complex interplay when they write texts still needs to be systematically investigated. In this study, we analyse German-speaking 10-year-old children's use of connectives in written narratives in comparison to an adult control group.

The paper proceeds as follows. In Section 2, we describe connectives, syntactic relations and coherence relations (2.1), and summarize previous studies on the acquisition of the use of connectives (2.2). In Section 3, we present the research questions of the present study. Section 4 covers the method of the study. In Section 5, we present the results. The paper ends with a general discussion and conclusion (Section 6).

# 2 Background

## 2.1 Connectives, syntactic relations and coherence relations

Connectives are expressions that belong to different parts of speech (e.g. conjunctions, subjunctions, adverbs) and express specific semantic relations between two propositional structures usually expressed as clauses (Breindl et al. 2014: 14). These specific semantic relations thus concern the meaning relationships between one proposition and another. They are also termed *coherence relations* (e.g. Sanders et al. 1993), and "[a] defining characteristic for these relations is that the interpretation of the related segments needs to provide more information than is provided by the sum of the segments taken in isolation" (Sanders and Pander Maat 2006: 593). A coherence relation therefore provides information about the specific meaning relationship in which the two propositions stand to each other. Connectives differ in terms of the specific coherence relation they express. For example, additive connectives (1a)[1] like *und* 'and' link two equivalent propositions, i.e. both propositions are independent of each other, whereas temporal connectives like *als* 'when' (1b) or *dann* 'when' (1c) serve to position a situation in time by relating it to a time interval given by the temporal extension of another situation (Breindl et al. 2014). Sanders et al. (1992) propose a cognitive approach to coherence relations where coherence relations are seen as cognitive relations that can be described via a taxonomy ranging from low to high complexity. Evidence from a study by Spooren and Sanders (2008) lends support to the hypothesis that the order of acquisition of coherence relations by children can be predicted by their relative complexity. Thus, different coherence relations and the connectives used to express them cannot be assumed to be equivalent in terms of their cognitive complexity, which makes connectives an interesting topic for language acquisition studies.

Coherence relations can be marked explicitly with connectives but can also be implicit (Sanders and Pander Maat 2006), as in (1d). Implicit relations are more difficult to identify than explicit ones, i.e. the difference between no coherence relation and an implicit one is not clear-cut. The classification of implicit relations is also more open to subjective interpretations, since their interpretations are based on world knowledge and language experience, which can vary between individual speakers and especially between children and adults. Explicit relations, however, can always be identified. In this paper, we therefore focus on those coherence relations that are explicitly marked.

On a syntactic level, coherence relations can be realized with different connective types (conjunctions, subjunctions, adverbs), and the connective type is connected to the type of syntactic relation. While conjunctions (1a) and adverbs (1b) link main clauses (coordination), subjunctions (1c) introduce a subordinate clause (subordination) (Breindl et al. 2014).[2] The choice of a connective type thus determines the syntactic relation expressed, and the other way around.

(1) a. Additive relation (conjunction)
*Das Donnern wird lauter und den beiden Jungs schlottern die Knie.*
the thunder gets louder and the two boys shake the knees
'The thunder gets louder and the two boys' knees shake.' (7A, adult)

1 All examples are taken from the data of the present study (see Section 3). The participant's code is given in brackets after the example together with information about the participant's group (adult, child).

2 Breindl et al. (2014) in fact propose a classification system which distinguishes between coordination and parataxis: Conjunctions juxtapose main clauses (coordination) and adverbs connect main clauses paratactically. However, in line with previous studies of German connectives (e.g. Binanzer and Langlotz 2019), in our study, conjunctions and adverbs are both classified as cases of coordination.

b. Temporal relation (adverb)
*Die Jungs treten ängstlich ein paar Schritte zurück.*
the boys step fearfully a few steps back
*Dann erkennen sie die Ursache des Donners.*
then realize they the cause of the thunder
'The boys fearfully take a few steps back. Then they realize the cause of the thunder.' (7A, adult)

c. Temporal relation (subjunction)
*Als Bello, Tim, und Max die beiden Geschöpfe sehen,*
when Bello Tim and Max the two creatures see
*erschrecken sie sehr.*
frighten they very
'When Tim, Max and Bello see the two creatures, they become very frightened.' (17B, adult)

d. Additive relation (without connective)
*Sie rannten weg. Bello blieb.*
they ran away Bello stayed
'They ran away. Bello stayed.' (JEFRER, child)

The same type of coherence relation can be expressed using different connective types. For example, temporally related propositions can be linked with an adverb (2a), but can also be expressed in the form of subordination (2b).

(2) a. *Doch erst mal gaben sie Bello etwas zu fressen.*
But first gave they Bello something to eat
*Danach gingen sie in Tims Zimmer.*
afterwards went they into Tim's room
'But first they gave Bello something to eat. Afterwards they went into Tim's room.' (ANSVER, child)

b. *Nach einigen Sekunden bellt Bello ein letztes Mal,*
after a few seconds barks Bello a last time
*bevor er den beiden Jungs hinterhereilt.*
before he the two boys after.hurries
'After a few seconds, Bello barks one last time before hurrying after the two boys.' (69B, adult)

In addition, some connectives are polysemous in terms of the coherence relation they express (Breindl et al. 2014). In German, one of these polysemous connectives is *da* 'then/because', which can express a temporal (3a) as well as a causal (3b) relation.[3]

(3) a. *Max, Bello und Tim stehen unter einer Eiche. Da sieht Max das Schloss.*
Max Bello and Tim stand under an oak then sees Max the castle
'Max, Bello und Tim are standing under an oak tree. Then Max sees the castle.' (ANSEAR, child)

b. *Die Jungen können kaum etwas sehen, da es dunkel ist.*
the boys can barely something see because it dark is
'The boy can barely see anything because it is dark.' (124B, adult)

To acquire an adultlike use of connectives, children need to learn which connective forms are used to express which syntactic relation and coherence relation. This form-function mapping is necessary to use connectives appropriately, i.e. to establish a coherent discourse and thus create a story that is understandable to the recipient (listener/reader). In the following section, we summarize previous research of children's use of connectives in discourse, with a focus on studies of children's narratives.

## 2.2 The acquisition of (the use of) connectives

A number of previous studies have addressed children's acquisition of connectives. The studies have focused on different aspects of the acquisition and use of connectives in different types of discourse. Some studies concentrate on children's comprehension of connectives and coherence relations (Becker et al. 2020; Cain and Nash 2011; Cristante et al. 2020; Dragon et al. 2015; Zufferey et al. 2015). Others deal with the influence of age and input on the acquisition of connectives (Veen et al. 2009, 2013) or analyse connectives in corpora that consist of texts written for primary school children (e.g. Tellings and Penning de Vries 2020). In addition, many studies have investigated young children's use of connectives in spontaneous speech or analysed specific connective forms or coherence relations (e.g. Bartz and Bittner 2018; Bloom et al. 1980; Evers-Vermeul 2005; Evers-Vermeul and Sanders 2009; Rodríguez-Muñoz and Níkleva 2019; Tribushinina et al. 2017; Veen et al. 2009). These studies have found stable patterns with respect to the acquisition order of different types of coherence relations (expressed via connectives) across languages, with additive connectives being the earliest to emerge, followed by temporal ones, and

**3** In addition, *da* can express locality by referring back to a previously mentioned local adverbial (Breindl et al. 2014), e.g. *Als er ankam, gingen sie in eine Höhle. **Da** sahen sie zwei Monster*. 'When he arrived, they went into a cave. **There** they saw two monsters.' (EWRINI, child). In these cases, *da* 'there' is not a connective, and cases with locative *da* are therefore not analysed in the study.

finally more complex types such as causal and adversative connectives (e.g. Bloom et al. 1980). Although some studies have found individual variation in the acquisition route for specific connectives (e.g. Evers-Vermeul and Sanders 2009), more complex connectives, such as causal ones, are always acquired after simpler ones, such as additive ones. At around age 3, children produce basic additive (*and*), adversative (*but*), causal (*because*) and temporal (*then*) connectives in spontaneous speech (e.g. Bloom et al. 1980; Evers-Vermeul and Sanders 2009).

The studies cited above have contributed substantially to our understanding of how children acquire the ability to comprehend and use connectives, but their results do not provide evidence about the acquisition of the complex interplay between connective forms and their syntactic (connective type and syntactic relation) and semantic (coherence relation) functions in specific types of discourse such as narratives, which is the topic of the present study. More relevant to the present study are therefore results from previous research of children's use of connectives in oral and written narratives. A number of studies have investigated children's use of connectives in oral narratives by pre- and primary school children (e.g. Czech 2020; Vermeer 2017; Vion and Colas 2005). A common result is that additive and temporal connectives are frequently produced, whereas other types of coherence relations are less common in children's narratives. There is an increase with age in both the range of coherence relations expressed and in the number of specific connectives used. For example, in their study of oral narratives by French-speaking 7-year-olds, 9-year-olds, and 11-year-olds ($N = 191$), Vion and Colas (2005) found that temporal connectives were the most frequent ones. In their study, *et* 'and' could be coded as temporal connective, whereas this connective is typically only coded as an additive connective, e.g. in the present study, which likely explains why temporal connectives were more frequent than additive in their study. With respect to the development with age, the oldest age group (11-year-olds) used a more diversified set of connectives to express adversative and causal relations. In a study of oral narratives elicited with the use of the frog story (Mayer 1969) from German-speaking 3-year-olds ($N = 12$), 5-year-olds ($N = 11$), and 9-year-olds ($N = 10$) as well as adults ($N = 10$), Czech (2020) analysed coherence relations that were explicitly expressed using connectives.[4] The results showed an increase in the average number of connectives per utterance until age 9. However, significant differences were only found between 3-year-olds and 5-year-olds, and not between the older groups. Czech (2020) also described a number of results that are relevant to our study, but that were not tested statistically. First, regarding the distribution of coherence relations, differences were found between the age groups. While the proportion of additive relations decreased with age, the proportion of temporal relations increased with age in the child group. However, in

4 The data were originally collected by Bamberg (1985).

the adult data, the proportion of temporal relations was lower than that of the 9-year-olds. The adults instead produced a larger proportion of causal and consecutive relations than the 9-years-olds. Second, in all age groups, conjunctions were most frequent, followed by adverbs and subjunctions. However, the proportion of conjunctions continuously decreased as the children got older. Finally, adults used a larger number of different connectives ($N$ = 37) compared to the 3-year-olds ($N$ = 10), 5-year-olds ($N$ = 12) and 9-year-olds ($N$ = 22). These results indicate that, as children grow older, their repertoire of connectives increases, both in terms of specific connectives and syntactic relations and coherence relations. These tentative conclusions still need to be tested statistically. In the present study, statistical comparisons of children and adults are carried out.

Four previous studies have analysed the use of connectives in written narratives by German-speaking children (Augst et al. 2007; Binanzer et al. 2022; Binanzer and Langlotz 2019; Langlotz 2014). None of these studies used inferential statistics to test whether the differences between the different age groups were significant; only descriptive statistics were reported and their results can therefore only be seen as tendencies. Augst et al. (2007) conducted a longitudinal study and elicited a total of three narrative texts from 39 children, one in second grade, one in third grade, and one in fourth, using the same image as stimulus. The texts were collected at the end of each school year. At the end of the first data collection, the average age of the children was 8;8 years. The results show that, first, the children often link clauses with *und dann* ‘and then’, a combination of a conjunction and an adverb, before they begin to use temporal adverbs in isolation. Augst et al. (2007) observe a strong increase from second to fourth grade in the use of *als* ‘when’, which was the most frequent subjunction in their data. They describe this developmental process as a *Zunahme der Syntaktisierung von Zeitlichkeit* ‘increase of the syntactization of temporality’ (Augst et al. 2007: 64). However, it is important to point out that the task used in the different grades was always the same, and the development with age seen in the study could possibly be linked to the practice the children had with the specific task. In addition, using a single picture as stimulus may lead to large differences between individual children in their narrative content, which in turn influences connective use; this type of methodology thus leads to results that are difficult to generalize.

Langlotz (2014) elicited written narratives from 180 German-speaking children in fifth ($N$ = 58), seventh ($N$ = 56) and ninth grade ($N$ = 66).[5] The participants were asked to invent a funny, exciting, or scary story about an event that might

5 Langlotz (2014) does not report the mean age or the age range of the participants. In the German school system, however, children are on average between 10 and 11 years old in fifth grade, between 12 and 13 years old in seventh grade and between 14 and 15 years old in ninth grade.

have happened at the school. In all grades, the children produced more coordination than subordination. Regarding the connective type, conjunctions were the most frequent type, followed by subjunctions, adverbs and finally combinations of conjunctions and adverbs. Overall, in all grades, additive relations were most often expressed, followed by temporal and adversative relations. When the data was split into coordination and subordination, however, the order of frequency of coherence relations changes: Additive relations occurred most frequently in coordination followed by adversative and temporal relations, while temporal relations were the most frequent in subordination followed by causal relations.

In a similar, but much smaller study of younger children's narratives, Binanzer and Langlotz (2019) elicited written narratives from 15 monolingual German-speaking children aged 6–10 years from second ($N = 5$), third ($N = 5$) and fourth ($N = 5$) grade using two different pictures as stimuli. Similar to the older children in Langlotz' (2014) study, additive, temporal and adversative relations were most frequently produced. Analysing the connective forms qualitatively, the authors describe the development from the use of prototypical connective forms for each coherence relation to the literary use of connective forms. However, since very few participants were investigated and the overall number of cases was very low, these results may not generalize to children in general.

To our knowledge, no previous study has compared written narratives by German-speaking children and adults. Binanzer et al. (2022) compared temporal connectives in a corpus of children's written narratives, which contains the texts from Augst et al. (2007), Langlotz (2014), and Binanzer (2017),[6] to the childLex corpus (Schroeder et al. 2015), a corpus comprising literature for children and youth literature, but these cannot be considered genuine adult narrative productions as they are adapted to children's language skills. Interestingly, the most frequent temporal connectives in childLex are the same as the primary school children's (first to fourth grade). The most frequent temporal connective was the adverb *dann* 'then', followed by the subjunction *als* 'when' and the adverb *da* 'then'. However, it is yet unknown how adults use connectives in written narratives when not writing texts specifically for children.

# 3 The present study

The present study extends the studies described above in a number of ways. First, in contrast to previous studies, we systematically compare the use of connectives in

6 Binanzer (2017) did not investigate connective use.

written narratives of children in fourth grade (10-year-olds) with those of an adult control group. This will provide new insights into the how and when children acquire the use of connectives in written language, a topic that is less studied than the acquisition of connectives in oral language. Second, by using picture-based stimuli showing a sequence of events, we ensure comparability in the narrative content expressed by individual participants, something that has not previously been done in studies of connective use in written texts. This methodology allows for increased generalizability of the results, with respect to similarities and differences between the groups, as connective use is heavily influenced by the content expressed. Finally, we investigate a sufficiently large number of participants to allow us to test differences between the groups using inferential statistics; with our study, tendencies seen in previous studies that only reported descriptive statistics can thus be confirmed. We chose to investigate children in fourth grade as their writing skills are developed enough for them to be able to carry out the type of controlled task used, which could pose difficulties for younger children. Furthermore, in the German school system, fourth grade constitutes an important milestone, as it marks the end of primary school. Investigating German-speaking children at this specific age makes it possible to gain an impression of the skills they have as a group before they are split into different school types based on their academic achievements.

To paint a comprehensive picture of adults' and children's connective use, it is necessary to investigate the complex interplay between connective types, coherence relations and syntactic relations in detail. We therefore seek to answer the following three research questions:

– Q1: Do children and adults differ in how often they use connectives in written narratives?
– Q2: Which differences can be found between children and adults in the syntactic relations (coordination vs. subordination) and coherence relations expressed and in the connective types (conjunction, adverb, subjunction) used to mark these relations?
– Q3: Which differences in the use of specific connective forms can be seen between children and adults?

# 4 Method

## 4.1 Participants

A total of 84 German native speakers participated in the study, 32 10-year-olds (15 females, mean age: 10;4, age range: 9;11–10;10) and 52 adults (44 females, mean age: 22 years, age range: 18–50 years), who were first year students of German linguistics at

Osnabrück University and TU Dortmund University. All participants had grown up monolingually. All 10-year-olds attended fourth grade at the same primary school in a rural area close to the city of Osnabrück in Northern Germany. Written consent was obtained from the adult participants and the parents of the children. The participants were the same as in a recent study of anaphoric reference (Lehmkuhle and Lindgren 2022).[7]

## 4.2 Material

We elicited written narratives using a stimulus that consisted of a picture sequence with six coloured pictures plus the written beginning of the story (see Soboll 2019). The story is about two boys (Tim and Max) and their dog (Bello), who are on a treasure hunt to a mysterious castle. On their way, they encounter two monsters (Monster 1, Monster 2).

## 4.3 Procedure

The data collection for the child participants took place in their classrooms during one school lesson (45 min). All child narratives were handwritten. In order to anonymize the narratives, the children wrote a code, which consisted of the first two letters of their mother's first name, the first two letters of their father's first name and the last two letters of their own month of birth on the sheet they wrote their narrative on. After this procedure, the pictures and a written introduction of the story were presented to the children followed by the instruction: *Schreibe die Geschichte weiter. Die Bilder helfen dir dabei* 'Write the continuation of the story. The pictures are there to help you'. The teachers were told in advance not to assist the children in writing their narratives. Children who completed their narratives before the end of the school lesson were allowed to draw a picture.

For the collection of the adult narratives, the online tool LimeSurvey was used. Like the children, the adult participants received the task to write the continuation of the story and were shown the pictures and the written introduction of the story. Because adults are more experienced writers than primary school children and the adults could use their computer keyboards, they were given 20 min for writing their narratives.[8]

7 The data were originally collected as part of the first author's dissertation (Lehmkuhle 2022).
8 The original plan was to collect handwritten narratives also from the adults, so as to avoid the possibility that differences in methodology would influence the results. However, it was necessary to collect the adult data during the Covid-19 pandemic, and for this reason, the data collection had to be carried out using an online tool.

## 4.4 Coding and analysis

First, the complete narratives were divided into clauses. A clause was defined as a finite verb with at least one of its arguments (i.e. both main and subordinate clauses were counted). Next, each clause was coded for the occurrence of a clause-initial connector. All connectives were then coded according to their *form* (e.g. *und* 'and', *dann* 'then'), the *syntactic relation* that they express (coordination, subordination), their *connective type* (conjunction, subjunction, adverb), and the *coherence relation* they express (e.g. additive, temporal, causal).[9] The first author coded the complete data set. To calculate inter-rater reliability, 20 % (17/84) of the narratives was randomly chosen and subsequently coded independently by the second author. The inter-rater agreement was very high for all aspects of the coding.[10] All cases of disagreement were discussed until consensus was reached. For one specific connective, the semantically unspecific *da* 'then/because/since/there' (Breindl et al. 2014: 313–316), which leaves room for interpretation regarding the coherence relation it expresses, a specific procedure was carried out after the overall inter-rater agreement had been calculated. All *da* cases were then (re)coded independently by both authors. All cases where *da* expresses a coherence relation (e.g. *Sie gingen weiter.* ***Da*** *hörten ein Troll und ein Oger sie laufen.* 'They continued walking. **Then** a troll and an ogre heard them walking.' [SIANER, child]; ***Da*** *es Vollmond ist, können sie gut sehen.* '**Since** it is full moon, they can see well.' [51B, adult]) were coded as connectives. All cases where *da* expresses locality (e.g. ***Da*** *war der Freund Max* 'There was the friend Max' [JEFRER, child]) were not coded as connectives (six cases) and were excluded from the analysis. All ambiguous cases were discussed until agreement was reached; a total of six further cases were excluded from the analysis since they were judged to be too ambiguous (e.g. *Als sie reingingen,* ***da*** *war das Licht aus.* 'When they walked in, **then/there** the light was off.' [CHTOAR, child]).

All statistical analyses were done in R. For each of the investigated dependent variables (use of connectives, syntactic relation, connective type, coherence relation), we either ran a logistic (binomial) mixed effects model using the function glmer of the *lme4* package (Bates et al. 2015) or a Bayesian multinomial mixed effects model (with a logit link function) using the brm function of the *brms* package (Bürkner 2017), depending on the type of dependent variable. All models contained participant as random intercept and group (adults vs. children) as a fixed effect (For details of the

**9** Following Breindl et al. (2014), *und* 'and' was always coded as an additive coherence relation. In some studies, e.g. Vion and Colas (2005), *and* could also be coded as temporal connective. Just as is the case with English *and*, drawing a line between purely additive and temporally-flavoured cases of *und* is not straightforward as no strict criteria exist; for this reason, we chose to follow the standard classification of Breindl et al. (2014) with respect to *und*.

**10** Occurrence of a connective: 98.74 %; connective form: 97.48 %; coherence relation: 96.85 %; connective type: 98.42 %; syntactic relation: 98.42 %.

specific models, see the different subsections in Section 5).[11] Finally, we took a closer look at the specific connective forms used to express temporal relations by creating a word cloud per group using the R package *ggwordcloud* (Le Pennec and Slowikowski 2019). The size of each connective form in the word cloud represents the relative frequency of the connective form in comparison to the other forms, i.e. the connective form written in the largest font size is the most frequent connective form in the dataset. The word clouds are thus used to illustrate the relative importance of specific temporal connective forms in the narratives of the adults and the children.[12]

# 5 Results

## 5.1 Use of connectives

Table 1 shows the results for the use of connectives by the children and the adults. In total, the participants produced 2,097 clauses, out of which 671 contained a clause-initial connective. The children used connectives in 33 % of their clauses; the corresponding figure for the adults was 32 %. As expected from these figures, the logit mixed effects model showed no significant difference between the children and the adults ($B$ = 0.07, $SE$ = 0.13, $z$ = 0.57, $p$ = .57).[13]

In all remaining analyses, the data consists of the clauses containing a clause-initial connective ($N$ = 671).

## 5.2 Syntactic relations

Table 2 shows the results for the type of syntactic relation expressed by the connectives. In both groups, coordination was substantially more frequent than

**Table 1:** Use of connectives by children and adults: percentage (%) and raw figures (*N*).

| | Children | | Adults | |
|---|---|---|---|---|
| | % | *N* | % | *N* |
| Connective | 33 | 136 | 32 | 535 |
| No connective | 67 | 273 | 68 | 1,153 |
| Total | 100 | 409 | 100 | 1,688 |

**11** We are grateful to Siri Hussenius for advice regarding multinomial mixed effects models and Bayesian statistics.

**12** The dataset and the R scripts are available for download from the OSF using the following link: https://osf.io/vptjx.

**13** Complete model summaries for all analyses can be found in the Appendix.

**Table 2:** Syntactic relations comparing children and adults: percentages (%) and raw figures (*N*).

| | Children | | Adults | |
|---|---|---|---|---|
| | % | *N* | % | *N* |
| Coordination | 83 | 113 | 77 | 410 |
| Subordination | 17 | 23 | 23 | 125 |
| Total | 100 | 136 | 100 | 535 |

subordination: the children produce 83 % connectives that express coordination and the corresponding figure for the adults is 77 %. As expected from these figures, the statistical analysis showed no significant difference between the children and the adults in the type of syntactic relation expressed ($B = -0.42$, $SE = 0.26$, $z = -1.61$, $p = .11$).

## 5.3 Syntactic relations and connective type

Next, we analysed the connective types (adverbs, conjunctions, subjunctions) used with the different syntactic relations. The results are shown in Table 3.[14]

With one exception produced by a child participant (*Weil das große Monster war sehr groß* 'Because the big monster was very tall' [KACHAI, child]), subjunctions were only used in subordination. In subordination, with a few exceptions, only subjunctions were produced and percentages were comparable for the adults (94 %) and

**Table 3:** Connective type by syntactic relation and group: percentages (%) and raw figures (*N*).

| | Children | | | | Adults | | | |
|---|---|---|---|---|---|---|---|---|
| | Coordination | | Subordination | | Coordination | | Subordination | |
| | % | *N* | % | *N* | % | *N* | % | *N* |
| Adverb | 30 | 34 | 0 | 0 | 9 | 38 | 0 | 0 |
| Conjunction | 65 | 74 | 0 | 0 | 87 | 356 | 0 | 0 |
| Subjunction | 1 | 1 | 96 | 22 | 0 | 0 | 94 | 118 |
| Other | 4 | 4 | 4 | 1 | 4 | 16 | 6 | 7 |
| Total | 100 | 113 | 100 | 23 | 100 | 410 | 100 | 125 |

14 The category 'other' in Table 3 consists of combinations of two or more different connective types, such as conjunction + adverb (e.g. *aber dann* 'but then'), conjunction + subjunction (e.g. *doch als* 'but when'), and subjunction + adverb (e.g. *bis endlich* 'until finally').

children (96 %). In coordination, almost all cases (children: 95 %, adults: 96 %) consisted of either adverbs or conjunctions. Conjunctions were the most frequent in both groups, but there was a relatively large difference in their use between the groups (adults: 87 %, children: 65 %). This difference was mirrored in the use of adverbs; adverbs were used by the children in 30 % of all cases, whereas the corresponding figure for the adults was 9 %. The frequency of other connective types in coordination, including the one case of subjunction produced by a child, was very low. We therefore removed these cases from the dataset and then compared the children's and the adults' use of adverbs versus conjunctions in coordination ($N = 502$) using a logit mixed effects model. The analysis shows a significant difference between the children and the adults ($B = -1.47$, $SE = 0.28$, $z = -5.22$, $p < .001$); adverbs were significantly more likely to be produced by the children than by the adults, whereas conjunctions were more frequent in the adult data.

## 5.4 Coherence relations

Next, we analysed the types of coherence relations expressed by the children and the adults. The results are shown in Table 4.[15]

In both groups, additive relations are the most frequently produced, constituting around half of all coherence relations in the data, followed by temporal relations, with both adversative and other types of relations being relatively infrequent. To investigate differences between children and adults in which coherence relations

**Table 4:** Coherence relations by group: percentages (%) and raw figures (*N*).

| | Children | | Adults | |
|---|---|---|---|---|
| | % | *N* | % | *N* |
| Additive | 46 | 63 | 54 | 289 |
| Temporal | 37 | 50 | 20 | 105 |
| Adversative | 8 | 11 | 11 | 61 |
| Other | 9 | 12 | 15 | 80 |
| Total | 100 | 136 | 100 | 535 |

**15** The category 'other' in Table 4 consists of a wide range of different relations. The most frequent ones are causal (e.g. *da* 'because'), consecutive (e.g. *also* 'so'), concessive (e.g. *obwohl* 'although'), conditional (e.g. *wenn* 'if/once'), final (e.g. *damit* '[in order/so] that'), and combinations of adversative and temporal (e.g. *aber dann* 'but then'). For these types, more than five cases were found in the data; other types were less frequent.

they express, we ran a Bayesian multinomial mixed effects model (using a categorical family with a logit link function), with four outcome levels (additive, temporal, adversative, other)[16] for the dependent variable coherence relation.[17] The results indicate that group (adults vs. children) has a significant effect on the use of temporal coherence relations (posterior mean: 1.18, 95 % credible interval: 0.48–1.93); the children were significantly more likely to express temporal coherence relations (37 %) than the adults (20 %). There were no significant effects of group for the use of temporal or adversative coherence relations.

## 5.5 Coherence relation, syntactic relation and connective type

Next, we analysed the use of the two syntactic relations (coordination and subordination) for the three most frequent coherence relations (additive, temporal, adversative) separately in the adults' and children's narratives. The results are shown in Table 5.

The results show that additive and adversative coherence relations are always expressed with coordination. The only difference between the groups is seen in the temporal relations. For temporal relations, the majority of the children's uses (60 %) are also coordination, whereas the adults almost always (83 %) use subordination. We therefore compared the children's and the adults' use of subordination versus coordination in temporal relations ($N$ = 154) using a logit mixed effects model. The

**Table 5:** Syntactic relation by coherence relation and group: percentages (%) and raw figures ($N$).

| | Children | | | | | | Adults | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Additive | | Temporal | | Adversative | | Additive | | Temporal | | Adversative | |
| | % | *N* | % | *N* | % | *N* | % | *N* | % | *N* | % | *N* |
| Coordination | 100 | 63 | 60 | 30 | 100 | 11 | 100 | 289 | 17 | 18 | 100 | 61 |
| Subordination | 0 | 0 | 40 | 20 | 0 | 0 | 0 | 0 | 83 | 86 | 0 | 0 |
| Total | 100 | 63 | 100 | 50 | 100 | 11 | 100 | 289 | 100 | 104 | 100 | 61 |

16 The level 'other' was used as the reference level for the model.

17 The model, which was fitted using NUTS, using default weakly informative priors, was run with four chains, each with 2,000 iterations, and a warmup of 1,000 iterations. We assessed convergence with Rhat values, all of which were at 1.00, which indicates good convergence. Effective sample sizes were above (or in one case just below) 1,000, indicating effective sampling and reliable posterior estimates.

**Table 6:** Connective type by coherence relation and group: percentages (%) and raw figures (*N*).

| | Children | | | | | | Adults | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Additive | | Temporal | | Adversative | | Additive | | Temporal | | Adversative | |
| | % | *N* | % | *N* | % | *N* | % | *N* | % | *N* | % | *N* |
| Adverb | 0 | 0 | 60 | 30 | 0 | 0 | 1 | 1 | 17 | 18 | 7 | 4 |
| Conjunction | 100 | 63 | 0 | 0 | 100 | 11 | 99 | 288 | 0 | 0 | 93 | 57 |
| Subjunction | 0 | 0 | 40 | 20 | 0 | 0 | 0 | 0 | 83 | 86 | 0 | 0 |
| Total | 100 | 63 | 100 | 50 | 100 | 11 | 100 | 289 | 100 | 104 | 100 | 61 |

analysis showed a significant difference between children and adults ($B$ = –2.27, $SE$ = 0.57, $z$ = –3.97, $p$ < .001); the adults were more likely to use subordination to express temporal relations compared to the children.

We also analysed the use of the three most frequent connective types (adverb, conjunction, subjunction) by coherence relation. The results are shown in Table 6.

With additive and adversative coherence relations, the children exclusively use conjunctions. The adults use only a few adverbs with these relations (one case for additive, four cases for adversative); differences between the groups for these relations are thus marginal and not possible to analyse statistically. However, just as was the case for the syntactic relation, a clear difference is seen between the groups for temporal relations. The children express temporal relations using 60 % adverbs and 40 % subjunctions, whereas the corresponding figures for the adults are 17 % and 83 %. We therefore ran a logit mixed effects model comparing the use of adverbs versus subjunctions by the children and the adults on the cases of temporal relations ($N$ = 154). The analysis showed a significant difference between the children and the adults ($B$ = –2.27, $SE$ = 0.57, $z$ = –3.97, $p$ < .001); the children were more likely to use adverbs, whereas the probability of producing a subjunction was higher for the adults.

## 5.6 Specific temporal connective forms

Finally, we took a closer look at the specific connective forms that the children and adults used to express temporal relations. We used word clouds to illustrate the relative importance of specific temporal connective forms in the children's and adults' narratives. The size of a specific connective in the cloud corresponds to its frequency in the data.[18] Figure 1 shows all connectives the children used to express temporal relations ($N$ = 50). The children produced 10 different temporal connectives.

18 Due to the relatively small size of the data in relation to the number of different connective forms produced, it was not possible to carry out any statistical analysis here.


**Figure 1:** Children. Temporal relations: connective form.


**Figure 2:** Adults. Temporal relations: connective form.

The most frequent connective was *als* 'when' (*N* = 18) followed by *da* 'then' (*N* = 15) and *dann* 'then' (*N* = 9). Together these three connectives accounted for 85 % of all temporal connectives produced by the children. The remaining connective forms were produced just once and in one case (*danach* 'afterwards') twice.[19]

Figure 2 shows all connectives the adults chose to express temporal relations (*N* = 105). The adults produced 13 different temporal connectives. Similar to the children, the most frequent connective was *als* 'when' (*N* = 56). Differently from the children, however, *da* 'then' only occurred twice in the adult data. Following *als* 'when', the subordinating connective forms *nachdem* 'after' and *während* 'while', which were both produced ten times, were the most frequent ones.[20]

In the children's narratives as well as in the adults', the connective *als* 'when' was thus the most frequent. However, as has also been shown above, the children used adverbs, and especially *da* 'then' and *dann* 'then', more often than the adults,

**19** *als* 'when' (*N* = 18), *da* 'then' (*N* = 15), *dann* 'then' (*N* = 9), *danach* 'afterwards' (*N* = 2), *anschließend* 'afterwards' (*N* = 1), *bis* 'until' (*N* = 1), *daraufhin* 'after that' (*N* = 1), *wo* 'when' (*N* = 1), *schließlich* 'finally' (*N* = 1), *zuletzt* 'in the end' (*N* = 1).

**20** *als* 'when' (*N* = 56), *nachdem* 'after' (*N* = 10), *während* 'while' (*N* = 10), *dann* 'then' (*N* = 9), *bis* 'until' (*N* = 7), *daraufhin* 'after that' (*N* = 3), *bevor* 'before' (*N* = 2), *da* 'then' (*N* = 2), *dann erst* 'only then' (*N* = 1), *sofort* 'immediately' (*N* = 1), *woraufhin* 'whereupon' (*N* = 1), *zuerst* 'at first' (*N* = 1), *zunächst* 'at first' (*N* = 1).

who instead expressed temporal relations with a wider range of subordinations (e.g. *nachdem* 'thereafter', *während* 'while', *bis* 'until'). Generally, compared to the children, the adults used a wider range of different connectives to express temporal relations. Another difference between children and adults is that adults used connectives that expressed different types of temporal relations: anteriority (e.g. *bevor* 'before'), simultaneity (e.g. *während* 'while') and posteriority (e.g. *nachdem* 'after'). In contrast, with the exception of *als* 'when', which can express different temporal structuring principles (anteriority, simultaneity, and posteriority; Breindl et al. 2014: 299), the children mainly expressed posteriority (*da* 'then', *dann* 'then', *danach* 'thereafter'). Finally, the connective *da* 'then' seems to play a crucial role in the children's narratives, but not in the adults' production. Similar to *als* 'when', *da* 'then' is not specific in terms of temporal structuring principles. This indicates a central role of *da* 'then' in children's acquisition process of the use of connectives for temporal relations.

# 6 Discussion

In this paper, we systematically compared the use of connectives in written narratives by German-speaking children in fourth grade (10-year-olds, $N$ = 32) and adults ($N$ = 52). We analysed the overall use of clause-initial connectives and the types of syntactic relations and coherence relations expressed and the connective types used as well as the relationships between syntactic relations, coherence relations and connective types. The results show that the children and adults expressed an overt coherence relation using a clause-initial connective equally often; in both groups, around a third of all clauses contain a clause-initial connective. The most common coherence relation in both groups was additive, but the children expressed temporal relations significantly more often than the adults. The adults generally showed a larger diversity in the types of relations expressed. There was no overall difference between the groups in the use of subordination and coordination, but the adults expressed temporal relations significantly more often with subordination than the children, who showed a preference for coordination. The children used adverbs to express coordination significantly more often than the adults. A closer look at the specific connectives used to express temporal relations revealed that the adults used a wider variety of different connectives with which they expressed a greater range of different types of temporal relations (anteriority, simultaneity, posteriority). In contrast, the children mainly used temporal connectives to express posteriority. Finally, the connective adverb *da* 'then' played an important role in the children's but not in the adults' production.

Our results are in line with results from previous studies: Similar to Czech's (2020) results for oral narratives of German-speaking 9-year-olds and adults, the children and the adults in our studies used connectives equally often. Taken together, our results and Czech's (2020) thus indicate that 9–10-year-old children and adults do not differ in the extent that they explicitly mark coherence relations. In addition, the children in our study produced mainly additive, temporal, and adversative coherence relations and used coordination more often than subordination, similar to what has been found in previous studies of German-speaking children's written narratives (Binanzer and Langlotz 2019; Langlotz 2014). Finally, we observed differences between children and adults in the amount of variation in connective forms, with adults choosing from a greater repertoire of connectives when expressing temporal relations. This supports findings from developmental studies indicating that, with increasing age, a more diversified set of connectives is used (e.g. Czech 2020; Vion and Colas 2005). It is important here to point out that our study is the first to use inferential statistics to analyse the use of connectives in written narratives by German-speaking children and adults; the previously untested tendencies shown in previous studies can thus be confirmed by our results. Furthermore, the results from the qualitative analysis of the connective *da* support the general observation that complex connectives, such as causals, are acquired later than simpler ones, such as additives (e.g. Evers-Vermeul and Sanders 2009). The adults in our study mainly used *da* to express causal relations (*da* 'because'), whereas the children overused *da* to express posteriority – a temporal coherence relation (*da* 'then'). The children produced only one causal relation (*weil* 'because'), while the adults produced 27 causal relations using various causal connectives (*da* 'because', *denn* 'because', *weil* 'because', *deshalb* 'therefore', *schließlich* 'after all', *sodass* 'so that'). Even though causal relations were relatively infrequently expressed also by the adults compared to other coherence relations in our data, this difference between children and adults is noteworthy and indicates that children in the fourth grade have not yet fully acquired an adultlike use of coherence relations in their written production. This is also seen in the differences in the proportions of different coherence relations between children and adults. Similar to Czech's (2020) findings for 9-year-olds compared to adults in oral narratives, the children in our study used a greater proportion of temporal relations than adults, who instead produced a greater proportion of causal and consecutive relations.

Our qualitative analysis of the connective forms used to express temporal relations showed that the connective *da* 'then' seems to play a crucial role in children's expressions of temporal relations. The statistically significant differences between the children and adults in both syntactic relation and connective type for expressing temporal relations seem to stem at least partially from the children's overuse of *da* 'then'. Since temporal *da* 'then' is an adverb, the children's higher use of this specific connective leads to their higher proportion of coordination and adverbs, compared to the adults. One reason for this could be that *da* is frequent in child-directed literary input, as shown by Binanzer et al. (2022) in their study of child and youth literature, where *da* 'then' was the third most common temporal connective. In addition, the lexical item *da* is likely very frequent in general, since it can express a wide range of different meanings. Breindl et al. (2014: 314) describe *da* as an adverb connective that is semantically unspecific. Similarly, *da* has been characterized by Altmann (1981: 241) as an *Allerweltsproform* 'everyday proform', being able to refer anaphorically to local, directional, temporal, instrumental, comitative, negative-comitative, final, conditional, framing, and substitutive adverbs (see also Breindl et al. 2014: 314).

It has been argued (e.g. Binanzer and Langlotz 2019) that children's use of connectives in narratives develops from the use of one prototypical connective form for each coherence relation towards the use of semantically more specific connectives, which can be characterized as typical for the narrative genre. It could thus be the case that children overuse *da* because it can be used for many different purposes. This is reflected in the children's multifunctional use of *da* in the narratives in this study, which also goes beyond its use as a connective. The children used *da* not only to express temporal relations, as in (4a), but also to express locality. In (4b), *da* 'there' expresses the place where Tim and Bello met their friend Max, namely at the tree. Finally, there were also cases in which *da* was used anaphorically. *Da* in (4c) refers back to the whole temporal adverbial *als sie reingingen* 'when they went in', i.e. *da* can be used to refer back to extensive text passages. The children's use of *da* is in stark contrast to the adults, who, as mentioned above, almost exclusively used *da* as a causal connective, as in (5). Differentiating the different functions of *da* seems to be a complex object of acquisition.

(4) a. Temporal

*Tim geht mit seinem Hund Bello und seinem Freund Max auf*
Tim goes with his dog Bello and his friend Max on
*die Suche nach dem Schatz.* ***Da*** *fanden sie das Schloss und*
the search for the treasure then found they the castle and
*sahen zwei Kreaturen.*
saw two creatures.
'Tim goes on a search for the treasure with his dog Bello and his friend Max. **Then** they found the castle and saw two creatures.' (OLWAST, child)

b. Local

*Tim, Bello suchen nach dem Schatz. Dann war ein Baum*
Tim Bello search for the treasure then was a tree
*neben den beiden.* ***Da*** *war der Freund Max.*
next to the two there was the friend Max
'Tim and Bello search for the treasure. Then there was a tree next to them. **There** was their friend Max.' (JEFRER, child)

c. Anaphorical
*Sie sahen vom Weiten schon das Schloss. Es war sehr groß*
they saw from afar already the castle it was very big
*und es sah gruselig aus. Als sie reingingen*
and it saw scary out when they entered
***da** war das Licht aus.*
there was the light off
'They could already see the castle from afar. It was very big and looked scary. When they went in, the lights were out.' (CHTOAR, child)

(5) ***Da** auf der Karte auch ein Wald abgebildet ist, gehen die*
as in the map also a forest shown is go the
*beiden Jungs sofort davon aus, dass sie mit Bello den*
two boys immediately thereof out that they with Bello the
*Wald durchqueren müssen.*
forest cross have.to
'**As** the map also shows a forest, the two boys immediately assume that they have to cross the forest with Bello.' (71B, adult)

The children's use of *da* could also be an explanation for the difference between children and adults in the types of temporal relations expressed. Temporal *da* can only be used to express posteriority, i.e. it signals that the event happened after the one in the previous sentence. This type of temporal relation is the one most frequently expressed by the children, whereas the adults produce a wider range of temporal relations; most notably, simultaneity is more common in the adults' production. The difference in the types of temporal relations expressed by adults and children is thus linked to the children's frequent use of *da*. It could be the case that the children use *da* specifically because they intend to express posteriority. This explanation is in line with results from previous studies of temporal relations that show that children aged 9 to 10 rarely express simultaneity in their oral narratives (Aarssen 2001; Aksu-Koç and Stutterheim 1994; Bos 2001). However, it is also possible that the children are overgeneralizing *da*, i.e. use it as a default form for all types of temporal relations because they have not yet learned which connectives can be used for which type of temporal relation. The fact that *da* 'then' occurs frequently in child-directed literature (Binanzer et al. 2022) could possibly also influence the children's use of this specific connective. To shed light on this issue, it would be necessary to analyse the same children's use of *da* over a longer period of time, e.g. from age 3 until the school age, in order to trace its developmental process and also to compare the children's use to the functions of *da* in child-directed speech. This would be a fruitful line of future research.

Another interesting result of our study was the large difference between adults and children in the use of subordination with temporal coherence relations. One explanation for this result is that subordination is acquired relatively late in German. For example, in a large-scale study of German-speaking children ($N$ = 968), Ulrich (2017) found that even among 8-year-olds, 12.8 % were less than 90 % accurate in their use of subordinate clauses. Building subordinate clauses thus seems to still pose some difficulty for German-speaking primary school children. These difficulties could be linked to the verb-final structure of the German subordinate clause, i.e. that the finite verb is placed at the end of the clause in German subordinate clauses, as shown in the constructed example in (6a). The verb-final structure means that children have to keep substantial amounts of information in their working memory until they produce the core of the proposition, the finite verb, which may be more demanding. Using an adverb like in (6b) leads to a main clause structure where the finite verb directly follows the adverb, which may be less demanding.

(6) a. *Tim füttert seinen Hund, bevor er sich mit seinem Freund Max* ***trifft****.*
Tim feeds his dog before he himself with his friend Max meets
'Tim feeds his dog before he meets with his friend Max.'

b. *Tim füttert seinen Hund. Danach* ***trifft*** *er sich mit seinem Freund*
Tim feeds his dog afterwards meets he himself with his friend
*Max.*
Max
'Tim feeds his dog. Afterwards he meets with his friend Max.'

Results from previous research provide some support for this explanation. Delage and Frauenfelder (2019: 168) found a strong predictive relationship between working memory (WM) and complex syntax in French-speaking children: "It thus seems that the bottleneck that WM capacities impose on the processing of complex sentences limits the child's ability to master such sentences until the necessary resources develop." Additionally, their results showed that WM developed with age from 5 to 12 years, but that adults outperformed children aged 11–12 years, meaning that working memory is still developing at this age. The stronger preference for adverb-initial main clauses of our 10-year-olds compared to the adults' stronger preference for subordinate clauses could thus be linked to the lower WM capacity of the former group combined with the fact that subordinate clauses are more taxing for the WM.

This effect could also be strengthened by the fact that the 10-year-olds are still developing their writing skills, meaning that the writing process may be a cognitively challenging task for them. In a previous study, primary school children exhibited a lower memory span performance in written compared to oral recall (Grabowski 2010). In our study, the writing task in itself may thus have occupied a large part of the children's cognitive capacities, leaving less room for the use of more complex syntactic structures. A preference for adverb connectives, requiring a main clause structure, which is less cognitively demanding, over subjunctions, which require a more demanding subordinate verb-final structure, as shown by the children in our study, follows logically from this line of reasoning. In sum, it can be said that the use of connectives and syntactic complexity as well as working memory capacities appear to be closely related. Future studies should systematically investigate this complex interplay further, for example by comparing the use of connectives in oral and written narratives.

In conclusion, our results are in line with results from previous studies (e.g. Binanzer et al. 2022; Binanzer and Langlotz 2019; Czech 2020; Langlotz 2014; Vion and Colas 2005). In addition, our results provide new insights and open up new research perspectives for future studies. Children aged 10 do not differ significantly from adults regarding the use of connectives and syntactic relations in general. However, the children overtly mark temporal relations significantly more often than the adults. Differences between children and adults regarding temporal relations seem to stem from the children's higher use of adverb connectives in comparison to subjunctions. Specifically, we observed an overuse of the adverb *da* 'then' in temporal relations in the children's narratives and propose that children use *da* as a default form for temporal relations until they have differentiated form-function mappings for different temporal relations. Overall, our results suggest that children at the end of the German primary school (fourth grade) have not yet fully acquired an adultlike use of connectives in written narratives. Our study has implications for our understanding of what it means to state that children have acquired a specific structure. For example, the fact that children have acquired subordination in the sense that they are *able* to use it correctly to express temporality does not necessarily mean that they have acquired it in the sense of *using it* in an adultlike manner or to the same extent as adults, as shown by our results. In our study, the children do use subordination, but the acquisition process is not completed by age 10. Similarly, the children explicitly express temporal relations more often than adults in general, but the adults express a wider range of different temporal relations. To be able to map the complete acquisition process of the use of connectives, future research into children's discourse skills thus needs to analyse connectives and specific coherence relations, including subtypes of temporal relations, and their development throughout the school years in detail, preferably longitudinally. Our study provides the starting point for such a line of research. Finally, the study has implications for the teaching of writing skills in subsequent school grades, as it has provided an overview of the connective use by children at the end of the primary school in relation to adults. Teaching children how to express coherence relations in general and temporal coherence in particular using subjunctions and how to use a more diversified set of connectives are key aspects for supporting them in their process of acquiring the adultlike way of linking clauses in written texts. Since coherence is important for creating texts that are understandable and enjoyable for the reader, didactic materials based on the results of our study could thus positively influence the development of skills in writing such texts, a competence that children need both in and outside of school.

# Appendix: Model summaries

**Table A1:** Summary of the logistic mixed effect model (glmer(Connective ~ Group + (1|Participant), family = binomial)) comparing the use of connectives out of all clauses ($N$ = 2,097) between the children and the adults.

| **Random effects** | ***Variance*** | ***SD*** | | |
|---|---|---|---|---|
| Participant: intercept | 0.03 | 0.18 | | |
| **Fixed effects** | ***B*** | ***SE*** | ***z*** | ***p*** |
| Intercept | −0.77 | 0.06 | -12.97 | <.001 |
| Group: children versus adults | 0.07 | 0.13 | 0.57 | .57 |

Note: Values have been rounded to two decimal points.

**Table A2:** Summary of the logistic mixed effect model (glmer(Syntactic_Relation ~ Group + (1|Participant), family = binomial)) comparing the use of coordination versus subordination out of the clauses containing a connective ($N$ = 671) between the children and the adults.

| **Random effects** | ***Variance*** | ***SD*** | | |
|---|---|---|---|---|
| Participant: intercept | 0.05 | 0.23 | | |
| **Fixed effects** | ***B*** | ***SE*** | ***z*** | ***p*** |
| Intercept | −1.20 | 0.11 | −10.84 | <.001 |
| Group: children versus adults | −0.42 | 0.26 | −1.61 | .11 |

Note: Values have been rounded to two decimal points.

**Table A3:** Summary of the logistic mixed effect model (glmer(Connective_Type ~ Group + (1|Participant), family = binomial)) comparing the use of adverb versus conjunction out of the coordinated clauses containing a connective ($N$ = 502) between the children and the adults.

| **Random effects** | ***Variance*** | ***SD*** | | |
|---|---|---|---|---|
| Participant: intercept | 0.09 | 0.30 | | |
| **Fixed effects** | ***B*** | ***SE*** | ***z*** | ***p*** |
| Intercept | 2.27 | 0.19 | 11.70 | <.001 |
| Group: children versus adults | −1.47 | 0.28 | −5.22 | <.001 |

Note: Values have been rounded to two decimal points.

**Table A4:** Summary of the Bayesian multinomial mixed effect model (brm(Coherence_Relation ~ Group + (1|Participant), family = categorical(link = logit))) comparing the use of coherence relations (additive, adversative, temporal, other) out of the clauses containing a connective ($N$ = 671) between the children and the adults.

| **Random effects** | ***B*** | ***SE*** | ***95 % CI*** |
|---|---|---|---|
| Additive – participant: intercept | 0.16 | 0.12 | [0.01, 0.43] |
| Adversative – participant: intercept | 0.51 | 0.26 | [0.04, 1.04] |
| Temporal – participant: intercept | 0.18 | 0.13 | [0.01, 0.49] |
| **Fixed effects** | ***B*** | ***SE*** | ***95 % CI*** |
| Additive – intercept | 1.28 | 0.13 | [1.03, 1.55] |
| Additive – group: children versus adults | 0.41 | 0.35 | [−0.26, 1.11] |
| Adversative – intercept | −0.39 | 0.21 | [−0.83, 0.01] |
| Adversative – group: children versus adults | 0.19 | 0.48 | [−0.76, 1.15] |
| Temporal – intercept | 0.26 | 0.15 | [−0.03, 0.57] |
| Temporal – group: children versus adults | 1.18 | 0.37 | [0.48, 1.93] |

Note: 'Other' was used as the reference level. The model was fitted using NUTS, using default weakly informative priors, and was run with four chains, each with 2,000 iterations, and a warmup of 1,000 iterations. All Rhat values were at 1.00, indicating good convergence, and effective sample sizes were above (or in one case just below) 1,000, indicating effective sampling and reliable posterior estimates. B = posterior mean. CI = credible interval. Values have been rounded to two decimal points.

**Table A5:** Summary of the logistic mixed effect model (glmer(Syntactic_Relation ~ Group + (1|Participant), family = binomial)) comparing the use of coordination versus subordination out of the clauses containing a temporal connective ($N$ = 154) between the children and the adults.

| **Random effects** | ***Variance*** | ***SD*** | | |
|---|---|---|---|---|
| Participant: intercept | 0.63 | 0.80 | | |
| **Fixed effects** | ***B*** | ***SE*** | ***z*** | ***p*** |
| Intercept | 1.77 | 0.37 | 4.76 | <.001 |
| Group: children versus adults | −2.27 | 0.57 | −3.97 | <.001 |

Note: Values have been rounded to two decimal points.

**Table A6:** Summary of the logistic mixed effect model (glmer(Connective_Type ~ Group + (1|Participant), family = binomial)) comparing the use of adverb versus conjunction out of the clauses containing a temporal connective ($N$ = 154) between the children and the adults.

| **Random effects** | ***Variance*** | ***SD*** | | |
|---|---|---|---|---|
| Participant: intercept | 0.63 | 0.80 | | |
| **Fixed effects** | ***B*** | ***SE*** | ***z*** | ***p*** |
| Intercept | 1.77 | 0.37 | 4.76 | <.001 |
| Group: children versus adults | −2.27 | 0.57 | −3.97 | <.001 |

Note: Values have been rounded to two decimal points.

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