

# Modeling Bilingual Children's Acquisition of Complex Sentences in German

**Daniel Wiechmann (wiechmann@anglistik.rwth-aachen.de)**

RWTH Aachen University  
Department of English Linguistics

**Judith Steinfeld (judith.steinfeld@rwth-aachen.de)**

RWTH Aachen University  
Department of English Linguistics

**Elma Kerz (kerz@anglistik.rwth-aachen.de)**

RWTH Aachen University  
Department of English Linguistics

## Abstract

Although Bilingual First Language Acquisition research has increased considerably over the past few decades, there is still much controversy regarding the rate of development, i.e. the question whether bilinguals lag behind their monolingual peers in various aspects of language. Some studies have found similar rates of development, whereas others have found that bilingual children lag behind their monolingual peers. The current study contributes to this discussion of (dis)similar rates of development by investigating bilingual children's acquisition of German complex sentence constructions involving adverbial clauses (ACs). Our findings are consistent with usage-based approaches to language acquisition, which predict that bilingual acquisition should proceed slower due to learners having less exposure, on average, to each language.

**Keywords:** bilingual first language acquisition; language production; rate of development; complex constructions

## Introduction

### Bilingual First Language Acquisition (BFLA)

There has been an increasing interest in early bilingual language acquisition. Commonly, this interest involves the question of whether the cognitive and developmental path (course of development) and time course (rate of development) of language learning by bilingual children is the same as that of their monolingual peers. Although prevailing theoretical models of language acquisition have different views regarding the influence of endogenous and exogenous factors on the acquisition of abstract linguistic structures and patterns, they agree upon the idea that monolingual and bilingual language learning is qualitatively equivalent in that children go through the same series of developmental phases, starting off with single word productions, followed by two and multi-word utterances before they finally develop the capacity to produce complex sentences (de Houwer, 1995, 2009; Meisel, 1986). Prior research comparing the rate of development in monolingual and bilingual learners has produced somewhat mixed

results. Some studies have found similar rates of development (cf. Paradis, Crago, & Genesee, 2005/2006; Paradis, 2010; Pearson & Fernández, 1994), whereas others have found that bilingual children lag behind their monolingual peers (Gathercole, 2002a, 2002b, 2007; Nicoladis, Palmer, & Marentette, 2007; Pérez-Leroux, Pirvulescu, & Roberge, 2009). The current study contributes to this discussion of (dis)similar rates of development by investigating the bilingual acquisition of complex sentences involving adverbial clauses (ACs) in German, which mark the last stage in a series of milestones mentioned above.

### Usage-based theory and BFLA

Usage-based (UB) theories belong to a family of emergentist models, which assume that the development of language competence is contingent on the experience with language (O'Grady, 2008; Tomasello, 2003; Lieven, & Tomasello, 2008). A conservative assumption about BFLA is that bilingual children, on average, receive less language input per language than their monolingual peers. UB-theories thus predict that reduction in overall exposure to a language should negatively affect children's rate of acquisition (Gathercole, & Hoff, 2007; Paradis, Nicoladis, Crago, Genesee, 2011).

### Usage-based theory and the acquisition of complex sentences

Complex sentences are grammatical assemblies consisting of multiple clauses. Two types of clauses are distinguished: (i) sentences including coordinate clauses and (ii) sentences including a matrix clause and a subordinate clause. Complex sentences containing subordinate clauses can be further subdivided into three basic sub-types: constructions with complement clauses, relative clauses and adverbial clauses. The most comprehensive study on the acquisition of complex sentences framed within UB-theory is Diessel (2004). Diessel proposes that complex sentences develop through two different types of processes: Complex

sentences involving complement and relative clause constructions develop through a process termed *clause expansion*. Complex sentences containing adverbial clauses develop through a process termed *clause integration*, in which two independent sentences are merged into a single bi-clausal unit. The earliest adverbial clauses produced by children are thus free-standing (isolated) clauses introduced by an adverbial subordinator, which are only pragmatically linked to a previous utterance. Over time, children learn to elaborate these structures and integrate them with a matrix clause. The last step in mastering complex sentences involves developing the capacity to produce sentence initial subordinate clauses, which impose greater demands on (verbal) working memory as initial clauses require that the producer has planned the entire complex structure at the onset of the utterance (Gibson, 1998; Hawkins, 2004; Temperley, 2007). Initial adverbial clauses thus develop later and their frequency, at first, is limited to specific subordinators. Another finding of Diessel's (2004) study is that children's early productions of complex sentences are tied to specific lexical expressions. The emergence of more schematic representations of such constructions takes place only after children have been exposed to a sufficient number of types to generalize over. This is reflected in the fact that children only gradually elaborate their repertoire of adverbial subordinators and overextend already learned types to situations where those types are semantically inadequate (e.g. use of a causal subordinator to express concessive or other adverbial relations). Two additional, more general indicators of language proficiency are the mastery of syntactic differences in German main and subordinate clause (verb second in main clauses vs. verb-final positioning in subordinate clauses) (cf. Clahsen & Muyskens, 1986; Miller, 1976; Park, 1981; Roeper, 1973) and mean length of utterance (MLU). MLU has been shown to be an important measurement of a child's gross language development and was found to correlate with the development of morphological and syntactic skills in young children (Brown, 1973; Parker, & Brorson, 2005). Building on this research, the present study sets out to derive statements about differences in the rate of development of complex sentence constructions from measurements of five indicators of language proficiency:

1. Proportion of isolated/integrated adverbial clauses
2. Proportion of sentence-initial adverbial clauses
3. Proportion of misused subordinators
4. Proportion of correct verb position in sub clause
5. (Log) length of adverbial construction (MLU)

### Method

All relevant data were elicited by having children watch a 6.5 minutes episode of a popular stop-motion animated children's television series. The children were then given a visual cue to a particular scene and asked to describe what happened in that scene. The children's responses were audio-recorded and transcribed.

### Participants

A total of 50 children from 4 to 6 years old participated in the study: 25 bilingual child participants (German in combination with another language) and a control group consisting of 25 monolingual children.<sup>1</sup> All bilingual children have started learning both languages before the age of three (McLaughlin, 1984). The children participating in the study were selected from several kindergartens with families from different socioeconomic backgrounds (SES; low SES (~5%), middle SES (~75%), high SES (~20%). The final proportional distributions of monolingual and bilingual children across these three categories exhibit minor, statistically insignificant asymmetries (the proportion of bilinguals was a little greater than expected assuming statistical independence in high and low SES categories). All parents and kindergartens, agreed to participate in the study.

### Data

The elicitation procedure resulted in 27,301 word tokens produced by monolingual learners and 21,023 word tokens produced by bilingual learners. From these corpora, all instances of the target constructions were extracted by way of manual inspection of the corpus data, yielding a total of 1,023 data points (601 from monolinguals, 422 from bilinguals). The extracted data were annotated with information pertaining to the indicators of language competency listed in the preceding section. Table 1 presents relevant descriptive statistics of the sample.

Table 1: Descriptive Statistics

	monolingual	bilingual
age (mean)	5;4	5;5
age (SD)	7.16	6.87
number of ACs total	601	422
ACs integrated	62.73%	50%
ACs in initial position	23.34%	13.74%
subordinator misused	1%	17.77%
correct verb position	72.38%	66.11%
length (mean)	12.36%	10.55
length (SD)	7.2	5.91

The language proficiency levels of the monolingual and bilingual children were compared with respect to five indicators of language proficiency. To test whether and to what extent the proficiency levels of mono- and bilingual learners differ, we asked: Does competence indicator *x* differ significantly between bilingual and monolingual children after controlling for age? The data were analyzed using linear and logit mixed effects models in which each of

<sup>1</sup> There are total of 12 different language pairs within the data. German was acquired in combination with one of the following languages: Albanian, Arabian, Bosnian, English, French, Hungarian, Kurdish, Persian, Russian, Spanish, Turkish or Vietnamese.

the five indicators of language proficiency was modeled as a function of the Boolean predictor BILINGUAL (monolingual vs. bilingual), a control variable AGE (measured in months) and SUBJECT as a random effect.<sup>2</sup> We checked for normality and homogeneity by visual inspections of plots of residuals against fitted values. For all models, the significance of the predictor BILINGUAL was assessed through model comparison: For each model, we conducted likelihood ratio tests to see if a model including BILINGUAL is significantly better than the corresponding model containing only AGE and the random effect (SUBJECT).

### Model 1: Length

Linear Mixed Model fit by REML approximation; p-values estimated via Markov Chain Monte Carlo (MCMC) sampling (n=10.000). Outcome variable (log) length of utterance.

Table 2: (Log) Length Model

Random effects:		Variance	Std.Dev.
child	(Intercept)	2.09	1.44
Fixed effects:		Estimate	MCMCmean
(Intercept)		1.21	1.23
<b>bilingual</b>		<b>0.17</b>	<b>0.17</b>
age		0.01	0.01
			pMCMC
			0.0001
			<b>0.015</b>
			0.0012

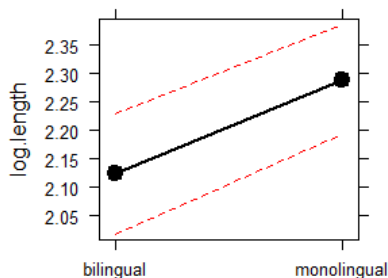


Figure 1: Effect of BILINGUAL on (log) LENGTH of construction

The analysis reveals that there is a weak but statistically significant effect of BILINGUAL on the (logged) length of the construction (a log likelihood ratio test comparing null model and model including bilingual yields  $\text{Pr}(\text{Chi}) < 0.05$ ). The positive coefficient estimate in Table 2 indicates that the average construction length of monolingual learners is greater than that of bilingual learners, when age is controlled for.

### Model 2: Integration

Mixed Logit Model fit by Laplace approximation. Outcome variable is proportion of integrated (= non-isolated) adverbial clauses.

Table 3: Integration Model

Random effects:		Variance	Std.Dev.
child	(Intercept)	2.09	1.44
Fixed effects:		Estimate	SE
(Intercept)		-5.64	1.87
<b>bilingual</b>		<b>1.30</b>	<b>0.46</b>
age		0.07	0.03
			Pr(> z )
			0.00254
			<b>0.00461</b>
			0.01469

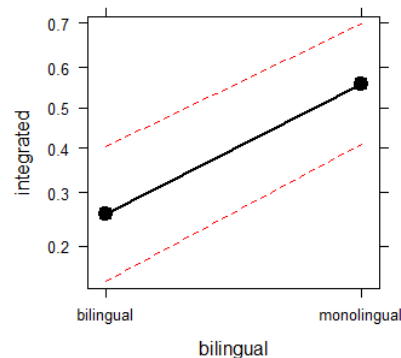


Figure 2: Effect of BILINGUAL on proportion of integrated adverbial clauses (AC)

The analysis reveals a weak but statistically significant effect of BILINGUAL on the proportion of integrated adverbial clauses (a log likelihood ratio test comparing null model and model including bilingual yields  $\text{Pr}(\text{Chi}) < 0.01$ ): Monolingual learners produce significantly more complex constructions (integrated ACs), when age is controlled for.

### Model 3: Verb Position in Subordinate Clause

Mixed Logit Model fit by Laplace approximation. Outcome variable is proportion of adverbial clauses with correct (=clause final) verb position.

Table 4: Verb Position Model

Random effects:		Variance	Std.Dev.
child	(Intercept)	1.61	1.27
Fixed effects:		Estimate	SE
(Intercept)		0.94	1.61
<b>bilingual</b>		<b>0.46</b>	<b>0.40</b>
age		-0.01	0.03
			Pr(> z )
			0.56
			<b>0.25</b>
			0.75

<sup>2</sup> All data were analyzed using R (R Core Team, 2012) and the functions provided in the R packages *lme4* (Bates & Maechler, 2009) and *languageR* (Baayen, 2009)

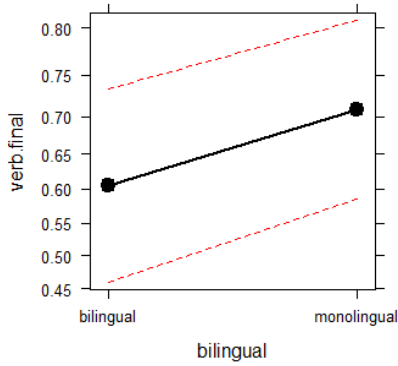


Figure 3: Effect of BILINGUAL on correct verb position in adverbial clauses (AC)

The analysis reveals a tendency for monolingual learners to produce a greater number of correct verb position but the effect is not statistically significant (a log likelihood ratio test comparing null model and model including bilingual yields  $\Pr(\text{Chi}) > 0.25$ ).

**Model 4: Subordinator Misuse**

Mixed Logit Model fit by Laplace approximation. Outcome variable is proportion of incorrectly used subordinators

Table 5: Subordinator Misuse Model

Random effects:		Variance	Std.Dev.
child	(Intercept)	5.90	2.43
Fixed effects:		Estimate	SE
(Intercept)		2.49	4.10
<b>bilingual</b>		<b>-3.74</b>	<b>1.05</b>
age		-0.08	0.06
			0.22

The analysis reveals a medium sized and statistically significant effect of BILINGUAL on the proportion of correctly used subordinators (a log likelihood ratio test comparing null model and model including bilingual yields  $\Pr(\text{Chi}) < 0.001$ ): Bilingual learners produce significantly more semantically inadequate subordinators.

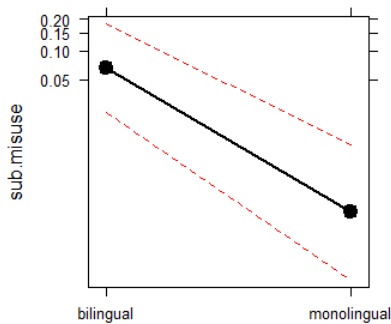


Figure 4: Effect of BILINGUAL on misuse of adverbial subordinator

**Model 5: Adverbial Clause Position**

Mixed Logit Model fit by Laplace approximation. Outcome variable is proportion of sentence-initial adverbial clauses. This model was fit to the subset of the data that contains only those utterances that contain at least two clausal constituents, so that the adverbial clause can either precede or follow the main clause (N=588).

Table 6: AC Position Model

Random effects:		Variance	Std.Dev.
child	(Intercept)	5.39E-20	2.32E-10
Fixed effects:		Estimate	SE
(Intercept)		0.21	1.17
<b>bilingual</b>		<b>0.56</b>	<b>0.24</b>
age		-0.03	0.02
			0.0755

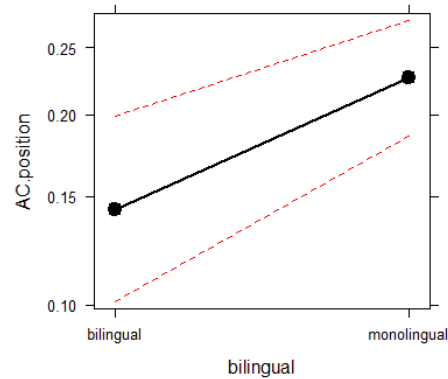


Figure 5: Effect of BILINGUAL on proportion of sentence-initial ACs

The analysis reveals a weak but statistically significant effect of BILINGUAL on the proportion of sentence-initial adverbial clauses (a log likelihood ratio test comparing null model and model including bilingual yields  $\Pr(\text{Chi}) < 0.05$ ): Bilingual learners produce significantly fewer sentence initial adverbial clauses.

**Discussion**

Prior research into the rate of bilingual and monolingual development has produced somewhat inconclusive results. While some studies have found similar rates of development, other studies found that bilingual children lag behind their monolingual peers in various aspects of language. Furthermore, the majority of research on the accuracy of bilingual production has been devoted to earlier phases of grammatical development such as the acquisition of the past tense (e.g. Paradis et al., 2011), the acquisition of mass/count nouns (Gathercole, 2000a) or the acquisition of grammatical gender (Gathercole, 2000b). Our findings contribute to this area of research by providing additional evidence from later stages of grammatical development, namely complex sentences, which constitute the last milestone in the acquisition of grammar (cf. Clahsen, 1986).

The research question guiding our analysis was as follows: Are bilingual children less proficient than their monolingual peers in the production of German complex sentences with adverbial clauses? *Experience-driven* or *usage-based* theories of language predict that bilingual children's acquisition of complex sentences should proceed slower due to them having less exposure, on average, to each language. We tested this general prediction across multiple dimensions. The five dimensions that served as responses in our models jointly define the space in which we measured language proficiency of monolingual and bilingual learners. We observed that bilinguals in fact lag behind in four out of five dimensions: their adverbial constructions are shorter, less often integrated into a complex sentential structure and when they are integrated, they are less often placed in sentence-initial position. Furthermore, bilingual productions exhibited a greater amount of violations of the semantic usage conditions of adverbial subordinators. This suggests that bilingual children have not yet developed a very nuanced set of words to link verbalizations of two events.

Overall, the present work clearly indicates that bilinguals around age five have not caught up on their monolingual peers in the domain of complex sentences. The only dimension where performance was equivalent across the two groups concerns the positioning of the finite verb in German subordinate clauses. However, as both groups are still quite removed from adult-level performance (< 80% correct usages in both groups), this finding cannot be attributed to the children's having mastered this grammatical domain. Our results also display a considerable amount of inter-individual differences as evidenced by rather pronounced intercept adjustments in the models. Some bilingual children even outperform some monolingual children across all dimensions. While some variation is expected to result from inter-individual differences in learning performance, prior research suggests that a large portion of the observed differences may also relate to various types of group-level differences (cf. Werker, & Byers-Heinlein, 2008, for an overview). These include variation due to specific language pairs (Döpke, 2000; Holm, & Dodd, 1999; Müller, 1999; Müller & Hulk, 2001; Nicoladis, 2003; Paradis, & Navarro, 2003; Yip & Matthews, 2000), contexts of exposure (Kazuya, 1998), social status of the languages (De Houwer, 2007; Pearson, 2007), socioeconomic status (Morton, & Harper 2007), and language dominance (Cutler, Mehler, Norris, Segui, 1989; Flege, MacKay, & Piske, 2002; Gathercole, & Mön Thomas, 2009). Disentangling the effects of these variables from the effects of an individual's learning performance is subject to further investigation.

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