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Research Report

Children with specific language impairment: The role of prosodic processes in explaining difficulties in processing syntactic information☆

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ABSTRACT

Children with specific language impairment (SLI) experience great difficulties in language comprehension and/or production whereby the majority of these children have particular problems in acquiring syntactic rules. In the speech stream boundaries of major syntactic constituents are reliably marked by prosodic cues. Therefore, prosodic information provides an important cue for discovering the syntactic structure of a language [Jusczyk, P.W., 2002. How infants adapt speech-processing capacities to native language structure. Curr. Dir. Psychol. Sci. 11, 15–18.]. Following this, the question is, whether children with SLI differ in the processing of syntactic information from normally developing children and to what extent this is related to the processing of the inherent prosodic information. Children heard either correct sentences or sentences with a word category violation (syntactic level) and a joined prosodic incongruity (prosodic level) while event-related brain potentials (ERPs) were recorded. Judging the sentence's correctness, control children performed better than children with SLI for all types of sentences. With respect to the ERPs, control children showed a bilateral early starting anterior negativity sustaining into a late anterior negativity and a P600 in posterior regions in response to incorrect sentences. Children with SLI showed a comparable P600 but unlike the control children there was only a late, clearly left lateralized anterior negativity. The complete absence of a right anterior negativity in children with SLI suggests that they may not access prosodic information in the same way normal children do. The differences in prosodic processing may in turn hamper the development of syntactic processing skills as indicated by the absence of the syntax-related early left anterior negativity.

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Abbreviations: SLI, Specific language impairment; ERPs, Event-related brain potentials

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1. Introduction

The term specific language impairment (SLI) refers to children whose language development is substantially below their chronological age, despite a normal nonverbal intelligence and no obvious neurological or physiological impairments, or emotional and/or social difficulties which could impact on language use (Bishop, 1997; Leonard, 2000). There is evidence that children with SLI experience significant difficulties in a variety of linguistic domains (e.g., semantics, Neville et al., 1993). However, a substantial portion of these children have significant problems acquiring syntactic rules (van der Lely, 2005; van der Lely and Fonteneau, 2006). The difficulty children with SLI have in successfully learning novel syntactic rules has been attributed to their inability to use prosodic information in the way normally developing children do (Weinert, 1992). In a recent study, Fisher et al. (2007) showed that children with SLI could not use prosodic cues as their peers did in order to decide whether low-pass filtered sentences matched or were different from unfiltered sentences. The authors concluded that children with SLI might not benefit from prosodic information to the same degree as normal children.

From developmental studies there is convincing evidence that young infants are sensitive to prosodic cues that mark syntactic phrases (Hirsh-Pasek et al., 1987; Höhle and Weissenborn, 2003; Pannekamp et al., 2006), thereby facilitating the discovery of the syntactic structure (for an overview see Gerken and McGregor, 1998; Jusczyk, 2002).

Normal comprehension of a spoken sentence requires the analysis and integration of phonetic, prosodic, syntactic, and semantic information within a very short timeframe. Event-related potentials (ERPs) – a measure of brain activity – have proved useful for characterizing the time course of language comprehension by providing precise information in the range of milliseconds (Banaschewski and Brandeis, 2007). ERP components are sensitive to different types of linguistic information (e.g., Münte et al., 1993). Two ERP components, namely an early left anterior negativity (ELAN, 100–300 ms after the onset of the critical word) and a late positivity (P600, 300–900 ms) have been observed in response to the processing of syntactic information (Friederici, 2002; Hahne and Friederici, 1999). Functionally, the ELAN is thought to reflect processes of initial phrase structure building, while the P600, elicited by syntactic violations, is thought to represent processes of revision (e.g., reanalyses or repair). From studies of language development, there is evidence that a biphasic pattern of a child-like ELAN (300–500 ms) followed by a P600 (1100–1500 ms) already can be observed in 32-month old toddlers in response to active sentences with a local phrase structure violation (Oberecker et al., 2005). Interestingly, 24-month old children showed only a P600 (1100–1700 ms) and no child-like ELAN, when listening to the same sentences as the 32-month olds (Oberecker and Friederici, 2006). In response to sentences with a morpho-syntactic violation (e.g., verb tense violation), Silva-Pereyra et al. (2005) reported for 36-month children a slightly different pattern comprising two positivities. An early positivity (200–600 ms) most prominent over anterior region and a late, broadly distributed positivity (600–1000 ms, Silva-Pereyra et al., 2005). Functionally, the latter was interpreted as process of repair once the syntactic violation has been detected.

With respect to age related changes, an adult-like ELAN with an early onset and a left lateralization was only observed in 13-year olds (Hahne et al., 2004). The differences in the development of these components could be based on the characteristics of the reflected processes. There is evidence that processes reflected in the ELAN were characterized as highly automatic while processes reflected in the P600 seem to be more controlled than automatic in nature (Hahne and Friederici, 1999).

In two recent studies, Eckstein and Friederici (2005, 2006) reported a right lateralized anterior negativity (300–500 ms after the stimulus onset) elicited by a prosodic incongruity and a bilateral early anterior negativity in response to a syntactic violation and a joined prosodic incongruity (Eckstein and Friederici, 2006). The right anterior negativity was interpreted as reflecting prosodic processes in supporting sentence comprehension. This interpretation converges with the Dynamic Dual-Path Model which describes the underlying network of phonological, syntactic and semantic processes in auditory sentence comprehension (Friederici and Alter, 2004). Functionally, a right fronto-temporal pathway has been suggested to be involved in the processing of sentence-level prosody while the left fronto-temporal pathway is devoted to the processing of segmental phonological information.

With respect to developmental changes, only sentences with a syntactic violation and a joined prosodic incongruity were investigated in children so far (Hahne et al., 2004). Children find sentences including only a prosodic incongruity very difficult to comprehend both, on the syntactic and semantic level. Sentences with a syntactic and joined prosodic manipulation were created by excising a noun from a prepositional phrase thus resulting in a violation of the syntactic structure and an incongruous continuation of the prosodic contour (see Fig. 1). The study conducted by Hahne et al. (2004) investigated five groups of normally developing children, including 6-, 7-, 8-, 10- and 13-year olds. Sentences with a syntactic and joined prosodic manipulation elicited in children between 6 and 8 years of age a bilaterally distributed anterior negativity in a later time window (400–600 ms). By contrast, in older children (13 years of age) these effects tend to be more left lateralized with an earlier onset (100–300 ms, Hahne et al., 2004).

Moreover, differences in prosodic awareness on the individual level have been shown to be reflected in distinctive differences in the topographical distribution of the ERP responses (Eckstein, 2007). Using the identical experimental manipulation as in the present study, ERP effects of three groups of adult participants with low, medium and high prosodic awareness were compared. A combination of a bilaterally distributed E(L)AN and a sustained negativity was observed in participants with low prosodic awareness. By contrast, participants with high prosodic awareness showed an ELAN restricted to the left hemisphere and no sustained negativity. Participants with medium prosodic awareness showed an ERP pattern in-between the EPR pattern found for the groups with high and low prosodic awareness, comprising

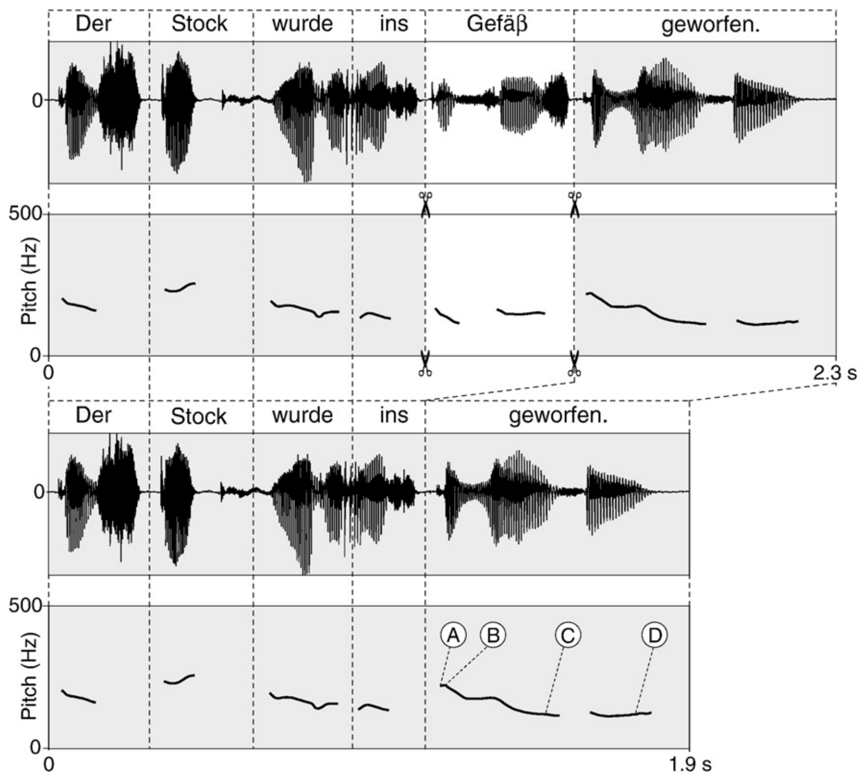


Fig. 1 – The upper two panels show the oscillogram and the fundamental frequency (f_0) for the original sentences containing a complete prepositional phrase. The scissors indicate the cutting points. The lower two panels provide the oscillogram and the pitch contours after the excision of the filler noun Gefäß ('container'). The past participle appears now immediately after the preposition resulting in an unexpected continuation of the prosodic contour that is characterized by the following prosodic features: (A) fracture in the prosodic contour since the rose up of the sentence melody is disrupted; (B) the f_0 maximum of the past participle (*geworfen*) is higher than the f_0 maximum of the filler noun (*Gefäß*); (C) the sharp fall in the f_0 contour at the end of the past participle (*geworfen*); (D) small rise in the f_0 contour at the end of the past participle following the sharp fall described under (C).

a bilaterally distributed E(L)AN followed by a left lateralized sustained negativity.

Prosodic information has been shown to play an important role during language acquisition in order to learn syntactic regularities (Höhle and Weissenborn, 2003; Jusczyk, 2002). As language learners become more experienced and proficient, prosodic information might be in particular relevant for language comprehension if there is a mismatch between different types of information such as prosody and syntax. However, children with SLI may not be able to use prosodic information in the way unimpaired children do in order to acquire new syntactic rules.

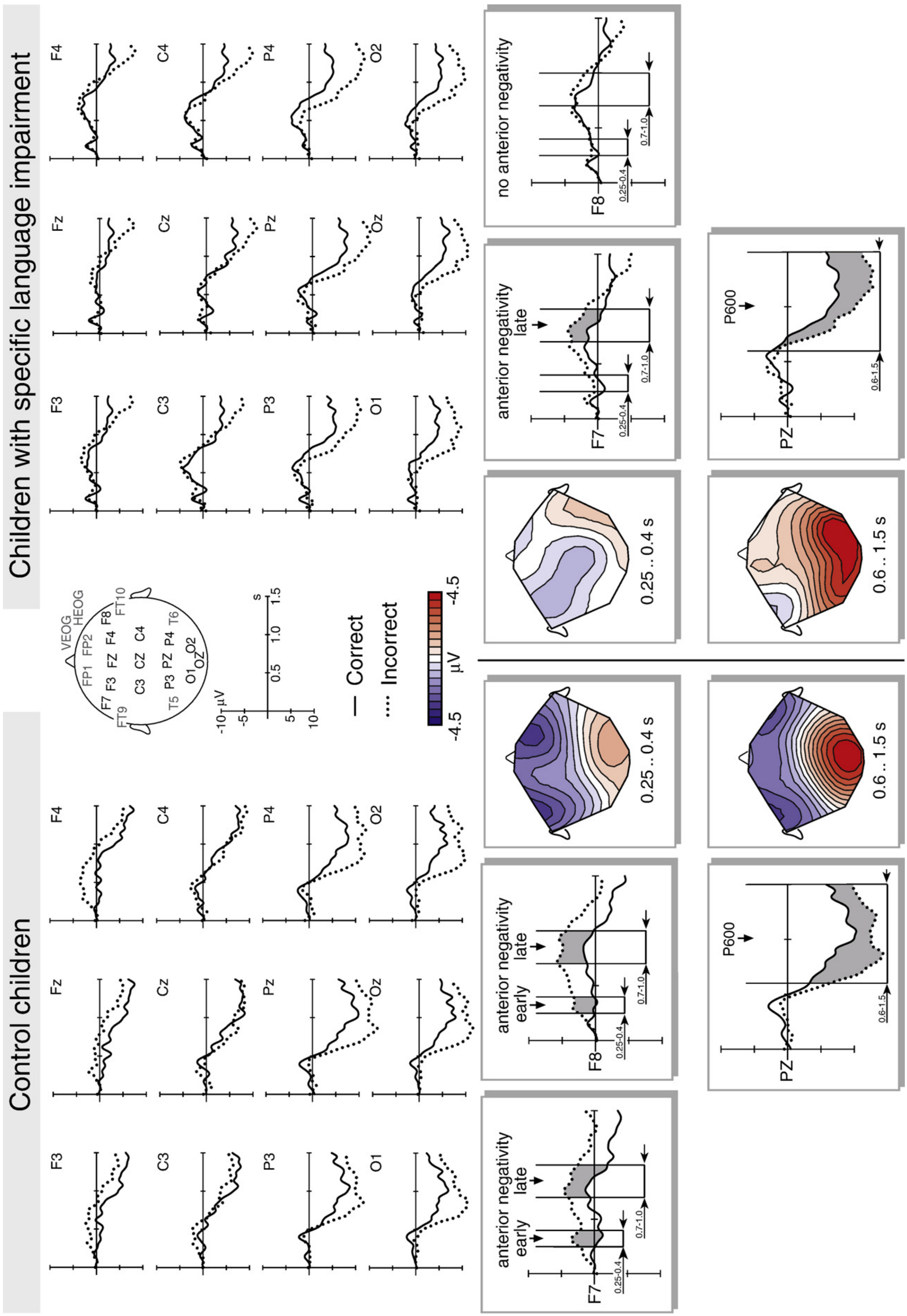
The aim of the present study was two-fold, (a) to test whether children with SLI differ from normally developing children in the processing of syntactic information (indexed by the early left anterior negativity and the P600) and, (b) to test differences in the processing of prosodic information (indicated by the right anterior negativity).

2. Results

In the judgment task, both groups of children performed clearly above chance level and accuracy rates (performance of correct answers in percentage) were high [control children: correct: $M=91.3$ (SD=5.2), incorrect: $M=93.7$ (SD=3.6); children with SLI: correct: $M=83.2$ (SD=7.1), incorrect: $M=79.8$ (SD=12.0)]. The mean accuracy rates obtained in the judgment task were submitted to a repeated-measure ANOVA with the factors Group and Condition. The analysis revealed a significant effect of Group [$F(1,30)=30.6$, MSE=1936.9, $p<0.001$] but no further effect or interaction. This means that control children performed better than children with SLI without any difference across conditions.

The grand averaged ERPs evoked by the violation condition showed for the control children a combined pattern of an early bilateral anterior negativity (250–400 ms) sustaining into a late negativity over anterior electrode sites and a positivity (600–1500 ms) over posterior electrode sites (see Fig. 2). For children with SLI only a late left lateralized anterior negativity (700–1000 ms) and a broadly distributed positivity (600–1500 ms) was observed.

For the statistical analysis three time windows were identified. In time window 1 (250–400 ms), the Between-Group analysis revealed a significant two-way interaction of Condition and Region [$F(1,30)=6.22$, MSE=8.21, $p<0.05$] and a marginally significant three-way interaction of Group, Condition, and Region [$F(1,30)=3.22$, MSE=8.21, $p=0.08$] for the lateral electrodes. There was no significant effect for the


Control children
Children with specific language impairment
F3
Fz
F4
C3
Cz
C4
P3
Pz
P4
O1
Oz
O2
anterior negativity early late
anterior negativity late
no anterior negativity
P600
F7
F8
PZ
0.25-0.4
0.7-1.0
0.6-1.5
0.25 .. 0.4 s
0.6 .. 1.5 s
VEOG
HEOG
FP1 FP2
F7 F3 FZ F4 F8
FT9 FT10
C3 CZ C4
T5 P3 PZ P4 T6
O1 OZ O2
µV
-10
-5
5
10
s
0.5
1.0
1.5
Correct
Incorrect
-4.5

midline electrodes. Following up the interaction of Group, Condition, and Region further analyses for each group and region (anterior versus posterior) were conducted. For the control children, a main effect of Condition revealed significance for the anterior region reflecting an early anterior negativity [$F(1,15)=14.99$, MSE=29.49, $p=0.001$]. In addition, for the posterior region, there was a marginally significant interaction of Condition and Electrode [$F(7,105)=2.38$, MSE=4.20, $p=0.09$]. Resolving the interaction of Condition and Electrode, no effect revealed statistical significance. In contrast to the children of the control group, there was no statistical effect for the children with SLI.

In time window 2 (600–1500 ms), the Between-Group analysis for the lateral electrodes showed reliable interactions of Group×Condition [$F(1,30)=4.03$, MSE=16.04, $p=0.05$] as well as Condition×Region [$F(1,30)=29.97$, MSE=8.45, $p<0.001$]. For the midline electrodes, there was a significant main effect of Condition reflecting a similar P600 effect for both groups [$F(1,30)=8.81$, MSE=34.96, $p<0.01$].

Following up the interaction of Group×Condition and Condition×Region, separate analyses were calculated for each group for the anterior and posterior region. For the control children, there was a main effect of Condition for the anterior region, reflecting a reliable negativity over the frontal area [$F(1,15)=14.85$, MSE=28.71, $p<0.01$]. Furthermore, for the posterior region a main effect of Condition as well as an interaction of Condition×Electrode revealed significance [Condition: $F(1,15)=5.29$, MSE=51.87, $p<0.05$, Condition×Electrode: $F(7,105)=4.51$, MSE=6.31, $p<0.01$]. Resolving the interaction of Condition×Electrode, a positivity was observed at nearly all posterior electrodes except the central and left temporal electrodes (C3, C4 and T5, see Table 1).

In contrast to the control children, children with SLI showed no reliable effect for the anterior region. However, a main effect of Condition and an interaction of Condition×Electrode were observed for the children with SLI over the posterior region [Condition: $F(1,15)=13.25$, MSE=61.25, $p<0.01$, Condition×Electrode: $F(7,105)=2.90$, MSE=4.39, $p<0.05$]. Following up the interaction of Condition×Electrode, a positivity was found at nearly all electrodes except C3 (see Table 1). The P600 effect observed for the children with SLI is comparable with the P600 effect for the control children.

Based on the calculation of Condition effects for the 50 ms time intervals, a very late, left anterior negativity was observed for the children with SLI between 700–1000 ms. This effect coincides with the larger and broadly distributed P600 effect and subsequently does not reveal statistical significance in the global analysis. Therefore, additional analyses in the third time window (700–1000 ms) were conducted for the left and right anterior region for each group separately (left anterior: Fp1, F7, F3, Ft9, right anterior: Fp2, F8, F4, Ft10). For control children, a reliable effect of Condition was found [left: $F(1,15)=7.62$, MSE=32.75, $p=0.01$, right: $F(1,15)=9.48$, MSE=26.01, $p<0.01$] reflecting a bilaterally distributed negativity. In contrast, for children with SLI, a main effect of Condition revealed significance at left electrode sites pointing towards a very focal anterior negativity [left: $F(1,15)=4.86$, MSE=13.90, $p<0.05$, right: $F(1,15)=2.09$, MSE=23.68, $p=0.17$].

Table 1 – Mean amplitudes for the P600 effect (600–1500 ms) for the children with SLI and control children

Electrodes	Children with SLI (t_{15}=)	Control children (t_{15}=)
C3	<1	<1
C4	6.02*	<1
T5	6.62*	<1
T6	14.25**	6.67*
P3	10.85**	4.45°
P4	16.56**	10.04**
O1	11.81**	3.78°
O2	13.63**	13.55**

°$p<.1$, *$p<.05$, **$p<.01$, ***$p<.001$.

3. Discussion

The present study was conducted to investigate auditory sentence comprehension mechanisms in children with SLI. The processing of correct sentences was contrasted with that of sentences containing a word category violation and an incongruous continuation of the prosodic contour. The experimental manipulation was created by excising a noun from a prepositional phrase resulting in a syntactic violation and an unexpected modulation of the prosodic contour. Behaviorally, children with SLI performed significantly worse than control children although their performance was still above chance level. The difference in the performance is not surprising given that these children typically have deficits in comprehension as well as syntax (Bishop, 1997; van der Lely, 2005).

The ERP data for the control children revealed a combined pattern of a bilaterally distributed early anterior negativity (250–400 ms) sustaining into a late bilateral anterior negativity and a P600 over posterior regions (600–1500 ms). Interestingly, children with SLI had a similar P600 but differed with respect to the anterior negativity by showing only a very late and focal left anterior negativity (700–1000 ms) and no anterior effect in the earlier time windows.

With respect to the early left anterior negativity observed for the control children, these results confirm the findings from Hahne et al. (2004) for the 8- and 10-year old children. These children lack an anterior negativity within the early time window (100–300 ms) which is typically observed in children older than 13 years. In the current study, a slightly different time window (250–400 ms) was selected to focus on syntactic processes in normally

Fig. 2 – Grand average ERPs of the control children (left column) and the children with SLI (right column). The syntactically and prosodically incorrect condition (dotted line) is plotted against the correct condition (solid line). The axis of the ordinates indicates the onset of the critical word (past participle). Negative voltage is plotted up. The pictures of the enlarged electrodes F7, F8, and Pz contain gray-shaded sections indicating regions that were statistically different.

developing children and children with SLI rather than to analyse developmental changes.

The processing of a word category violation in simple active sentences was investigated in 2–3-year olds and elicited a left anterior negativity between 300 and 500 ms (Oberecker and Friederici, 2006). These results suggest that the neural mechanisms of syntactic processing, observed in adults, are also present at this young age. However, adult-like automatic processes of phrase structure building are not established until puberty (Hahne et al., 2004). Children with SLI lack a left anterior negativity in the early time window but show a left anterior negativity in the very late time window. The late left anterior negativity for children with SLI suggests that their comprehension processes are not as early as in age-matched controls and do not show the same level of automaticity. Functionally, it could be assumed that the late left anterior negativity observed for the children with SLI reflected delayed syntactic processes of phrase structure building.

The right anterior negativity which has been shown to reflect prosodic processing (Eckstein and Friederici, 2006), was not present in children with SLI. This suggests that they might not rely on prosodic information in the way normal controls do. These results converge with the findings of Weinert (1992) who showed that unimpaired control children were able to learn syntactic rules from prosodically enriched sentences whereas language impaired children were not. A deficiency in the processing of prosodic information as observed in children with SLI seems to have a negative impact on the development of fast, automatic syntactic processes.

In both groups, violations of syntax and prosody also elicited a P600 effect, which had a similar distribution and latency for the children with SLI and the controls. Functionally, the P600 in response to syntactic violations is assumed to reflect late and relatively controlled processes of reanalyses and repair (Friederici, 2002; Hahne and Friederici, 1999). The similarities in the distribution and latency of the P600 suggest that these processes might be intact in children with SLI. Given the absence of early and highly automatic syntactic processes in children with SLI it appears that they rely more on late and controlled syntactic processes to comprehend sentences.

4. Conclusion

The current study investigating processing of syntax and prosody of children with SLI and control children during auditory sentence comprehension revealed distinct differences in ERP response patterns in the two groups. The absence of a prosody-related right anterior negativity in children with SLI indicates deficiencies in the processing of prosodic information which may in turn hamper the development of early syntactic processing as reflected by absence of an early, left anterior negativity. The similarities in the distribution and latency of the P600 in children with SLI and controls suggest that these processes are intact in children with SLI and provide a mechanism to achieve comprehension in the course of auditory sentence comprehension.

Table 2 – Descriptive data for the children with SLI and control children

	Children with SLI	Control children	Differences
Age	9;8 (1;9)	9;7 (1;9)	$t=-.47$
Nonverbal intelligence°	101.7 (12.1)	102.5 (9.3)	$t=.26$
Language comprehension#	37.1 (7.1)	51.6 (5.1)	$t=7.69^{***}$
Language production#	23.3 (6.9)	53.1 (6.5)	$t=15.15^{***}$

Mean (Standard deviation), °IQ-Scores ($M=100$, $SD=15$), #T-Scores ($M=50$, $SD=10$), $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$.

5. Experimental procedures

5.1. *Participants*

In the present study, sixteen children with SLI and 16 normally developing children (12 boys) were investigated. The children of both groups were matched pairwise on age, gender and nonverbal intelligence (see Table 2).

All children were monolingual German speakers with a nonverbal intelligence within the normal range as tested by the Kaufman-Assessment Battery for Children (Melchers and Preuss, 1991) or the German Version of the Wechsler Intelligence Scale for Children (Tewes et al., 2000). None of them had any hearing deficit (audiometric screening procedure) or reported a history of neurological disorders (parent questionnaire, spontaneous EEG assessed by an experienced child and adolescent psychiatrist). Furthermore, to ensure the control participants had no signs of developmental or psychiatric disorders, the German version of the Child Behavior Checklist (Arbeitsgruppe Deutsche Child Behavior Checklist, 1998) was applied.

The two groups differed significantly in their language abilities. Children with SLI had language comprehension and/or production abilities at least 1.5 standard deviations below the mean, resulting in significant group differences in language comprehension and production as shown in Table 2. Children with SLI additionally met the diagnostic criterion of a difference of at least 1 standard deviation between their nonverbal intelligence and their language abilities. All participants' parents gave informed consent as specified in the guidelines of the Ethic Commission of the Ludwig-Maximilians-University Munich.

5.2. *Stimuli and experiment*

The experiment consisted of 192 sentences in passive voice, comprising four test conditions. Two experimental conditions contained either a violation of syntactic or semantic constraints while the two other conditions fulfilled all syntactic and semantic requirements. Please note, that in the context of this article data obtained in response to two test conditions will be compared, namely the sentences with a syntactic violation and a joined prosodic incongruity versus the sentences that are syntactically and prosodically correct. ERP responses in relation to the sentences with a semantic violation and sentences of the control condition were reported in Sabisch et al., (2006).

In the syntactic violation condition, sentences were created from sentences which included a full prepositional phrase (e.g. *ins Gefäß* 'in-the container'), from which the noun had been deleted (excised, see Fig. 1). At the segmental level, the local transitions between the preposition and the noun (e.g., *ins Gef…*) as well as the local transition between the noun and the past participle (e.g., *…fäß gef…*) were identical. These constrains were set up to control for coarticulation.

The excision of the noun from the prepositional phrase resulted in a word category violation as the preposition obligatorily requires a noun phrase (e.g., *Der Stock wurde ins geworfen*. 'The stick was *in-the* thrown.'). Additionally, this manipulation resulted in a prosodic incongruity since it was followed by a sentence-final intonation contour instead of prefinal intonation contour. In the control condition, sentences fulfilled all syntactic and semantic constraints (e.g., *Der Ball wurde geworfen*. 'The ball was thrown.'). In addition, there was a second syntactically and semantically correct condition (e.g., *Der Stein wurde ins Wasser geworfen*. 'The stone was in-the water thrown.'). Sentences in this condition were included to ensure that the participants did not immediately recognize the syntactic violation condition whenever they encountered the preposition. In all conditions, ERPs were analysed from the onset of the sentence final past participle (e.g., *geworfen* 'thrown'). All the participles used began with the morpheme *ge-*. All sentences were spoken by a female native speaker of German and recorded on a digital audiotape. The taped sound files had a 16-bit resolution and were sampled at a frequency of 20 kHz.

5.3. *Procedure*

The diagnostic procedure and the ERP recording were carried out in two separate sessions each lasting approximately 2 h. The ERP experiment was divided into four blocks, each containing 48 sentences. After the sentence offset participants waited for 3000 ms before making a judgment about the sentence's correctness. The wait was designed to avoid movement artifacts. Each sentence was judged as being correct or incorrect by pressing one of two buttons. One of the buttons contained a smiling face indicating correctness whereas the other button showed a frowning face referring to incorrectness. Participants practiced before the experiment on 15 trials.

5.4. *EEG recording*

EEG-data were recorded from 22 Ag/AgCl electrodes with a right mastoid reference (electrode impedances $<5\ k\Omega$, sampling rate of 256 Hz, bandpass filter 0.16–30 Hz). Vertical and horizontal eye movements were monitored by a bipolar montage with electrodes placed below and above the right eye as well as at the outer left and right canthi. Offline, the recordings were re-referenced to the average of the right and left mastoids.

5.5. *Data analyses*

For the EEG analysis only correctly answered trials were analyzed. As a first step, the mean amplitude and the standard deviation within a 200 ms sliding window was calculated. These segments of the EEG signal in which the standard deviation exceeded a threshold of 40 μV were automatically marked as artifact. Afterwards all segments with markings were inspected and rejected if these segments contained real artifacts (e.g., head or jaw movement). As a second step, segments with typical eye movements were marked and corrected afterwards by applying an electrooculogram correction tool (exog, EEP software 3.1 for Unix, Nowak & Pfeiffer, Leipzig, Germany).

The mean number of retained trials for each condition and each group was estimated [control children: correct: $M=23.7$ (SD=4.8), incorrect: $M=26.2$ (SD=5.4); children with SLI: correct: $M=23.6$ (SD=6.4), incorrect: $M=21.6$ (SD=4.8)]. These mean numbers of retained trials were submitted to a repeated-measure analysis with the variables Condition (within-subject factor) and Group (between-subject factor) with the covariate accuracy rate (performance of correct answers). There was no significant effect of Condition or Group ($F<1$) and no interaction of Condition × Group ($F(1,28)=2.91$, MSE=6.38, $p=0.10$) reflecting that a similar number of trials was averaged when taking the number of correctly judged trials into account.

EEG epochs of 1500 ms beginning from the onset of the past participle (e.g., *geworfen*) were extracted from the continuous EEG. ERPs were averaged relative to a 100 ms post-stimulus baseline covering the first 100 ms of the past participle (e.g., *geworfen*). This post-stimulus baseline was chosen in order to avoid the comparison of different word types (auxiliary versus preposition, cf. Hahne and Friederici, 1999).

Mean ERP amplitudes were calculated for three different time windows (250–400 ms, 600–1500 ms and 700–1000 ms). The time windows were determined based on the following steps. First, condition effects were calculated for intervals of 50 ms for each electrode over the whole time range of 1500 ms for both groups separately. Moreover, to define a time window there had to be a significant effect in at least three consecutive 50 ms intervals. These analyses showed a condition effect between 250 and 400 ms for the children of the control group over left and right anterior regions. In addition, there was a condition effect beginning at 450 ms and sustaining until 1500 ms. However, for the children with SLI there was only a late condition effect over left electrodes (700–1000). Second, the time window for the P600 (600–1500 ms) was based on the findings reported by Hahne et al., 2004 which showed that the P600 is a relatively stable effect with no shifts in the onset latency from 7 years of age on.

For the global analysis repeated-measure ANOVAs were performed for each time window separately with the exception that the analysis for time window three (700–1000 ms) was done for the frontal regions based on the coincidence of a large effect at posterior regions and a focal effect at the left frontal region. For the global analysis, the between-subject factor Group (control children vs. children with SLI) and three within-subject factors, Condition (correct vs. incorrect), Hemisphere (left vs. right) and Region (anterior vs. posterior), were defined to analyse the 16 lateral electrodes. The analysis of the midline electrodes included the between-subject factor Group, and the within-subject variables Condition, and Electrode (Fz, Cz, Pz, and Oz). Whenever an interaction between the factors Group and Condition and one of the topographical variables reached at least marginal significance ($p<.1$) for the lateral electrodes, a follow-up analysis for each group in the region of interest was performed. The follow-up analyses included the variables Condition and Electrode and was conducted region-wise (anterior: Fp1/2, F7/8, F3/4, Ft9/10, posterior: C3/4, T5/6, P3/4, O1/2).

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