

PROFILES OF POOR AND GOOD SPELLERS IN GERMAN NOUN CAPITALIZATION

KATINKA MANGELSCHOTS¹, SONJA UGEN² & CONSTANZE WETH¹

¹*Department of Humanities (DHUM), University of Luxembourg, Luxembourg;* ²*Luxembourg
Centre for Educational Testing (LUCET), University of Luxembourg, Luxembourg*

Abstract

This study investigated how fourth graders with different proficiency levels (1st and 4th quartile, 192 and 195 pupils respectively) produce and detect German noun capitalization in relation to two factors, lexical-semantic characteristics of the noun and the structure of the noun phrase (NP). The first factor includes concrete and abstract nouns, as well as nominalized verbs and adjectives; the second factor the syntactic context of the NP (with or without determiner and/or adjective, including bare noun). The two proficiency groups showed different patterns in the production and detection of capitalization in relation to these two factors after three years of instruction in noun capitalization. The low-proficiency group performed on chance level only for concrete nouns in the context with precedent determiner, the context highlighted at school. The high-proficiency group seemed to make use systematically of the expanded NP in order to recognize and capitalize the noun but still had difficulties with most bare nouns. The paper discusses the type of information low- and high-achieving pupils seem to use in noun capitalization and detection.

Keywords: German, noun capitalization, proficiency groups, syntactic spelling, error detection

1. INTRODUCTION

This paper investigates the performances of high- and low-achieving fourth graders in noun capitalization and detection in German. Noun capitalization refers to the mandatory use of an upper-case letter for nouns in German. It is an example of a syntactic marker, i.e., an orthographic element that is not represented in phonology and contains information on the agreement structure (Weth, 2020). Examples of other syntactic markers are the apostrophe in English (Bryant et al., 2000) or plural marking in French (Fayol et al., 2006). All syntactic markers are salient in writing and at first sight, the rule governing these syntactic markers seems easy: If the word is a noun, it is capitalized (in German) for example, or if the words is in plural, add –s (in French). Consequently, young children may already produce syntactic markers in some words and sentence contexts. Frequency and semantics also influence syntactic spelling (Sandra, 2012; Weth, 2020). Syntactic spelling, and some forms of detection and proof reading is, in general, unrelated to the orthographic lexicon and might require a syntactic analysis of the phrase or sentence structure (Betzler, 2015; Funke & Sieger, 2012; Largy et al., 2007; Sandra et al., 1999; Verhaert et al., 2016). It is therefore prone to errors across and beyond the school curriculum.

When examining noun capitalization in German, it is important to note that the definition of a noun is not restricted to lexical nouns belonging to the word class “noun.” Unlike in English, the German language allows every verb or adjective to become a noun, or more specifically the nucleus of a noun phrase (NP; for all abbreviations in the text, cf. Appendix) without undergoing any further morphological changes (Maas, 1992). In other words, every verb or adjective can be nominalized, in which case it is written with an upper-case letter. Compare, for example, the verb *schwimmen* (to swim) in the sentence *Sie mag schwimmen* (She likes to swim) with the nominalized form *Schwimmen* (swimming) in *Sie mag NP[Schwimmen]* (She likes swimming). The term “noun” therefore refers to a syntactic noun, i.e., the nucleus of a NP.

The capitalization of the NP’s nucleus systematically highlights the NP within a sentence. In fact, the NP can be expanded in different ways. It can contain a determiner (DN) and/or an adjective ((D)AN) or it can contain the noun only (N). However, the nucleus, i.e., the noun, always occupies the final position (cf. Table 1; Maas, 1992; Röber, 2015). Noun capitalization therefore provides a visual support for the reader (Bock, 1986, 1990; Pauly & Nottbusch, 2020).

In writing, the structure of the NP as well as the lexical-semantic characteristics of the noun seem to influence children’s performance in noun capitalization (see overview in Bangel et al., 2020). The lexical-semantic types of nouns are concrete nouns, abstract nouns, and nominalizations. Concrete and abstract nouns can be classified as both lexical and syntactic nouns. Nominalizations are words belonging to a different lexical category (e.g., verbs or adjectives) that function as the nucleus of a NP and are thus transformed into a syntactic noun (Korth, 2013). Several empirical studies have shown that capitalization was best for concrete nouns and

worst for nominalizations, as well as best for the NP structure DN and worst for N (Betzel, 2015; Bîlici et al., 2019; Brucher et al., 2020; Rautenberg & Wahl, 2019). These studies included children from second grade in primary school to secondary school. Table 1 illustrates three different lexical-semantic types of nouns (hereafter referred to as “item types”), realized in three possible grammatical expansions of the NP (hereafter referred to as “NP structures”).

Table 1. Examples of three different item types (concrete, abstract, nominalization) within three different noun phrase (NP) structures marked by brackets, i.e., NP with noun only (N), NP including a determiner (DN), and NP including an adjective ((D)AN)

Item type	NP structure		
	N	DN	(D)AN
Concrete	Sie mag _{NP} [Hunde]. (She likes dogs.)	Sie mag _{NP} [die Hunde]. (She likes the dogs.)	Sie mag _{NP} [große Hunde]. (She likes big dogs.)
Abstract	Sie mag _{NP} [Kälte]. (She likes coldness.)	Sie mag _{NP} [die Kälte]. (She likes the cold.)	Sie mag _{NP} [eisige Kälte]. (She likes the freezing cold.)
Nominalized	Sie mag _{NP} [Schwimmen]. (She likes swimming.)	Sie mag _{NP} [das Schwimmen]. (She likes *the swimming.)	Sie mag _{NP} [langsames Schwimmen]. (She likes slow swimming.)

To our knowledge, no study has examined how the lexical-semantic item type and the NP structure influence low- and high-achieving pupils in noun capitalization, i.e., poor and good capitalizers. The present study examines the capitalization performance of poor and good capitalizers in fourth grade on different item types and NP structures, and this in production of noun capitalization as well as in noun detection. Concretely, our study aims to answer two research questions.

The first research question examines whether item type and NP structure have an effect on noun capitalization of poor and good capitalizers equally in writing. Investigating the performance of poor and good capitalizers separately might give an indication of how the two performance groups make use of the expanded NP (including determiner and/or adjectives) in order to identify its nucleus that must be capitalized.

Since previous studies indicated that item type and NP structure exert an important impact on children’s capitalization in writing, these conditions are likely to influence the children in our study as well. In addition, our study investigates whether these conditions have an effect on poor and good capitalizers to the same extend.

The study is located in Luxembourg, where literacy education is in German. The curriculum is similar to Germany (KMK, 2004; MENFP, 2011): Concrete nouns are the nouns the children most frequently encounter in school, and these are also the nouns used to exemplify the capitalization rule for nouns. Abstract nouns are presented in school as additional nouns to be capitalized. When it comes to

nominalizations, they are introduced as exceptions. All in all, formal instruction of noun capitalization focusses on concrete nouns, as well as on the presence of a preceding determiner (DN) to identify nouns.

Relying on the literature, we thus expect the group of poor capitalizers to capitalize almost only concrete nouns immediately preceded by a determiner (DN), reflecting the input of schooling. Good capitalizers on the other hand might have acquired an implicit notion of the syntactic noun even though they received the same input in formal instruction, namely that concrete nouns in the NP structure DN need to be capitalized. They might have inferred indications about the presence of a noun or NP from the linguistic input they received. Consequently, we expect high performances for good capitalizers on nouns of all lexical-semantic item types and in all NP structures.

The second research question investigates how poor and good capitalizers perform in noun detection compared to noun capitalization with regard to item type and NP structure. In a study on second graders' ability to detect nouns, Rautenberg and colleagues already showed that second graders performed better in detecting than in capitalizing nouns, especially for nominalizations (Rautenberg & Wahl, 2019; Wahl et al., 2017). Moreover, as in writing noun capitalization, the second graders performed better on the noun detection task for nouns preceded by a determiner (DN) than for nouns without a preceding determiner.

Our study investigates whether the finding of Rautenberg and colleagues for second graders in Germany also apply to fourth graders in Luxembourg. In addition, we will examine the results for poor and good capitalizers separately to explore whether both performance groups make use of the expanded NP to detect the nucleus of the NP. We expect performance to be better for detection than for capitalization for both groups.

2. MATERIALS AND METHOD

2.1 *Participants*

In total, 782 fourth graders (373 boys) in Luxembourg took part in the study. The sample consists of a group of 528 children tested at the beginning of 2020 and a group of 254 children tested at the beginning of 2021 with similarly constructed tests. All pupils participated in the noun capitalization writing test, but only 538 pupils took part in the noun detection test. Three outliers were removed from the sample as they did not capitalize any noun in the capitalization test nor correct any noun in the detection test. Thus, the final sample consisted of 779 pupils for the capitalization and 535 pupils for the detection test.

Parental consent for each pupil was obtained prior to the start of the study, as well as general consent from the Research Ethics Committee of the University of Luxembourg and of the National Centre for Data Protection in Luxembourg. The mean estimated Highest International Socio-Economic Index (HISEI) scores of the

municipalities in which the schools were located was 47.14 (cf. Helfer et al., 2015). The pupils' first languages, as indicated by their parents in a questionnaire, were integrated as dummy-coded covariates in all analyses (Luxembourgish/German, French, Portuguese, South Slavic, other language). Luxembourgish and German were coded as one language as both are linguistically very close. Additional to Luxembourgish, French, Portuguese, and South Slavic languages are the most prominent languages of the multilingual pupils in Luxembourgish schools.

All pupils had attended public school in Luxembourg since grade one. The participating schools all followed the national curriculum. Throughout the first years of early childhood education (ages 3 to 5), the main language of instruction was Luxembourgish. In Grade 1 (age 6), the children learned to read and write in German, which is also the main language of instruction throughout primary school. The German language was taught as if it were a first language, independently of the varying linguistic backgrounds of the children. At the time of the study, the pupils had received about three years of instruction in the German writing system and in noun capitalization. Nominalizations were not yet part of the curriculum.

As the aim of the study was to compare fourth-grade children who succeed in capitalizing nouns in writing (good capitalizers) and children who do not yet accurately capitalize nouns in writing (poor capitalizers), the entire sample was divided into quartiles based on the pupils' performance on capitalizing the target items (nouns) in the noun capitalization test. The pupils in the highest quartile, i.e., the good capitalizers ($n = 192$, mean percentage of items correct above 54.17%), and in the lowest quartile, i.e., the poor capitalizers ($n = 195$, percentage of items correct below 32.75%), were retained for further analysis (see Table 2). As not all pupils who participated in the capitalization test also participated in the noun detection test, for the detection test, the group of poor capitalizers included 125 pupils, whereas the group of good capitalizers consisted of 143 pupils. Table 2 provides a complete sample description.

Table 2. Background characteristics (age, gender, first language) and mean test performance in % (general spelling, noun capitalization, noun detection) of the poor (Q1) and good capitalizers (Q4)

Background characteristics	Poor capitalizers (Q1)		Good capitalizers (Q4)	
	M	SD	M	SD
Age (in months)	122	8.77	116	5.98
<i>Number of students</i>	n	%	n	%
Gender				
Male	106	54.36	77	40.10
Female	73	37.44	104	54.17
Unknown	16	8.21	11	5.73
First language				
Luxembourgish/German	31	15.90	106	55.21
French	22	11.28	16	8.33
Portuguese	86	44.10	20	10.42
South-Slavic language	2	1.03	4	2.08
Other language	20	10.26	23	11.98
Unknown	34	17.44	23	11.98
Noun capitalization test	195	100.00	192	100.00
Noun detection test	125	64.10	143	74.48
<i>Test performance</i>	M (%)	SD	M (%)	SD
General spelling	25.81	13.85	70.18	16.65
Noun capitalization	19.20	9.02	65.34	8.87
Noun detection	55.37	22.19	86.56	11.50

2.2 Materials

The materials included a general standardized German spelling test and two tasks designed for the present study (noun capitalization and noun detection).

2.2.1 General spelling test

Prior to testing the pupils' performance in capitalizing and detecting nouns, their general German spelling performance was tested using a shortened version of the standardized German spelling test *Diagnostischer Rechtschreibtest für 4. Klassen*, DRT 4 (Grund et al., 2004). The test was used in order to compare general spelling performances in both groups. The results are displayed in Table 2.

2.2.2 Noun capitalization test

The noun capitalization test was an experimental dictation test assessing the pupils' performance in capitalizing nouns in writing. The number of items presented in the

2020 and 2021 test versions differed slightly. They will be presented as x_1 (x_2), with the first number referring to the test version in 2020 and the number in parentheses to the test version in 2021 (cf. Appendix). The dictation test consisted of 72 (60) sentences with one gap per sentence. Each sentence was dictated twice with a small pause (5 seconds) in between by means of an audio recording with a female native speaker of Standard German. In total, 48 (36) target items (nouns) and 24 (24) control items (verbs and adjectives) were presented.

All target nouns were equally distributed over item type (concrete (CON), abstract (ABS), or nominalized (NOM)) and the NP structure in which they occurred (determiner + noun (DN), adjective + noun ((D)AN), or noun only (N)). To counterbalance any influence of the determiner, half of the NPs with a (D)AN structure contained a determiner before the adjective (DAN), whereas in the other half the noun was preceded by the adjective only (AN).

The target items' distribution in terms of item type and NP structure is depicted in Table 3. Each cell also contains an example in which the target item is underlined.

Table 3. Number of target items in the noun capitalization tests per item type (concrete (CON), abstract (ABS), or nominalized (NOM)) and NP structure (determiner + noun (DN), adjective + noun ((D)AN), or noun only (N)) with an example sentence for each condition. The two tests are represented as such: x_1 (x_2), where the first number refers to the test in 2020 and the number in parentheses to the test in 2021. NPs are marked by square brackets and target items are underlined.

NP structure	Item type		
	CON	ABS	NOM
DN			
Number of items	4 (4)	4 (4)	4 (4)
	<i>Im Schrank steht ^{NP}[das <u>Mehl</u>].</i> (The <u>flour</u> is in the cupboard.)	<i>Eine schöne Jahreszeit ist ^{NP}[der <u>Sommer</u>].</i> (The <u>summer</u> is a beautiful season.)	<i>^{NP}[Das <u>Gehen</u>] ermüdet uns.</i> (The <u>walking</u> tires us.)
(D)AN			
Number of items	8 (4)	8 (4)	8 (4)
DAN	<i>^{NP}[Einen riesigen <u>Hut</u>] trägt der Zauberer.</i> (The magician wears a huge <u>hat</u> .)	<i>Die Freunde haben ^{NP}[einen schönen <u>Abend</u>].</i> (The friends have a beautiful <u>evening</u> .)	<i>Mich nervt ^{NP}[das lange <u>Warten</u>].</i> (The long <u>wait</u> irritates me.)
AN	<i>Die Gärtnerin pflanzt ^{NP}[rote <u>Blumen</u>].</i> (The gardener plants red <u>flowers</u> .)	<i>Bestelle deiner Mutter ^{NP}[liebe <u>Grüße</u>].</i> (Send your mother kind <u>regards</u> .)	<i>^{NP}[Nur lautes <u>Lachen</u>] hört man hier.</i> (Here you can only hear loud <u>laughing</u> .)
N			
Number of items	4 (4)	4 (4)	4 (4)
	<i>Für diese Torte brauche ich ^{NP}[<u>Zucker</u>].</i> (For this cake I need <u>sugar</u> .)	<i>Auch ^{NP}[<u>Hilfe</u>] kam zu spät.</i> (Even <u>help</u> came too late.)	<i>Hier ist ^{NP}[<u>Fahren</u>] von Fahrrädern verboten.</i> (Here, <u>riding</u> bikes is forbidden.)

The target items were controlled for frequency with respect to the mean frequency according to each lexical-semantic item type by means of the CHILDEX corpus (Schroeder et al., 2015) and the pupils' schoolbooks. For both, concrete nouns were more frequent than abstract nouns and abstract nouns in turn more frequent than nominalizations.

In scoring the test, an upper-case letter for target items and a lower-case letter for control items were scored as correct. Missing or indecipherable words were excluded from further analysis. Other orthographic errors were neglected. For data analysis, participants' scores on each item were added up and converted into percentage correct. Reliability analyses for the entire test revealed acceptable reliability measures, with Cronbach's Alpha = .888 (.896).

2.2.3 *Noun detection test*

The noun detection test contained a short text of 6 (8) sentences written entirely in lower case. The children were explicitly asked to correct the capitalization in the text. The complete text consisted of 52 (60) words, of which 15 (17) were target nouns. The latter included 7 (9) concrete, 7 (4) abstract, and 1 (4) nominalization(s). The three NP structure types were also represented in the task, although sometimes in unequal number. There were 6 (5) nouns in a DN structure, 6 (12) nouns in a (D)AN structure, and 3 (0) nouns in a N structure. Due to the low number of nominalizations, only the results for the concrete and abstract nouns will be displayed in the analyses below. Since the NP structure with bare noun (N) was underrepresented or even absent in one test, no statistical analyses were performed with this NP structure.

For target nouns, each correction of a lower-case letter to an upper-case letter was coded as 1, whereas each non-correction was coded as 0. Verbs and adjectives were used as control words. For all control words not occurring at the beginning of a sentence, each correction of a lower-case letter to an upper-case letter was coded as 0. If the control word was left as it is, i.e., with a small initial letter, this was coded as 1. All other corrections were not taken into account. For the final analysis, the scores were summed and converted into percentage correct. Cronbach's alpha for this test was .802 (.775).

3. ANALYSES

The data were analyzed with repeated measures analyses of covariance (ANCOVA) in SPSS and R Studio with the Tidyverse package (Wickham et al., 2021). Statistically significant results were analyzed in more detail using pairwise comparisons, for which Bonferroni corrections were applied.

Some analyses exhibited a significantly non-normal distribution of error variances ($p < .001$). Taking into account the relative robustness of ANCOVAs against violations of normality (Schmider et al., 2010) and the fact that we decided to consider only the data located at two extreme parts of the normal curve (the upper and lower quartile), we chose to proceed with the analysis with repeated measures ANCOVAs.

4. RESULTS

4.1 *Noun capitalization in poor and good Capitalizers*

The first research question concerns the effect of item type and NP structure on poor and good capitalizers' use of the German upper-case for nouns in writing. We performed a 3 (item type: CON, ABS, NOM) X 3 (NP structure: DN, (D)AN, N) repeated

measures ANCOVA with group (poor vs. good capitalizers) as between-subjects factor on participants' mean scores on the noun capitalization test.

The assumption of sphericity, as assessed by Mauchly's test of sphericity, was violated for each factor in the analysis. Since the Huynh-Feldt estimates were larger than .70 and the Greenhouse-Geisser estimates larger than .75, the Huynh-Feldt values will be reported here.

Table 4 gives an overview of the mean percentage correct per condition and performance group in the noun capitalization test.

Table 4. Mean scores (in percentage correct) and standard deviations of good and poor capitalizers for all nouns (total) and per condition (item type and NP structure) in the noun capitalization test.

	CON		ABS		NOM		Total for all nouns	
	M	SD	M	SD	M	SD	M	SD
<i>Poor capitalizers</i>								
<i>n = 195</i>								
Total nouns	39.99	21.12	14.53	9.99	5.08	6.24		
DN	47.83	27.35	24.8	20.07	8.25	12.89	26.96	13.45
(D)AN	32.04	25.71	12.73	14.05	3.75	6.91	16.17	10.90
N	36.15	27.91	7.20	11.94	3.82	9.08	15.72	11.40
<i>Good capitalizers</i>								
<i>n = 192</i>								
Total nouns	94.15	7.33	74.36	11.72	27.53	21.25		
DN	94.85	7.32	80.87	14.09	35.64	30.15	70.46	11.87
(D)AN	94.59	7.25	80.67	15.44	30.88	26.54	68.72	11.09
N	92.79	10.44	57.10	24.39	12.69	21.02	54.19	11.34

The analysis revealed a significant main effect of item type: $F(1.80, 154690.21) = 128.10$, $p < .001$, $\eta^2_p = .28$, with CON > ABS, CON > NOM, and ABS > NOM ($p < .001$ for all pairwise comparisons). The interaction between item type and group was also significant: $F(1.80, 134257.94) = 111.18$, $p < .001$, $\eta^2_p = .26$. All differences between item types were significant at $p < .001$ for poor as well as for good capitalizers. For poor capitalizers, the performance difference between concrete and abstract nouns was larger (25.05% between CON and ABS vs. 13.14% between ABS and NOM). For good capitalizers, on the other hand, the performance difference between abstract and nominalized nouns was larger (48.26% between ABS and NOM vs. 20.57% between CON and ABS).

The main effect of NP structure was small but significant as well: $F(1.99, 20418.52) = 33.25$, $p < .001$, $\eta^2_p = .09$, with DN > (D)AN > N ($p < .001$ for all pairwise comparisons). The NP structure also interacted with group: $F(1.99, 17889.19) = 29.13$, $p < .001$, $\eta^2_p = .08$. The poor capitalizers scored better on nouns in a DN structure, with DN > (D)AN and DN > N ($p < .001$ in both cases), but not on nouns in a (D)AN structure ((D)AN = N, $p > .05$). The good capitalizers performed significantly better on nouns embedded in a DN structure as well, with DN > (D)AN ($p < .05$) and

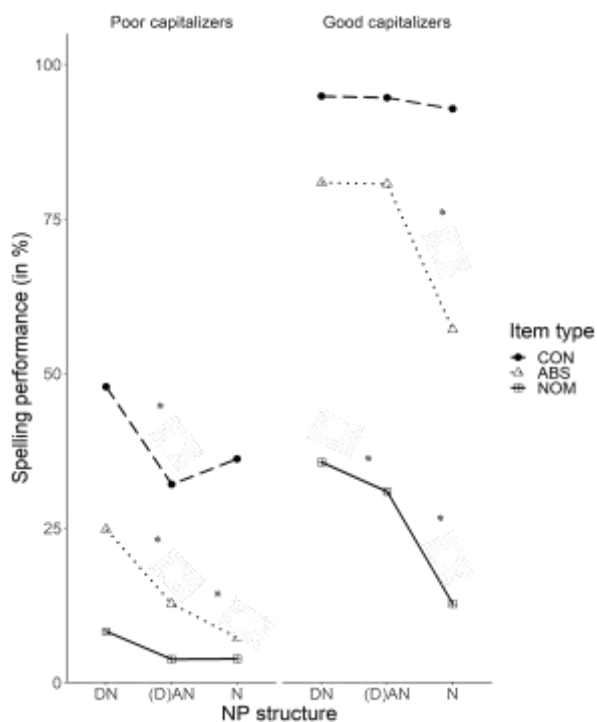
DN > N ($p < .001$), but also on nouns in a (D)AN structure compared to the N structure ((D)AN > N, $p < .001$).

There was a significant but small interaction between item type and NP structure: $F(3.86, 4026.948) = 3.76$, $p = .005$, $\eta^2_p = .01$, with CON > ABS, CON > NOM, and ABS > NOM in all NP structures ($p < .001$ for all pairwise comparisons). For DN and (D)AN, the largest mean difference was between abstract and nominalized nouns (DN: 34.18% between ABS and NOM vs. 18.20% between CON and ABS; (D)AN: 32.45% between ABS and NOM vs. 16.17% between CON and ABS). For N, on the other hand, the largest difference was between concrete and abstract nouns (34.05% between CON and ABS vs. 25.47% between ABS and NOM).

The triple interaction item type*NP structure*group was also small but significant: $F(3.86, 24088.12) = 22.51$, $p < .001$, $\eta^2_p = .06$. For poor capitalizers, CON > ABS, CON > NOM, and ABS > NOM with $p < .001$ in all NP structures, except for N where ABS = NOM ($p > .05$). Moreover, DN > (D)AN and DN > N with $p < .001$ for all item types except for NOM, where DN = (D)AN = N ($p > .05$ for all pairwise comparisons). The difference between (D)AN and N was not significant for any item type except for ABS, where (D)AN > N ($p < .001$). It is noteworthy that the poor capitalizers' performance in capitalizing nouns never exceeded chance level. They capitalized only about half of the concrete nouns in the DN position correctly (see Table 4). For good capitalizers, CON > ABS, CON > NOM, and ABS > NOM with $p < .001$ in all NP structures. Moreover, DN > N and (D)AN > N with $p < .001$ for all item types except for CON, where there were no significant differences between any NP structures ($p > .05$ for all pairwise comparisons). The difference between DN and (D)AN was not significant for ABS ($p > .05$), but significant for NOM ($p < .001$). The difference between (D)AN and N was significant for both ABS and NOM ($p < .001$ for both pairwise comparisons).

Thus, the difficulty patterns in noun capitalization differed between poor and good capitalizers not only on the level of total performance for all nouns but also with regard to the effect of the lexical-semantic item type and the NP structure (see Figure 1). Poor capitalizers only reached chance level for concrete nouns in DN position. The NP structure DN seemed to influence poor capitalizers' capitalization of concrete and abstract nouns, whereas the expansion with an adjective ((D)AN) did not help to increase capitalization performance. Nominalizations were almost never correctly capitalized (total NOM 5.08%) and there was no significant effect of the NP structure on poor capitalizers' performance for nominalizations. Good capitalizers achieved good performance on concrete and abstract nouns. They achieved good performance on concrete nouns independently of the NP structure. For abstract and nominalized nouns, their performance seemed to be influenced by the NP structure, with equally high results for DN and (D)AN, but a considerable performance drop for nouns occurring alone (N).

Figure 1. Mean performance (in percentage correct) in the noun capitalization test for poor (left) and good capitalizers (right) per item type (dot – CON, triangle – ABS, square – NOM) and per NP structure (DN, (D)AN, N). * $p < .001$



4.1.1 Control items

The noun capitalization test also included control items, i.e., verbs and adjectives to be written in lower-case, in order to control for a strategic overuse of upper-case letters. These control items were written correctly by the poor capitalizers in 85.41% of cases and by the good capitalizers in 90.74% of cases. The ANCOVA investigating whether poor and good capitalizers differed with respect to their performance on the control items revealed a small but significant effect of performance group: $F(1, 1011.01) = 9.98$, $p = .002$, $\eta^2_p = .03$, indicating that the poor capitalizers wrongly capitalized the control items more often than the good capitalizers did.

4.2 Different performance in noun capitalization and detection

To answer the second research question, poor and good capitalizers' performance in noun capitalization and detection were compared. Do poor and good capitalizers perform differently in capitalizing and detecting nouns across the item types CON

and ABS and/or across the NP structures DN and (D)AN? We performed two separate repeated measures ANCOVAs, one examining the effects across the two item types and the other one looking at the effects across the two NP structures. Due to a lack of sufficient instances for each item type in each NP structure, we did not analyze the interaction between these two factors.

The data input for the analyses consisted of participants' mean scores for the two item types CON and ABS and for the two NP structures DN and (D)AN, calculated separately for the two performance groups (good, poor capitalizers). Descriptive statistics for both tests per condition and performance group can be found in Table 5.

Table 5. Mean scores (in percentage correct) and standard deviations (in parentheses) of good and poor capitalizers per condition (item type and NP structure) for the two syntactic tasks (noun capitalization and detection).

	Syntactic task			
	Noun capitalization		Noun detection	
	Poor capitalizers	Good capitalizers	Poor capitalizers	Good capitalizers
<i>Item type</i>				
Total CON and ABS	27.26 (20.69)	84.26 (13.57)	61.07 (31.66)	96.22 (13.71)
CON	39.99 (21.12)	94.15 (7.33)	82.79 (24.73)	100.00 (8.49)
ABS	14.53 (9.99)	74.36 (11.72)	39.34 (37.50)	92.43 (22.86)
<i>NP structure</i>				
Total DN and (D)AN	21.57 (15.78)	69.59 (14.22)	62.77 (27.29)	92.06 (14.64)
DN	26.96 (13.45)	70.46 (11.87)	80.15 (31.24)	100.00 (12.22)
(D)AN	16.17 (10.90)	68.72 (11.09)	45.38 (27.53)	84.12 (19.30)

4.2.1 Lexical-semantic item type

The first 2 (syntactic task: capitalization, detection) X 2 (item type: CON, ABS) repeated measures ANCOVA comparing the two syntactic tasks focused on the two item types (concrete and abstract nouns) with group (poor vs. good capitalizers) as between-subjects factor.

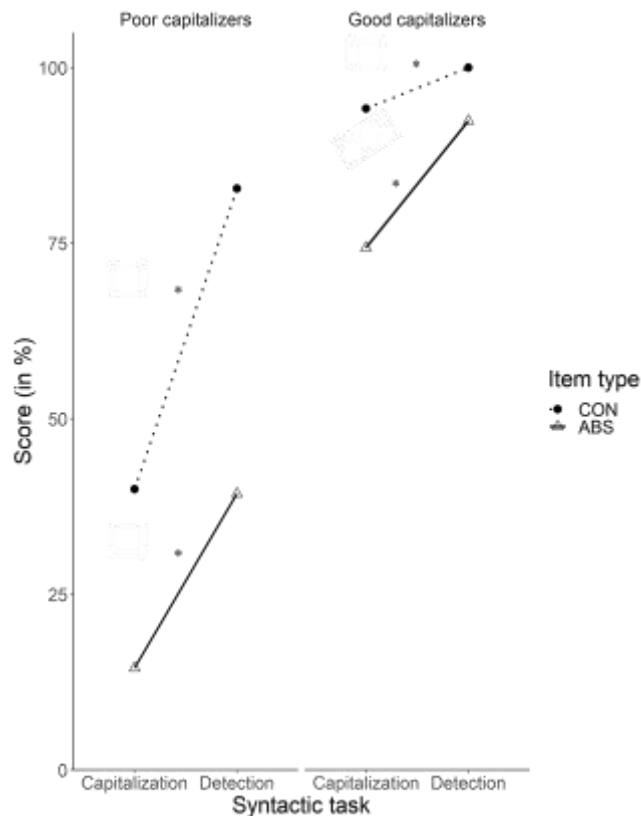
The analysis revealed a significant main effect of syntactic task concerning item type: $F(1, 22413.52) = 67.31, p < .001, \eta^2_p = .23$, with capitalization < detection. The interaction syntactic task*group was also significant: $F(1, 22485.54) = 67.53, p < .001, \eta^2_p = .23$. The performance advantage in detection over capitalization was larger for the poor capitalizers (33.69%) than for the good capitalizers (10.97%).

There was also a significant main effect of item type: $F(1, 15196.28) = 62.21, p < .001, \eta^2_p = .21$, with CON > ABS. The interaction item type*group was significant as well: $F(1, 12004.26) = 49.14, p < .001, \eta^2_p = .18$. CON > ABS at $p < .001$ for poor and good capitalizers, but the mean difference was larger for the group of poor capitalizers (30.28%) than for the good capitalizers (13.68%).

The interaction term syntactic task*item type was not significant ($p > .05$). The triple interaction syntactic task*item type*group, however, was significant: $F(1, 9294.40) = 48.73, p < .001, \eta^2_p = .17$. For both poor and good capitalizers, detection > capitalization at $p < .001$ for concrete as well as for abstract nouns. The difference between detection and capitalization was especially large for concrete nouns in the group of poor capitalizers. With an absolute performance difference of 44.18%, the poor capitalizers much better in detecting than in capitalizing concrete nouns. For abstract nouns, this difference was smaller (23.21%). For the good capitalizers, on the other hand, the pattern was reversed. The difference between detection and capitalization was larger for abstract (15.09%) than for concrete nouns (6.85%). The smaller results could be due to the already high results in the capitalization performance for the good capitalizers.

The performance patterns for the two item types CON and ABS in capitalization and detection are illustrated in Figure 2.

Figure 2. Mean performance (in percentage correct) of poor and good capitalizers for the item types CON and ABS in the two syntactic tasks (capitalization and detection). * $p < .001$



4.2.2 NP structure

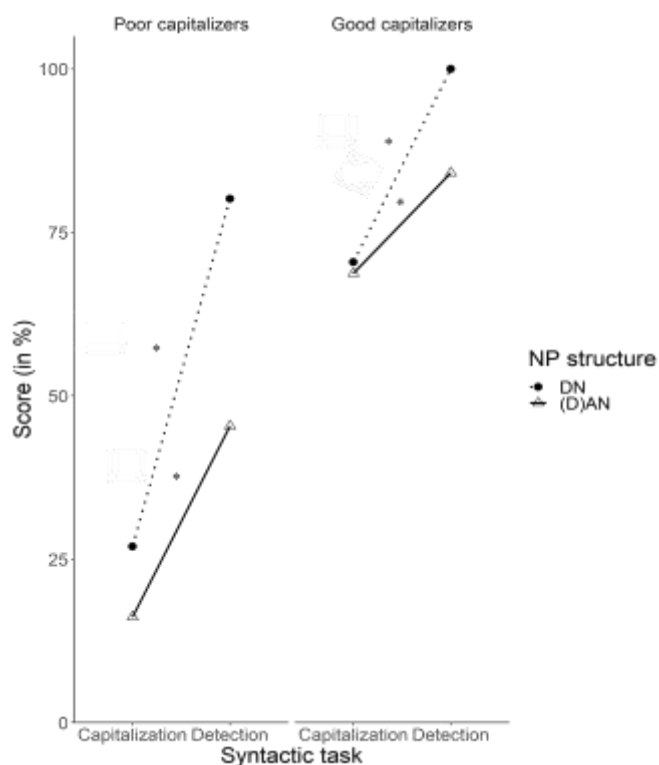
The second 2 (syntactic task: capitalization, detection) X 2 (NP structure: DN, (D)AN) repeated measures ANCOVA focuses on the two NP structures DN and (D)AN with group (poor vs. good capitalizers) as between-subjects factor.

The results indicated a significant main effect of syntactic task on the children's performance concerning NP structure: $F(1, 33013.02) = 113.77, p < .001, \eta^2_p = .33$, with capitalization < detection. Moreover, syntactic task interacted with group: $F(1, 16093.64) = 55.46, p < .001, \eta^2_p = .19$. Capitalization < detection at $p < .001$ for both groups, but the performance differences between capitalization and detection differed more for the poor capitalizers (39.65%) than for the good capitalizers (20.43%).

The main effect of NP structure was significant as well: $F(1, 10527.68) = 41.26, p < .001, \eta^2_p = .15$, with DN > (D)AN. Again, a significant interaction effect with group could be found: $F(1, 10485.73) = 41.09, p < .001, \eta^2_p = .15$, with DN > (D)AN for poor as well as for good capitalizers ($p < .001$ for both pairwise comparisons). However, the mean difference was larger for the poor (23.35%) than for the good capitalizers (7.84%). This finding could possibly be due to the higher results in capitalization for the good capitalizers compared to the poor capitalizers.

The interaction syntactic task*NP structure was also significant: $F(1, 1803.83) = 10.66, p = .001, \eta^2_p = .04$. This significant interaction effect reflects a bigger performance advantage in detection compared to capitalization for the DN (37.95%) than for the (D)AN structure type (22.12%), although both pairwise comparisons were significant at $p < .001$. The triple interaction syntactic task*NP structure*group was significant as well: $F(1, 2147.10) = 12.688, p < .001, \eta^2_p = .05$, with detection > capitalization for both NP structures within both performance groups ($p < .001$ for all pairwise comparisons). However, the differences were especially large for the group of poor capitalizers, as they performed much better on nouns within a DN structure in detection compared to capitalization (mean difference of 51.08%). For the NP structure (D)AN, the difference between detection and capitalization among the poor capitalizers was smaller (28.22%). Likewise, the performance difference between detection and capitalization for the good capitalizers was larger for the DN (24.83%) than for the (D)AN structure type (16.02%). Also, the mean differences here were smaller than for the poor capitalizers. This finding as well could be due to higher results in capitalization for the good capitalizers in comparison to the poor capitalizers. The results of the analysis are visualized in Figure 3.

Figure 3. Mean performance (in percentage correct) of poor and good capitalizers for the NP structures DN and (D)AN in the two syntactic tasks (capitalization and detection). * $p < .001$



4.2.3 Control items

The noun detection test included control items (verbs and adjectives) to control for a systematic overuse of upper-case letters. The mean number of control items detected correctly in the detection test was 91.70% among poor capitalizers and 97.53% among good capitalizers.

5. DISCUSSION

This study examined how the lexical-semantic properties of nouns (CON, ABS, NOM) and the grammatical properties of a more or less expanded NP (DN, (D)AN, N) influence noun capitalization in writing and noun detection in poor and good capitalizers in grade four.

The analyses revealed that poor capitalizers' performance in noun capitalization approached chance level only for the item type CON immediately preceded by a determiner (DN), capitalizing never more than half of the items correctly. Their use

of the upper case was almost exclusively limited to the condition that constitutes the focus of formal instruction. This finding is in line with our expectation that the poor capitalizers would stick to the item type and the NP structure they have been focusing on in formal instruction in noun capitalization, i.e., CON in the NP structure DN. Even in this scope, the resources of poor spellers seem to be scarce even after three years of instruction in noun capitalization and they seem to have memorized isolated words of the lexical category noun.

The results of the noun detection task revealed that poor capitalizers were indeed able to identify concrete nouns and nouns immediately preceded by a determiner (DN) in a sentence. Still, the poor capitalizers' performance in detection exceeded chance level only for concrete nouns and for nouns in the NP structure DN, but not for the other condition. This suggests that they applied the rule they learned in school again: concrete nouns immediately preceded by a determiner (DN) are nouns and are written in upper case.

The performance difference between noun capitalization and detection is likely to be related to the differing nature of the two tasks. The noun detection task removed the need to reflect upon the correct spelling of a word. Moreover, in the noun detection task, the orthographic representation of the words was already present. This made it possible for the children to compare the printed image of each word with the representation they had stored in their orthographic lexicon, including the presence or absence of an upper-case letter (Wimmer et al., 2016). Additionally, the results could also reflect the differing task instructions for both tests. The instruction for the detection task provided a stronger focus on capitalization compared to the capitalization task, as correcting capitalization was explicitly requested from the children in the detection task.

For the good capitalizers, we expected their performance to be equally good for concrete and abstract nouns, independently of the NP structure. In addition, we expected that this group might already capitalize nominalizations to some extent. These expectations were not confirmed. In noun capitalization, the good capitalizers obtained an almost perfect score for concrete nouns (>90%) but not for abstract nouns (>70%). This performance difference between concrete and abstract nouns reflects the performances in other empirical studies (cf. Bangel et al. 2020). Moreover, the performance of nominalizations remained low (<30%). The results also indicated that, for all item types, the good capitalizer's performance in noun capitalization was better when the noun was embedded in an extended NP (DN and (D)AN) compared to the condition where it occurred alone (N). This suggests that in case of abstract nouns and nominalizations, the expanded structure of the NP helped the good capitalizers to detect the NP and its nucleus. Only for concrete nouns, their performance remained stable across all NP structures. For good capitalizers, concrete nouns seem to be familiar words that are stored in the orthographic lexicon including the initial capital letter.

The difference between noun capitalization and noun detection was smaller for the good than for the poor capitalizers. This might have been due to the already high

results in noun capitalization for the good capitalizers, but the differences between capitalization and detection are still significant.

For both groups, we concluded that the persistent influence of item type and NP structure might firstly be related to the strong presence of concrete nouns in formal education. A stronger focus on concrete nouns is likely to facilitate their processing compared to abstract nouns. Also, previous research indicated a processing advantage for concrete over abstract words in i.e., lexical decision tasks (Bottini et al., 2022; Eviatar et al., 1990; Schwaneflugel & Stowe, 1989). As for nominalizations, this item type had not yet been part of the children's formal instruction. Additionally, capitalizing a nominalized verb or adjective required inhibition from the children, since verbs and adjectives are more frequent than the nominalized forms and since formal instruction lays emphasis on both word categories as being words to be written in lower case.

It is necessary to consider the results on noun capitalization of the two groups in the context of their general spelling performance and language background. Indeed, the results of the general spelling test (DRT 4) reflected the low general spelling performance of the poor capitalizers, as the group mean for this test was around 25% correct. The results for the control words indicated in addition a higher level of insecurity for the poor capitalizers in comparison to the good capitalizers, as the poor capitalizers showed a lower performance for these control words. Furthermore, 84.1% of the children in this group spoke a language other than the language of instruction, German or Luxembourgish, at home. The mean results in general spelling of the good capitalizers are, in contrast, at 70% and the big majority of this group has a Luxembourgish/German language background. The capitalization performance of the two performance groups thus seems to be linked to their general spelling performance and their language background. Previous research with children of various linguistic backgrounds found similar spelling patterns for children with German as first or second language. Our results however seem to indicate that children with differences in general spelling performance and/or linguistic background might behave differently. The children's first language was added to the analysis as a covariate to control for any influence, but there seems to be an important difference in linguistic background between the two performance groups, nevertheless.

All in all, the results show, that the differences in noun capitalization production and detection between poor and good capitalizers exist regarding the effect of the lexical-semantic item type and the NP structure. This result affects grammar and spelling instruction at school: Instruction could foster good capitalizers if it considered that this group uses the expanded NP structure to the NP and its nucleus already. Poor capitalizers do not use this grammatical information, however. Similar to learners with learning disabilities, poor capitalizers might need more extensive explicit instruction in order to detect the inflected NP unit and, thus, the capitalized noun. Intervention studies have already shown that a scaffolded syntactic approach shows positive effects (Bilici et al., 2019; Brucher et al., 2020; Wahl et al., 2017).

Further questions follow on from this study. One question would be to examine whether the different performances of poor and good capitalizers are due to differences in the first language of the pupils. Another question occurs related to the predominance of correct capitalization of concrete nouns in both groups, as well as over all existing studies on noun capitalization. Do capitalization of concrete noun, and in the NP with determinant, is a prerequisite for generalizing the capitalization of an NP's nucleus?

This study entailed some limitations related to the noun detection task. The distribution of the item conditions (item type and NP structure) in this task was not sufficiently equalized, leading to unequal distributions and underrepresented item conditions, giving the detection task a more explorative nature than the rigidly controlled noun capitalization task in which all experimental conditions were equally distributed. Nonetheless, the study's findings represent a first step towards shedding light onto two performance groups in two tasks, and in three lexical-semantic item types and three NP structure types.

CREDIT AUTHOR STATEMENT

All authors contributed to the present study.

K.M. wrote the first draft, collected the data and performed the analyses.

S.U. and C.W. discussed the results and commented on the manuscript.

C.W. is PI of the study, formulated the overarching research goals and aims and acquired the funding, and wrote the final version.

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APPENDIX

Explanation of the symbols and abbreviations used throughout this paper

Symbol	Example	Explanation
NP		Noun phrase
$x_1 (x_2)$	8 (4)	Number of items in the 2020 and in the 2021 test (in brackets): the 2020 test included 8, the 2021 test 4 items
CON		Lexical-semantic type of concrete nouns
ABS		Lexical-semantic type of abstract nouns
NOM		Lexical-semantic type of nominalizations
DN		NP consisting of determiner + noun
(D)AN		NP consisting of adjective + noun
N		NP consisting of a bare noun
>	A > B	A was significantly better than B ($p < .05$)
<	A < B	B was significantly better than A ($p < .05$)
=	A = B	There was no significant difference between A and B