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The acquisition of constructions: Does modality matter?

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Background: Language analytic ability is well researched in the context of foreign language acquisition but its role in the acquisition of grammar in the native language is under investigation.

Objectives: Our study explored the influence of language analytic ability and print exposure on receptive grammar and reading comprehension in childhood. Additionally, we investigated whether exposure to specific constructions through the written modality held an advantage over exposure in the audio modality.

Method: We assessed the language analytic ability, reading comprehension, reading fluency, print exposure, and receptive grammar of 12-year-olds. Subsequently, we exposed them to written or spoken target constructions, followed by an assessment of receptive grammar. Linear regression models were used to analyse the contributions of reading fluency, print exposure, and language analytic ability to reading comprehension and receptive grammar. We also examined the influence of the intervention on receptive grammar.

Results: Language analytic ability and print exposure significantly predicted receptive grammar. Print exposure significantly predicted reading comprehension and improvement in receptive grammar.

Conclusion: Language analytic ability is important for grammar and reading comprehension development. Print exposure enhances reading comprehension by supporting vocabulary development and providing exposure to intricate structures. Both language analytic ability and experience are key factors in construction acquisition.

Contribution: This study adds to the growing body of evidence emphasising the role of language analytic skills in native language grammar acquisition and advocates for explicit grammar teaching. Furthermore, it underscores the importance of adequate print exposure in grammar acquisition and the development of reading comprehension skills.

Keywords: literacy; print exposure; language aptitude; grammar; language analytic ability.

Introduction

In South Africa, a country characterised by its linguistic diversity and educational challenges, ensuring that children attain proficiency in reading and writing is of paramount importance for cognitive development and societal progress (Zua 2021). The South African schooling system faces multifaceted hurdles, including a historical legacy of inequality, resource disparities, and a linguistic landscape featuring 12 official languages, including 11 spoken languages alongside South African Sign Language. A crucial aspect of challenges faced in the education system is the linguistic diversity. One of the major challenges is that, even though home language education is encouraged, and the education system aims to promote multilingualism, English is still the dominant language of learning and teaching (Jordaan 2011). Many children may thus receive English language instruction at the home language level, even if their home language is not English and their level of English only that of an additional language. As education landscapes seldom change drastically, especially within short periods, it is important to understand the impact and outcomes of children in the current system to support them in the best feasible way.

The linguistic environment that individuals grow up in is important to understand, as it is both the quantity and quality of language input that influences linguistic outcomes (Hart & Risley 2003). There is some evidence that adult speakers vary widely in their grammatical competence, which can partly be attributed to differences in education where rich experience with written language is provided (Dąbrowska 2012). One of the major advantages of reading is the reciprocal relationship that it shares with vocabulary (Stanovich 1986). Written language is also lexically

richer than spoken language and generally contains more rare words per 1000 tokens (Hayes & Ahrens 1988) and advantages have been found for exposure in the written modality in the acquisition of vocabulary (Nelson, Balass & Perfetti 2005). The reciprocal relationship between print exposure and vocabulary may also support reading comprehension by providing repeated contextual exposure to vocabulary (Mol & Bus 2011; Nation 2008). High levels of leisure reading of books specifically is also associated with better reading comprehension (Torppa et al. 2020).

Individuals, however, only become fluent readers as a function of time and experience. Fluency is achieved after the basic mechanics of reading have been mastered and individuals no longer need to focus on decoding single words but can rather allocate cognitive resources to understanding the content of the text. Fluency could be referred to as the change from learning to read to reading to learn. There is evidence that this is the case as reading fluency has been found to be a principal factor in reading comprehension in both first language (L1) and second language (L2) settings (Marx et al. 2015).

While there is considerable evidence that reading improves vocabulary, it is less clear whether it also influences syntax. Studies examining the relationship between print exposure and grammatical comprehension have produced mixed effects overall. Dąbrowska (2018) and Street and Dąbrowska (2010) found a significant effect of print exposure on grammatical comprehension and, while Acheson, Wells and MacDonald (2008) also found a small positive correlation, it was not significant in their study. Misyak and Christiansen (2012) found a significant correlation between scores on an author recognition test and comprehension on one of the three sentence sets they used; however, the relationship was not significant in the regression analysis. A training study by Wells et al. (2009) showed that additional experience with written object relatives resulted in shorter reading times but had no effect on comprehension. It is important to note that these studies were all done with adults and that the findings may be different for individuals, including children, who have had less cumulative exposure to written language.

The advantage that some of the above studies found for exposure to written language may be based on the fact that several syntactic structures, including passives and complementation structures, are found more frequently in written than in spoken language. The 'training wheels hypothesis' (Dąbrowska 2020) explains that when complex structures are encountered in the written medium, the written representation eases the burden on the working memory and allows the structures to be processed without time pressure. The written representation thus acts as training wheels while complex grammatical structures are in the process of being mastered. When individuals are highly literate, thus engaging frequently with written language, these complex structures may then make their way into the spoken language.

Given the fact that certain structures are found more commonly in written language and that written language may aid processing by reducing the working memory load, there should be evidence of a written modality advantage when it comes to the acquisition or comprehension of linguistic structures. Yet, a neuroimaging study with adults by Jobard et al. (2006) investigating the impact of modality and complexity in reading and listening tasks found that 'no higher order area previously described as involved in language comprehension contributed at a greater degree to one modality compared to the other' (p. 791). The authors also assessed comprehension and found comparable scores in both the reading and listening conditions. Thus, neurologically, the processing of information that is more complex than single words by literate adults does not appear to differentiate between the modality of the input, even though different brain regions are, understandably, involved in the initial signal processing. An applied study with university students into the presentation of longer texts in either the spoken or written modality also found no distinct advantage of either modality (Schüler, Scheiter & Gerjets 2013). They did note that, within the written modality group, participants who reread segments of text benefited more from the modality than those who did not. However, since this strategy was not employed by all participants in the written group, there was no overall advantage of the written modality. Participants in the spoken modality group rarely made use of the opportunity to listen to segments of the audio a second time. School-aged children have had less cumulative exposure to written language than participants from these studies, and it is possible that they benefit more from the processing crutch offered by the written representation. The current article presents a study on this school-aged population with the aim of investigating if there is an advantage of the written representation when the cumulative education and print exposure levels are low.

Experience is not the only factor that matters in language acquisition. Strong relationships are consistently found between foreign language aptitude test scores and L2 grammatical proficiency (see Li 2015 for a meta-analysis). More recently, research that included measures of foreign language aptitude, specifically language analytic ability, with adult native speakers have found even stronger relationships between L1 grammar and foreign language aptitude than previously found in the L2 research (Dąbrowska 2018; Llompart & Dąbrowska 2023; Winckel & Dąbrowska 2024). The research is almost exclusively done on adults, leaving a gap for investigating this relationship during acquisition in childhood.

We conducted a study with 12-year-old children in schools in South Africa who identified as English L1 speakers. They completed tasks that measured their reading comprehension, reading fluency, receptive grammar, print exposure, and language analytic ability. The children then had targeted exposure to specific constructions in either the written or the audio modality before again completing the receptive grammar task. The aims of this study were, firstly, to explore

the role of language analytic ability in first language and, as may be the case for many students in our study, dominant language grammar acquisition. A second aim in the exploration of grammar acquisition was to determine the role of print exposure given the higher frequency of syntactically complex structures in written language than in spoken language. Our third aim was to determine the contribution of language analytic ability and print exposure to the development of reading comprehension. Lastly, in an intervention that involved targeted exposure to constructions, we wanted to investigate possible modality advantages in learning from exposure.

The importance of this study is twofold. From a social perspective, it seeks to address a pressing educational concern by shedding light on the skills that may underlie the acquisition of grammar and literacy. Given the link between literacy and socioeconomic development, understanding, and improving literacy outcomes among South African children can contribute significantly to the nation's well-being. Additionally, this research aligns with broader global efforts to enhance our understanding of language acquisition and literacy development. South Africa's linguistic diversity and educational challenges make it an ideal testing ground for theories and practices that can have broader implications.

Scientifically, this study contributes to the literature by bridging the gap between usage-based linguistics and education practices. While language analytic ability has been extensively explored in the realm of second and foreign language acquisition, its intersection with language experience, especially in the written modality within a multilingual environment, remains relatively uncharted territory. Our study aimed to explore this connection, thus enriching our understanding of how learners acquire linguistic structures and the potential advantages of different modalities of exposure.

Research methods and design

Study design

The study involved three phases. The first was a pretest where we examined the contributions of print exposure, reading fluency, and language analytic ability to reading comprehension and receptive grammar.

The second phase involved an intervention where participants were provided with targeted exposure to one of two target constructions in either the written or the audio modality. The target constructions were complex postmodifying prepositional phrases (CPPP) and object clefts (OC). These structures were chosen as they are two of the more difficult constructions in the receptive grammar task and should allow the influence of the exposure to be measured. The CPPP constructions are complex to process given the distance between the subject and its description and that CPPPs are often misinterpreted by applying the description to the nearest noun. For example, in 'The window in the room with the chair is broken', simple processing may cause a person to ascribe brokenness to the chair instead of the window. Clefts and relatives, including the OC construction, contain long-distance dependency relations, which are cognitively demanding to process. Such OC constructions, for example 'It was the girl that the man fed', are often processed as subject clefts ('It was the girl that fed the man') (e.g. Kidd et al. 2007). The differences in processing and producing these structures are more pronounced in early childhood (Diessel & Tomasello 2005), although both children and adults are known to find object relatives more difficult to process than subject relatives (Kidd et al. 2007). The subject/object asymmetry and how it relates to processing difficulties and structural complexity is well established (Gordon, Hendrick & Johnson 2001; Samo & Merlo 2021), although the asymmetry does seem to disappear when the object relatives take forms that are most found in the natural speech environment (Kidd et al. 2007).

Phase 3 was a post-exposure assessment where we investigated how the learning scores on the two target structures from the intervention were influenced by the modality of exposure as well as print exposure, reading fluency, and language analytic ability.

Predictions

We formulated the following predictions based on the introduction above. Firstly, we expected that participants who read considerable amounts (high print exposure) and have high language analytic ability would have better reading skills and better knowledge of grammar. Secondly, we expected that, after the intervention, participants would show more improvement in the trained construction than in the untrained construction. We also expected that participants who read the constructions (written modality) would improve more than those who heard the constructions (audio modality).

Setting

Students from two private schools in the city of Pretoria in South Africa who had English home language instruction participated in the study. The schools represented a range of socioeconomic statuses and learner backgrounds. Participants were recruited through the school and completed the tasks during the school day.

Data collection

Baseline assessment materials and procedures

Receptive grammar: Receptive grammar was measured using a modified version of the 'Pictures and Sentences' test (Dąbrowska 2018). This task is a forced-choice picture selection task consisting of 8 sentences each of 10 different constructions, including the two target constructions. In our version, we replaced actives and simple locatives with two constructions of higher complexity: the complex postmodifying prepositional phrase and the X-Is-Difficult-to-Answer construction (Herbst & Hoffman under review).

Two basic structures that are typically acquired early by children (subject relatives and object relatives) were retained as control conditions to ensure comprehension of the task. Examples of the constructions can be seen in Table 1. In each trial, participants read a sentence and chose one of two pictures that best matched the sentence. The location of the target picture (right vs left) was randomised across trials and the items were pseudo-randomised so that there were no consecutive items targeting the same construction.

Language analytic ability: Words in sentences is a subtest of the Modern Language Aptitude Test Elementary (MLAT-E; Carroll & Sapon 2002a). This test is a children's version of the Modern Language Aptitude Test (MLAT, Carroll & Sapon 2002). The words in sentences subtest aims to measure grammatical sensitivity without the use of the traditional part of speech terminology such as nouns, verbs, and adjectives. Language analytic ability, of which grammatical sensitivity is a part, is an aspect of 'foreign' language aptitude and refers to the ability to take linguistic input, infer the rules from that input, and generalise these in novel contexts (Roehr-Brackin & Tellier 2019). This task is a metalinguistic task that requires explicit attention to grammatical structure and was specifically chosen because our area of investigation is grammar, and this subtest is the most relevant from the test battery. In the words in sentences test, participants are shown pairs of sentences and are asked to select a word in the second sentence that 'does the same job' as the capitalised word in the first sentence. For example, in the sentence 'Cindy cut a cake with a knife', *cake* fulfils the same grammatical function as *fish* in 'Yesterday, Mary caught a FISH at the lake'. The test contains 30 sentence pairs. Each correct answer scores 1 and incorrect answers score 0. The maximum possible score is 30.

TABLE 1: Example sentences for each of the 10 constructions in the receptive grammar task.

Construction	Example of sentence	Picture descriptions
Quantifier + has	Every tray has a cup on it.	Right: 5 trays with 4 cups Left: 4 trays with 5 cups
Quantifier + is	Every spoon is in a cup.	Right: 5 cups with 4 spoons Left: 4 cups with 5 spoons
Subject relative	The woman was the one that caught the man.	Right: A man catching a woman Left: A woman catching a man
Subject cleft	It was the doctor that painted the woman.	Right: A doctor painting a woman Left: A woman painting a doctor
Object relative	The dancer was the one that the soldier kissed.	Right: A dancer kissing a soldier Left: A soldier kissing a dancer
Object cleft	It was the girl that the man fed.	Right: A girl feeding a man Left: A man feeding a girl
Passive	The boy was touched by the nurse.	Right: A boy touching a nurse Left: A nurse touching a boy
Postmodifying prepositional phrase	The cup on the tray is orange.	Right: An orange cup on a black tray Left: A blue cup on an orange tray
Complex postmodifying prepositional phrase	The window in the room with the chair is broken.	Right: Broken chair, whole window Left: Whole chair, broken window
X-Is-Difficult-to-Answer	The doll is hard to see.	Right: Doll hidden behind blocks Left: Blindfolded doll

Print exposure: Print exposure was assessed with the Author Recognition Test: Young (ART-Y; Wright, Dąbrowska & Winckel in preparation). The ART-Y consists of a list of names, of which 60 belong to real authors and 30 are made-up foil names. Participants were asked to select the names that they recognise as belonging to real authors and to avoid guessing as some of the names are made up. Author recognition tests are a well-established method of measuring print exposure (Wimmer & Ferguson 2023). They are quick to administer, less time-consuming than asking participants to keep a reading diary, and less susceptible to social-desirability influences than self-reported reading habits. The score is calculated as the number of correctly selected author names minus twice the number of incorrectly selected foil names. Following Dąbrowska (2018), final scores of less than 0 were replaced with a score of 0 as it is not possible to have negative print exposure.

Reading fluency: Reading fluency was measured with the 1-minute reading test (Transvaal Education Department 1987), which consists of monosyllabic words that are to be read as quickly as possible within the 60-s time limit. The score is equivalent to the total number of words read correctly within the given time limit.

Reading comprehension: The Hodder Group Reading Tests (HGRT) II (Vincent & Crumpler 2007) were used to assess the reading comprehension of the participants. They are cloze-type tests with items of increasing length and complexity that are suitable for administration in classroom settings. Participants are required to select the correct word from several options to determine reading comprehension at word, sentence, and text level. Scoring was done according to the test manual and the maximum possible score that can be obtained is 50.

Targeted exposure materials and procedures

Participant groups: Four classes participated in the research and were assigned to one of four conditions where modality and the target construction were varied. Fifty participants were in the written modality group, of which 23 participants got exposure to the OC construction and 27 participants to the CPPP. Fifty-nine of the participants were in the audio modality group, of which 25 had exposure to the OC construction and 34 had exposure to the CPPP construction.

Intervention materials: During the exposure phase, participants, according to their assigned modality of exposure, either read or heard stories containing 10 tokens each of the target construction. Each target construction had two dedicated stories, and participants read or heard each story twice, resulting in a total exposure of 40 tokens. The texts are available in the online repository (see results section below).

Participants in the written modality received a booklet with both stories. They were instructed to read the first story and then complete a filler task. The first filler task was a word recognition task, with a list of 20 words, 50% of which were

present in the story and participants had to circle the words that they remembered from the story. This was followed by the second story and its word recognition filler task. In the second round of story exposures, the filler task was to rate the story out of five, give a reason for the rating, describe their favourite or least favourite part, and judge whether the story was appropriate for 7-year-olds. Participants in the audio modality followed the same procedure, except that they heard the stories instead of reading them and completed the same filler tasks in the same order. The 2 rounds of story exposures were separated by a long break and the activities took place during the school day.

The filler tasks were not scored, but were included to motivate participants to pay attention to the stories and engage with the intervention phase. Participants were informed in advance that they would need to complete tasks based on the content of the stories.

Post-exposure assessment materials and procedures

One day after the participants had their last exposure to the target construction, they completed the same receptive grammar task described in the baseline assessment materials and procedures. This was done to measure the changes to the target constructions because of the targeted exposure. All 10 constructions were included again as to not draw undue attention to the target constructions.

Ethical considerations

An application for full ethical approval was made to the University of Birmingham and ethics consent was received on 4 March 2022. The ethics approval number is ERN_21-0551A. The study also received ethic consent on 28 April 2022 from the University of Pretoria and the approval number is 02543524, HUM004/0422.

Results

All analyses were performed using R Statistical Software (v4.2.2; R Core Team 2022). The code and data used in the analysis are available at https://osf.io/74uef/?view_only=2d397388ef1f4fed9dfcda1a3889a13c. Data from 109 participants aged 10–15 years in Grade 6 (median age = 12 years) are presented below. Missing data points were imputed using the mice package (Buuren & Groothuis-Oudshoorn 2011).

Descriptive statistics

Descriptive statistics for the assessment measure are presented in Table 2. Overall, the participants performed well on the measures. The mean reading fluency score of 108.1 is age equivalent to 12 years and the participant who scored lowest performed at an 8-year level. There is an overall improvement on the receptive grammar task from pre-intervention to post-intervention.

Table 3 shows the mean score by construction in the pre-intervention and post-intervention receptive grammar tests.

TABLE 2: Mean, median, standard deviation, interquartile range, and ranges of scores.

Measure	Maximum score	Mean	Median	Standard deviation	Interquartile range	Range
Reading fluency	-	108.10	108	21.66	92–121	66–161
Reading comprehension raw score	50	33.61	34	5.49	29–38	20–46
Language analytic ability raw score	30	17.61	20	6.45	11–23	2–26
ART-Y raw score	60	11.31	11	6.11	7–14	0–28
Receptive grammar pre-intervention score	80	69.67	70	5.81	66–74	55–78
Receptive grammar post-intervention score	80	72.41	73	5.34	71–76	59–79

TABLE 3: Mean pre-intervention and post-intervention scores by construction on the receptive grammar test.

Construction	Pre-intervention	Post-intervention
Quantifier + has	5.62	6.83
Quantifier + is	5.96	7.19
Subject relative	7.70	7.39
Subject cleft	7.72	7.30
Object relative	7.39	7.12
Object cleft	7.63	7.58
Passive	7.76	7.93
Postmodifying prepositional phrase	5.98	6.32
Complex postmodifying prepositional phrase	6.39	7.11
X-Is-Difficult-to-answer	7.52	7.63

The maximum score for each construction is eight. As such, ceiling effects are visible in many constructions, including OCs.

Correlational analysis

Table 4 contains the correlations between the assessment measures. Print exposure (ART-Y) was significantly correlated with reading comprehension (r = 0.34) and the post-intervention receptive grammar scores (r = 0.21). However, in contrast to findings in a meta-analysis on print exposure (Mol & Bus 2011), we did not also find a significant correlation with reading fluency, which is a technical reading skill.

The original 'Pictures and Sentences' task had a test-retest reliability of 0.81 (Dąbrowska 2018). We found a correlation of 0.16 between the pre-intervention and post-intervention scores on our version of the receptive grammar task. Even though this correlation is not a measure of test-retest reliability (as participants had additional exposure to constructions in the test and their attention was directed to overall form), it is lower than expected. This may be attributed to the short duration of time between the two tests, which could have resulted in poorer engagement, especially on the easier constructions. This possibility is supported by the small decline in accuracy on the two control conditions: subject relatives and object relatives (see Table 3). Poorer engagement on the posttest may also explain why the pre-intervention receptive grammar scores have higher correlations with reading fluency, comprehension, and language analytic

TABLE 4: Correlations between the reading measures, language analytic ability measure, and grammar measures.

Predictor	Fluency	Comprehension	Language analytic ability	ART-Y score	Grammar (pre)	Grammar (post)
Fluency	1.00	0.13	0.30**	-0.04	0.22*	-0.08
Comprehension	0.13	1.00	0.32**	0.34**	0.55**	0.32**
Language analytic ability	0.30**	0.32**	1.00	0.03	0.36**	0.14
ART-Y score	-0.04	0.34**	0.03	1.00	0.01	0.21*
Grammar (pre)	0.22*	0.55**	0.36**	0.01	1.00	0.16
Grammar (post)	-0.08	0.32**	0.14	0.21*	0.16	1.00

*, $p < 0.05$; **, $p < 0.01$.

ability. Nonetheless, we investigated the internal reliability of the receptive grammar task. Using the split-half package (Parsons 2021), the split-half reliability was calculated using 5000 random splits and resulted in a Spearman-Brown corrected reliability of 0.74 for the pre-intervention results (95% confidence interval [CI] of 0.66–0.81) and 0.77 for the post-intervention results (95% CI of 0.07–0.83).

Inferential analysis

We ran several regression models in R to investigate our predictions. The proportion of variance that can be explained by each variable (lmg) was calculated using the relaimpo package (Grömping 2006). All predictor measures were scaled. Language analytic ability was converted to a binary variable of 'high ability' and 'low ability' based on an antimode split due to bimodal distribution of the data.

Our first prediction was that participants with high levels of print exposure and higher language analytic ability would have better reading skills. Model 1 predicts reading comprehension from reading fluency, print exposure, and language analytic ability (see Table 5). Print exposure and language aptitude were both significant predictors and contributed to 11% and 10% of the variance in reading comprehension. This corroborates what we observed in the correlation matrix above and corresponds to our predictions that print exposure and language aptitude would be significant predictors of reading comprehension.

Our first prediction also stated that high print exposure and language analytic ability should lead to better knowledge of grammar. Model 2 was run to predict the pre-intervention receptive grammar scores based on reading fluency, print exposure, and language analytic ability (see Table 6). Language analytic ability was the only significant predictor and contributed 9% of the variance in receptive grammar. Reading fluency approached significance. This result adds to the body of evidence from studies with adults that language analytic ability is a good predictor for first language mastery of grammar. However, our prediction that print exposure would predict receptive grammar is not met.

Our second prediction was that the intervention should result in an improvement on the trained construction and that the improvement would be more in the written modality than in the audio modality. The third model investigated the influence

TABLE 5: Model 1: Regression model predicting reading comprehension (Hodder Group Reading Tests II).

Predictor	Parameter estimate	Standard error	*t* value	Pr(> |t|)	lmg
(Intercept)	31.22	0.88	35.40	< 0.001***	-
Reading fluency	0.31	0.49	0.64	0.526	0.01
Language analytic ability	3.43	1.07	3.20	0.002**	0.10
Print exposure	1.72	0.48	3.60	< 0.001***	0.11

**, $p < 0.01$; ***, $p < 0.001$.

TABLE 6: Model 2: Regression model predicting receptive grammar in the pre-test.

Predictor	Parameter estimate	Standard error	*t* value	Pr(> |t|)	lmg
(Intercept)	3.31	0.16	20.19	< 0.001***	-
Reading fluency	-0.18	0.09	-1.93	0.056†	0.050
Language analytic ability	-0.59	0.20	-2.98	0.004**	0.090
Print exposure	0.03	0.09	0.35	0.772	< 0.001

†, $p < 0.1$; **, $p < 0.01$; ***, $p < 0.001$.

of the intervention group, the intervention modality, print exposure, reading fluency, and language analytic ability on the difference scores between the pre-intervention and post-intervention scores of the CPPP items of the receptive grammar test (see Table 7). Table 3 shows that we have ceiling effects in the OC construction. We used difference scores in our model, as this is the recommended measure when there are ceiling effects (Jennings & Cribbie 2022).

Print exposure was the only significant predictor in Model 3 and explained 11% of the variance. Crucially, neither modality nor group (i.e., whether participants were trained in the construction at hand or not) were significant predictors, explaining only 0.3% and 0.5% of the variance.

Finally, we ran a fourth model that investigated the influence of intervention group, intervention modality, print exposure, reading fluency, and language analytic ability on the difference between the post-intervention and pre-intervention scores of the OC items of the receptive grammar test (see Table 7). There were no significant predictors in this model and language analytic ability approaches significance (explaining 3% of the variance in the difference scores). It should, however, be noted that 68% of the participants were at ceiling in the pre-intervention test for this construction. This was unexpected, given that previous results from the same task with the same age group in the UK found that only 35% of participants were at ceiling on this construction (Wright et al. under review). In this regard, our participants rather have similar results to the adult participants from Dąbrowska's (2018) study. The same reason might explain why there are not significant differences between the pre-intervention and post-intervention scores and that the model has little variation that can be explained.

Discussion

Key findings

Reading comprehension is significantly influenced by both language analytic ability and the amount of print exposure that an individual has. Language analytic ability is also an important

TABLE 7: Model 3 and Model 4: Regression model predicting the difference score between post-intervention and pre-intervention scores on complex postmodifying prepositional phrases phrases and object clefts.

Model	Predictor	Parameter estimate	Standard error	*t* value	Pr(> |t|)	Img
Model 3: Complex postmodifying prepositional phrases	(Intercept)	0.50	0.24	2.07	0.041*	-
	Reading fluency	-0.19	0.13	-1.42	0.158	0.01
	Language analytic ability	0.33	0.29	1.14	0.259	0.02
	Print exposure	0.44	0.13	3.43	< 0.001***	0.11
	Modality	0.08	0.13	0.62	0.535	0.00
	Group	0.10	0.13	0.79	0.429	0.00
	Modality X Group	-0.11	0.13	-0.87	0.387	0.01
Model 4: Object clefts	(Intercept)	0.18	0.16	1.11	0.271	-
	Reading fluency	-0.05	0.09	-0.57	0.572	0.01
	Language analytic ability	-0.34	0.20	-1.71	0.091†	0.03
	Print exposure	0.06	0.09	0.73	0.469	0.00
	Modality	0.11	0.09	1.21	0.228	0.02
	Group	-0.03	0.09	-0.30	0.767	0.00
	Modality X Group	0.02	0.09	0.24	0.808	< 0.001

†, $p < 0.1$; *, $p < 0.05$; ***, $p < 0.001$.

predictor of performance on receptive grammar. There was no effect of the intervention nor was there a clear modality effect. In the construction where participants were not at ceiling, the best predictor of improvement was print exposure.

Discussion of key findings

Reading comprehension: Both print exposure and language analytic ability were significant predictors of reading comprehension, explaining 11% and 10% of the variance (see Model 1).

Reading fluency was not a significant predictor of reading comprehension even though one may expect that more fluent readers would be able to devote their attention to the content rather than the mechanics of deciphering the words. The relationship between print exposure and reading ability, both fluency and comprehension, is a complex one. Twin studies using direction of causation modelling suggest that the direction of causality runs from reading ability to print exposure both for reading comprehension (Erbeli, Van Bergen & Hart 2020) and reading fluency (Van Bergen et al. 2018).

These studies show that it is ability that influences how much children read, at least in early childhood, although these are certainly also influenced by genetic and environmental factors. Regular print exposure increases the exposure to structures that are more common in written language and encountering words in context may increase the quality of the lexical representation, thus support reading comprehension (Mol & Bus 2011; Nation 2008). It is possible that the same effect exists for grammar to the extent that comprehension depends on the individual's grammar.

The relationship between reading comprehension and language analytic ability has previously been investigated in the context of the contribution of first language reading ability and language aptitude on later second language reading ability (e.g. Sparks et al. 2006, 2012). Our findings indicate that language analytic ability, specifically grammatical sensitivity, already plays a role in L1 reading comprehension. It is, however, difficult to disentangle the direction of causality between aptitude and literacy in an already literate population. The relationship is most likely reciprocal in that some degree of language analytic ability supports the acquisition of literacy skills and that the process of becoming literate feeds back into the language aptitude skills.

Receptive grammar: We investigated the role that reading measures, both reading fluency and print exposure, and language analytic ability play in receptive grammar acquisition. Language analytic ability is a significant predictor of receptive grammar (explaining 9% of the overall variance) and print exposure approaches significance (explaining 5% of the variance) (see Model 2). The impact of language analytic ability is weaker on the post tests, likely because of practice effects and ceiling effects on some constructions. These results mirror findings showing that aptitude is relevant for first language grammar in both acquisition during childhood (Wright et al. under review) and in adult outcomes (Llompart & Dąbrowska 2023; Winckel & Dąbrowska 2024). The language analytic ability task also measures metalinguistic awareness (Sparks & Dale 2023). It is, however, difficult to tease apart the directionality of the influence between literacy and metalinguistic awareness. While children certainly have metalinguistic awareness in the form of rhyme and alliteration awareness before learning to read (Snow, Burns & Griffin 1998), Sparks and Dale (2023) argue that it is the process of becoming literate that supports the bulk of metalinguistic awareness development.

Many suggest that the acquisition of grammar and phonology in the native language relies almost exclusively on implicit learning mechanisms (DeKeyser 2000; DeKeyser, Alfi-Shabtay & Ravid 2010; Ellis 2008). It is believed that young children do not have the metalinguistic awareness or skills that would enable them to learn from explicit grammar instruction or explanations, or to reason about linguistic structures. As far as teenagers are concerned, our results point in a different direction. We found that language aptitude (a measure of explicit language learning ability), specifically grammatical sensitivity, is a predictor of receptive

grammar in the L1. This indicates the presence of explicit knowledge or awareness about the grammatical structures and syntactic functions in the native language. However, we cannot comment on the contribution of other aspects of language aptitude to first language grammar acquisition, as these were not the focus of the current study.

The importance of explicit grammar knowledge has implications for the way that grammar is taught in the native language classroom and suggests that explicit teaching may be beneficial for the development of grammatical awareness, even in L1 acquisition. Based on research with adults, Dąbrowska (2009) made similar conclusions about the fact that L1 and L2 acquisition may not be as fundamentally different as previously thought, although there may be differences in the use of explicit and implicit learning mechanisms.

The influence of modality on the learning of constructions

Our participants were divided into 4 groups with each group experiencing targeted exposure to a specific construction in a specific modality. There were 2 target constructions (CPPP and OC) and 2 modalities (audio and written). The only significant predictor for improvement on the CPPP construction post-intervention scores was print exposure, which explained 11% of the variance in the difference scores on the target construction (see Model 3). There were no significant predictors for difference scores for the OC construction (see Model 4). As far this latter construction is concerned, it may be that the regression model does not explain much of the variance because there is very little variance that can be explained. There was not room for improvement for most of the participants who were already at ceiling on the pre-intervention test in this construction. In comparison, 91% of the participants were not at ceiling on the CPPP condition in the pretest, which left more room for improvement and meant that the regression model had more variance that it could explain.

The intervention in the form of targeted exposure to constructions did not have any significant effect on the comprehension of those constructions and neither did the modality of the exposure. The largest effect came from print exposure, indicating that participants who read more performed better on the post-test than those who read less. This may mean that additional exposure to any enriched language, regardless of the specific construction, increases awareness of form and contributes to improvement. Stanovich (1986) refers to the Matthew effect to explain what may be at work here. The Matthew effect is a well-known dynamic in sociology, according to which individuals who benefit from an initial advantage tend to accumulate this advantage over time, while individuals who start out with a disadvantage worsen their condition over time. In the present case, individuals who read more (i.e. have higher print exposure) are the individuals who are less likely to have reading difficulties and thus benefit more from exposure to written language. Thus, there may be a marked difference in experience with the structures found more often in written language between the groups based on their reading habits.

Strengths and limitations

There are several limitations that need to be considered in the generalisation of the results in this study. The largest limitation is that the study is correlational, meaning that limited inferences can be drawn about the direction of causality between grammar and the other predictors. It is possible that increased print exposure and higher language analytic ability lead to better grammar, however it is also likely that better grammar makes comprehension easier and thus makes reading more enjoyable. A third possibility is an underlying variable which affects both grammar and one or more of the predictors. It may also be the case that grammar and the predictors in this study have reciprocal causation in that any gain in one area leads to a gain in the other.

The second limitation of the study is that we had ceiling effects on the OC construction, making it difficult to draw conclusions about the additional exposure to constructions. This may also have played a role in the overall null effect of the exposure.

The modality of testing may also be a limitation. Testing grammar in the audio modality may have provided information to untangle the relationship between reading comprehension and grammar. However, this was not possible in the research setting.

Implications or recommendations

In the context of foreign language learning, there is some evidence to suggest that the relationship between metalinguistic awareness and language analytic ability increases when children learn a foreign language, which is typically done through explicit instruction in educational settings (Roehr-Brackin & Tellier 2019). This also means that language aptitude may be a dynamic trait, at least in children who are still in the process of acquiring literacy skills (Roehr-Brackin & Tellier 2019; Tellier, Roehr-Brackin & Arnold 2013). This view is opposed by those who consider language aptitude a stable and innate trait (see Chalmers et al. 2021 for a meta-analysis). The findings from our study suggest that explicit grammar instruction in the native language may also be beneficial, given the predictive power of language analytic ability (an explicit metalinguistic skill) for receptive grammar. More research into the specific role that the modality of exposure plays in the acquisition of grammatical structures is needed. Investigations into the teaching of grammar and exploiting and supporting individuals' language analytic ability may shed light on how students can be supported to develop expressive grammatical complexity in their spoken and written language as well. Regardless of the direction of causation, print exposure is an important factor for both grammar and reading comprehension and should be actively encouraged and supported.

Conclusion

In this study we provided targeted exposure to one of two constructions via either the audio or written modality and investigated the role that language analytic ability and print exposure have on the learning of constructions, and overall, on literacy and grammar skills. We found that print exposure was the most important predictor of learning a construction through incidental exposure, regardless of the modality of exposure. Language analytic ability, as the most significant predictor of baseline receptive grammar, and experience with written language are the most important determiners for the extent to which individuals learn constructions through exposure.

Language analytic ability was previously assumed to only be relevant for second or foreign language acquisition. The correlation we found between language analytic ability and grammar in the first language, implies that there may not be fundamental differences between how the two languages are acquired. This warrants further investigation into the differences between how native and foreign languages are taught in educational settings, with particular attention to the formal teaching of grammar.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

E.D. and R.W. conceptualised the study. E.D., R.W., and E.W. were responsible for the experimental design with methodological input from S.G. and M.L. Data were collected by S.G. The analysis of data were done by M.L. and R.W. with input from E.W. and E.D. All authors, R.W., E.W., E.D., and M.L., contributed equally to the writing of this research article.

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Data availability

The script and data sets analysed for this manuscript are available on the Open Science Framework (OSF) at https://osf.io/74uef/?view_only=2d397388ef1f4fed9dfcda1a3889a13c.

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