

This is the native speaker that the non-native speaker outperformed: individual, education-related differences in the processing and interpretation of object relative clauses by native and non-native speakers of English

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Abstract: This paper provides experimental evidence for considerable education-related differences in processing and comprehension of predicate nominal Object Relative Clauses. The experiment measured high academic attainment (HAA) and low academic attainment (LAA), native and non-native speakers' response time and decision accuracy using an online sentence-picture matching task which compared processing and comprehension of Active Transitive and Subject and Object Relative Clause sentences (e.g., This is the girl that hit the boy, This is the girl that the boy hit). The results support usage-based (e.g., Barlow and Kemmer, 2000, Bybee 2010, Langacker 2000) and constraint-based approaches, particularly those that predict that participants' performance is shaped by regularity, frequency and direct experience of the constructions (e.g., MacDonald and Christiansen 2002). All groups processed Actives and Subject Relative Clauses faster than Object Relative Clauses whilst the LAA native and HAA non-native participants made significantly more errors with Object Relative Clauses than Active and Subject Relative Clause sentences. However, since the results show evidence of non-native speakers outperforming (some) native speakers in an online task tapping knowledge of complex grammar, they are problematic for accounts which posit that only non-native speakers are restricted to 'shallow' syntactic processing (e.g., Clahsen and Felser 2006).

Keywords: Subject Relative Clause, Object Relative Clause, Sentence processing, Linguistic competence, Linguistic performance, Usage-based, Constraint-based

1. Introduction

A growing body of empirical research suggests that there is substantial individual variation in native speakers' underlying knowledge in various areas of the language system, including: inflectional morphology (Dąbrowska 2008, Indefrey and Goebel 1993); various non-canonical constructions such as passives (Dąbrowska and Street 2006, Street and Dąbrowska 2010, Street and Dąbrowska 2014, Dąbrowska, submitted); and quantifiers (Street and Dąbrowska 2010, Dąbrowska, Street & Farmer, submitted); and a variety of more complex constructions involving subordinate clauses (Chipere 2001, 2003; Dąbrowska 1997). Many of the observed individual differences are strongly related to level of educational attainment. In fact, a recurring pattern is that whilst those participants with high academic attainment (HAA) invariably perform at ceiling, participants with low academic attainment (LAA) show much more variable performance.

There are also several cases in the literature of non-native speakers outperforming natives on tasks tapping morphosyntactic abilities (Dąbrowska and Street 2006, Dąbrowska, Street & Farmer, submitted, Chipere 1998, Sasaki 1997). Together the results of these

studies suggest that type as well as amount of linguistic experience is important and that linguistic experience overall plays a much greater role in language attainment than is often assumed. This challenges the conventional wisdom in language acquisition research that first language acquisition is uniformly successful, with all learners converging relatively rapidly on the same grammar (see e.g., Birdsong, 2004: 83; Bley-Vroman, 2009: 179; Chomsky, 1975: 11; Crain & Lillo-Martin, 1999: 9; Lidz & Williams 2009: 177; Nowak et al., 2001: 114; Seidenberg, 1997: 1600). The results also raise several interesting implications for second language acquisition. Many second language researchers make appeal to native speaker norms based on assumptions of L1 convergence whilst the fact that second language learners typically do not converge is often used to argue that L2 learning is fundamentally different from L1 acquisition (e.g., Bley-Vroman, 1990, 2009, Birdsong 1992, 2004, 2006, Birdsong and Molis 2001, Coppieters 1987, Johnson and Newport 1989). Additionally, the results potentially raise problems for theories which posit that L1 and L2 processing are fundamentally different, such as the Shallow Structure Hypothesis (see, e.g., Clahsen & Felser 2006 and section 3, below) and suggest that assumptions about fundamental differences between first and second language acquisition may be in need of revision.

The present study has two main aims. The first is to provide further evidence demonstrating the existence of education-related individual difference in native speaker attainment of non-canonical constructions and thus further challenge the convergence argument. The second is to provide further evidence of non-native speakers outperforming native speakers on tasks tapping morphosyntactic knowledge. In doing so this study aims to provide further support for the idea that individual difference in language attainment is attributable to differences in amount and type of language experience. The paper also seeks to challenge the idea that non-native learners perform less well than native speakers on tasks tapping morphosyntactic knowledge because they have shallower representations of the grammar. To do this the study will focus on the processing of two constructions, predicate Subject Relative Clauses and predicate Object Relative Clauses, by native and non-native speakers of English with varying levels of academic attainment. Relative clauses, especially Object Relative Clauses, are particularly relevant here since they are non-canonical, and, since they involve embedding (complex structure), they have been employed in studies aiming to provide evidence in support of the Shallow Structure Hypothesis.

2. Relative clauses

Sentence 1(below) is a Subject Relative Clause sentence (SRC) which comprises a main clause (*the boy laughed*) and an embedded clause (*that chased the girl* – marked in brackets). In Subject Relative Clause sentences the head noun (*the boy*) occupies the subject role of the main clause verb (*laughed*) and the subject role (marked with a) of the embedded clause verb (*chased*). Sentence 2 is an Object Relative Clause sentence (ORC). In these sentences the head noun (*boy*) occupies the subject role of the main clause verb (*laughed*) and the object role (marked with a) of the embedded clause verb (*chased*).

1. The boy [that _chased the girl] laughed.
2. The boy [that the girl chased _] laughed.

Previous research, testing both adults and children, has found that Subject Relative Clause sentences are easier to process than Object Relative Clause sentences. Several competing theories (see Reali & Christiansen, 2006, for review) have sought to explain these differences, with explanation focusing on either the semantic complexity of Object Relative Clauses (see, e.g., MacWhinney & Pléh, 1988), the syntactic complexity of Object Relative Clauses (see, e.g., Miyamoto & Nakamura, 2003) or that Object Relative Clauses place heavier demands on Working Memory than Subject Relative Clauses (see, e.g., Warren & Gibson, 2002). Other explanations for the observed asymmetry in processing of Subject Relative Clause and Object Relative Clause sentences focus on the role of experience in language processing and attainment. According to usage-based and constraint-based accounts (e.g., Barlow and Kemmer, 2000, Bybee 2010, Langacker 2000, MacDonald and Christiansen 2002) sentence comprehension involves rapid integration of a variety of probabilistic constraints emerging from the lexical properties of individual words, the relative frequency of the verb in different constructions, the frequency of the constructions themselves, thematic fit of the verb's arguments, and information derived from the preceding discourse and the non-linguistic context.

On constraint- and usage-based accounts language processing and attainment are strongly related to linguistic experience. Since the input that language learners are exposed to contains many recurrent patterns (i.e., specific forms are associated with specific meanings), learners are able to extract schemas capturing these patterns. Through repeated use, these form-meaning pairings become entrenched, and hence more easily accessible. Thus, according to usage-based and constraint-based accounts, more experience with a construction should result in greater entrenchment and hence faster and more reliable retrieval during processing.

The asymmetry in processing difficulty between Subject Relative Clause and Object Relative Clause sentences appears problematic for usage-based models since it is often assumed to be the case that Object Relative Clauses are more frequent than Subject Relative Clauses, particularly in naturalistic speech. However, several studies have revealed some interesting distributional properties of relative clauses which indicate that not all types of Object Relative Clause are more frequent than Subject Relative Clauses, and that those types of Object Relative Clause that are more frequent are actually easier to process than Subject Relative Clauses. Several studies (e.g., Fox and Thompson 1990, Kidd et al. 2007, Brandt et al. 2009), for example, have found that Object Relative Clauses like those in 3 and 4 (below), which have an inanimate head NP and a discourse-old referent subject in the relative clause, such as a pronoun or proper noun, are more frequent than Subject Relative Clauses in naturalistic speech.

3. The book [that she read_] was interesting.
4. The book [that Nesta read_] was interesting.

Therefore, if frequency and experience play a role in sentence processing (and attainment), and if speakers are sensitive to typical pronoun usage patterns in relative clauses, then this should predict processing difficulty. That is, one would actually expect Object Relative Clauses like those in 3 and 4 to be no more difficult to process than Subject Relative Clauses since Object Relative Clauses like those in 3 and 4 are likely to be the type of relative clauses that people most often say and hear; and therefore one would predict the Subject Relative Clause /Object Relative Clause asymmetry to disappear. In fact several studies, looking at both adult and child sentence processing, have shown that the difficulty ascribed to Object Relative Clauses disappears when the head noun is inanimate (Mak et al. 2002, 2006, Traxler et al. 2002, Weckerly and Kutas 1999), whilst other studies have shown that Object Relative Clauses are easier to process when they contain a relative clause subject that is more accessible than a lexical NP, i.e., discourse-old referents such as pronouns or proper nouns (e.g., Brandt 2011, Reali and Christiansen 2007).

Further evidence for the role of frequency in the processing of Subject Relative Clause and Object Relative Clause sentences is provided by several constraint-based lexical approaches (e.g., Reali and Christiansen 2007, Gennari and MacDonald 2008). Reali and Christiansen (2007), for example, conducted a large-scale corpus study that showed that Object Relative Clauses of the type in 5 (below) which contain personal pronouns in the subject slot of the relative clause are more frequent than Subject Relative Clauses of the type in 6 which contain personal pronouns in the object slot of the relative clause. By contrast Subject Relative Clauses of the type in 7 which contain impersonal pronouns as the relative clause object are more frequent than Object Relative Clauses with impersonal pronouns as the relative clause subject as in 8.

5. The lady [that I visited_] enjoyed the meal.
6. The lady [that _visited me] enjoyed the meal.
7. The studies [that _motivated it] converged on similar results.
8. The studies [that it motivated_] converged on similar results.

The researchers then employed a self-paced reading task to test adult native speaker's processing of the different sentence types. They found that frequency of construction predicted processing difficulty. For example, participants processed Object Relative Clauses more easily than Subject Relative Clauses when the test sentences contained a personal pronoun as the relative clause subject (i.e., Object Relative Clauses like 5 are easier than Subject Relative Clauses like 6), but that Subject Relative Clauses were processed more easily when the relative clause object was an impersonal pronoun (i.e., Subject Relative Clauses like 7 are easier than Object Relative Clauses like 8). The results, therefore, support the claims of more general usage-based accounts that frequency plays a crucial role in shaping speakers' mental grammars and that more experience with a particular construction results in greater entrenchment, and hence faster and more reliable performance. There is also evidence from studies of statistical learning that statistical learning plays a key role in both L1 acquisition and adult language processing. For example, in acquisition evidence shows that statistical learning predicts children's comprehension of Object Relative Clauses (see, e.g., Kidd & Acriuli 2016). In

adult processing several studies have shown the statistical learning predicts online processing of Object Relative Clauses (see, e.g., Misyak & Christiansen 2012, Misyak et al. 2010).

2.1 Regularity x frequency x experience interaction

Of particular interest to the present study is the work of MacDonald and Christiansen (2002) who argue that the processing of relative clauses provides an example of a regularity x frequency x experience interaction. Following Seidenberg (1985), MacDonald and Christiansen (2002) argue that certain sentence types are more regular (i.e., they have more consistent syntax to semantic mapping) and that sentence ambiguity resolution shows a frequency x regularity x experience interaction. On this view, interpretation of less regular, and less frequent sentence types (e.g., those with non-canonical syntax-meaning mappings) depends on direct specific experience (frequency of encounters) with that particular structure.

MacDonald and Christiansen argue that Subject Relative Clauses are an example of regular sentence types in that they have SVO word order and typically AGENT-VERB-PATIENT thematic role assignment. Object Relative Clauses by contrast are an example of an irregular sentence type. Syntactically they have OSV word order and a PATIENT-AGENT-VERB thematic role assignment. Consequently, Subject Relative Clauses belong to a large neighbourhood in that they have many neighbours with similar word order and thematic role assignment. Object Relative Clauses, however, belong to a much more sparsely populated neighbourhood in that they have few, if any neighbours, in terms of word order and thematic role. Therefore, on this account, since Object Relative Clauses belong to very sparsely populated neighbourhoods, processing of Object Relative Clauses is more dependent on direct experience with Object Relative Clauses.

A key point here is that the exact nature of regularity x frequency interaction is argued to vary across individuals. That is, language users with more overall experience with language (e.g., highly skilled readers) consequently have more experience with both regular and irregular forms, including regular and irregular sentence types. However, the extra experience is most advantageous with irregular forms and, therefore, sentence processing exhibits a regularity x frequency x experience interaction. Variation in, for example, reading experience changes the nature of individual regularity x frequency x experience interaction for particular constructions. For example, amount of reading experience has little effect on processing of Subject Relative Clause because Subject Relative Clauses are from a large neighbourhood and speakers get lots of experience with SVO/AGENT-VERB-PATIENT patterns, even if they read very little (or at all). However, amount of reading, and overall increased linguistic experience generally, affects processing of Object Relative Clauses because these are from a sparsely populated neighbourhood and, thus, processing is dependent on direct experience with Object Relative Clauses. Therefore, one would expect faster processing and more reliable interpretation of frequent, regular constructions, than infrequent, irregular ones. Furthermore, one would expect Object Relative Clauses to be processed faster and more reliably by language users with more overall experience with language (e.g., highly

skilled readers) because they are likely to have more direct experience with this construction.

MacDonald and Christiansen provide support for the regularity x frequency x experience interaction via computational simulations using connectionist networks (MacDonald and Christiansen (2002). However, there is further support directly testing experience with real language users (e.g., Wells et al. 2009). The approach is also given some support from the results of Street & Dąbrowska (2010) who found moderately strong correlations between amount of reading and interpreting the full English passive construction, a linguistic construction that occurs more frequently in formal, written environments. However, I would like to extend the regularity x frequency x experience interaction hypothesis such that experience includes not only amount of experience with particular (non-canonical) constructions but also *type* of linguistic experience.

3. Shallow Structure Hypothesis

Like other generativist approaches to language processing, the Shallow Structure Hypothesis (SSH, see, e.g., Clahsen and Felser 2006) posits a dissociation between grammatical knowledge and processing development in language learners such that non native speakers may exhibit the same grammatical knowledge as native speakers for a particular construction, as measured by proficiency tests or grammaticality judgment tasks, but perform significantly worse than native speakers when tested on the same constructions using on-line measures, suggesting that non-natives have different processing strategies (see, e.g., Papadopoulou & Clahsen 2003). In fact, proponents of the Shallow Structure Hypothesis argue that second language learners employ specific processing strategies, fundamentally different to native speakers. According to the Shallow Structure Hypothesis there are two different types of language processing: a full parse and a shallow parse. The full parse involves information about grammar whilst the shallow parse relies on lexical, semantic, pragmatic and other information, such as world knowledge, rather than grammatical (syntactic) cues. The Shallow Structure Hypothesis states that second language learners do not process the input in the same way as native speakers; whereas native speakers are thought to employ both shallow and full processing, second language learners are argued to only employ shallow processing and thus second language users, even those highly proficient in the second language, may not be able to activate full syntactic information during sentence processing. The fundamental difference between first language and second language processing for proponents of the Shallow Structure Hypothesis then is that adult second language learners rely more strongly on lexical, semantic and pragmatic information and rely less on syntactic information and therefore supposedly have shallower structural/syntactic representations than native speakers. This manifests in slower processing and less reliable interpretation of complex grammatical constructions compared to native speakers.

Proponents of the Shallow Structure Hypothesis have, occasionally, drawn on evidence from experiments employing offline tasks. However, they are predominantly concerned with data from on-line processing in support of their central claims. Several studies have

investigated how second language learners from different first language backgrounds resolve syntactic ambiguity with results suggesting that second language learners underuse syntactic information during sentence processing (see, e.g., Clahsen and Felser 2006). Papadopoulou and Clahsen (2003) found that learners of second language Greek were more likely to ignore syntactic cues than native speakers. In another study Felser and Roberts (2004, 2011) found that advanced Greek learners of second language English were more strongly influenced by plausibility information than native speakers.

However, the Shallow Structure Hypothesis is controversial and several studies have challenged its central claims. For example, there is evidence that semantic processing and processing of local grammatical dependencies by non native speakers is similar to that of native speakers (e.g., Ojima *et al.* 2005, Sanders and Neville 2003, Wartenburger *et al.* 2003). Several studies have found evidence that second language learners process the target language the same as first language speakers, using syntactic and non-syntactic information as well as probabilistic information (e.g., Dussias & Scaltz 2007). Omaki and Arijji (2004), for example, found that Japanese speakers of second language English used both syntactic and lexical-semantic information whilst processing Subject Relative Clause and Object Relative Clause sentences.

In view of the Shallow Structure Hypothesis claims, studies from the individual differences literature (e.g., Dąbrowska and Street 2006) are particularly interesting, since not only do they show that some non-native speakers can outperform native speakers on tasks tapping morphosyntactic knowledge, but also, and importantly, that some native speakers, particularly those with low educational attainment, are more likely to ignore syntactic cues and rely on non-syntactic information during sentence processing, even with less complex non-canonical, constructions. This suggests that some native speakers' underlying grammatical representations are not as well entrenched as others and that, as a consequence, they too may be relying on other, non-linguistic cues when processing (see, e.g., Ferreira 2003, Daneman *et al.* 2006, 2007). Or in Shallow Structure Hypothesis terms there are also native speakers who rely on shallow structural processing. As noted above, proponents of the Shallow Structure Hypothesis acknowledge this (see, e.g., Clahsen & Felser 2006). However, they claim that with regard to first language processing, shallow processing is merely an option to the human language comprehension system whereas non-native adult learners are restricted to shallow processing in second language processing (*ibid.* p.34). By contrast, my claim is that for certain kinds of construction (e.g., those that are less frequent, non-canonical) some native speakers are also 'restricted' to 'shallow' processing – though I (and coauthors) offer a different explanation as to why this might be the case (see, e.g., Dąbrowska & Street 2006, Street & Dąbrowska 2010, Street & Dąbrowska 2014).

4. Experiment

This study tests processing and comprehension of three constructions: the Active Transitive and two variants of the Predicate Nominal Relative Clause construction (see Fox and Thompson 1990). Predicate Subject Relative Clauses and Object Relative Clauses in which the Head Noun slot and the embedded Noun slot are filled with a full

Noun Phrase differ in their frequency; Subject Relative Clauses are considerably more frequent than Object Relative Clauses in both spoken and written linguistic environments. However, whilst Subject Relative Clauses are more frequent overall, what is of particular interest is that predicate Object Relative Clauses occur much more frequently in written texts than spoken ones. That is, evidence from corpus studies (e.g., Roland et al. 2007) suggests that native speakers are three times more likely to encounter an Object Relative Clause of this type in written texts than in everyday speech.

4.1 Predictions

The experiment was designed to test usage-based predictions and an additional prediction relating to the Shallow Structure Hypothesis. According to usage-based theories (Bybee, 2010, Langacker, 2000), repeated experience with a particular construction leads to greater entrenchment, which in turn results in faster and more accurate processing. Therefore, I expect Active and Subject Relative Clause sentences to be easier than Object Relative Clause sentences for all participants. However, since Object Relative Clauses of this type are more frequent in formal written texts than in spoken texts, I expect that processing and interpretation differences between Actives and SRCs on the one hand and Object Relative Clause sentences on the other should be particularly pronounced in less educated participants - since overall these participants will have had less overall direct experience with Object Relative Clauses of this type.

I also expect, given findings from previous research, an effect of type of linguistic experience (as well as amount). Therefore, I predict that some high academic attainment non-native participants will outperform some low academic attainment native speakers. This, in effect, challenges the Shallow Structure Hypothesis account; on that account, native speakers, regardless of educational attainment, should outperform non-native speakers on tasks tapping processing/knowledge of complex morpho-syntax since non-natives are argued to be restricted to shallow structural processing. Nevertheless, I expect that this effect will only be evident on the accuracy measure, and not on response time, since various other factors (e.g., orthography) could affect the non-native speakers' performance on response times. Since I want to independently examine the effects of native language and education and their effect on grammatical performance, I will compare Language and Education as predictors of ability to interpret predicate Object Relative Clauses. The prediction is that whilst both will matter, education will be a stronger predictor than language. I fit two regression models using language and education as predictor variables; a binary logistic regression model is used to predict decision accuracy, while a linear regression is used to model response times.

4.2 Method

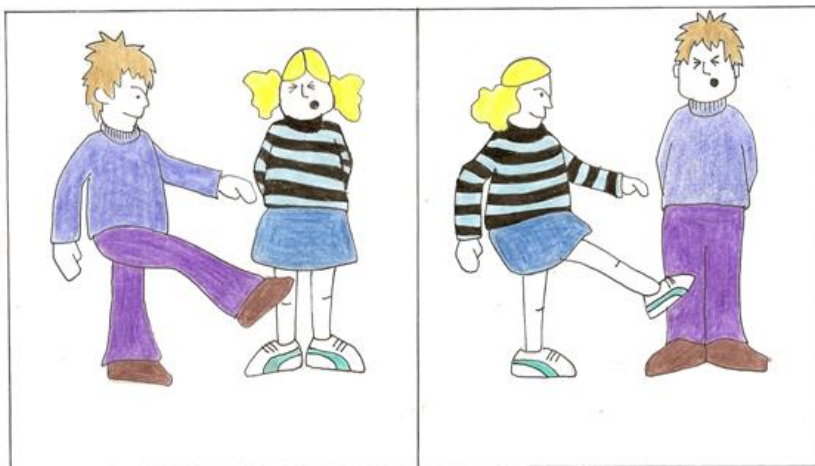
4.2.1 Participants

Eighty-five adults (40 males and 45 females) aged 17–50 participated in the experiment. The high academic attainment native speakers group comprised 31 postgraduate students

or recent graduates studying for an MA degree (and hence with at least 17 years of formal education); they came from a variety of academic disciplines (arts and humanities, social sciences and life sciences). The high academic attainment non-native speakers group comprised 27 postgraduate students who were studying for or had recently completed PhDs. These participants came from a variety of language backgrounds (including German, Polish, Chinese, Farsi, Arabic, and Hebrew). They had on average 13 years of learning / using English (13.3 (5) years). The remaining 27 participants (the non-graduate, low academic attainment group) were native speakers of English who had had at most 11 years of formal education and were employed in various unskilled manual labour positions (e.g. packers at a factory, building site labourers).

4.2.2 Materials

Participants read sentences and matched the sentence to a picture in a picture selection task. There were 18 test sentences comprised of three conditions: 6 x Active (e.g., *The girl kicked the boy in the leg*), 6 x Subject Relative Clauses (e.g., *This is the girl that kicked the boy*) and 6 x Object Relative Clauses (e.g., *This is the boy that the girl kicked*). The Active sentences served as control. The visual stimuli comprised 18 pairs of pictures depicting simple transitive events (e.g., a girl kicking a boy and a boy kicking a girl see Fig 1).



This is the boy that the girl kicked

Fig 1. Picture depicting simple transitive event

There were four versions of the test, each containing six sentences for each of the three conditions, and within any one version there were no repeats of the same action involving the same NPs (i.e., in any one version no NP (e.g., the boy or the girl) appears with the same verb twice). For the test conditions there are four possible descriptions (e.g., *This is the boy that kicked the girl*, *This is the girl that kicked the boy*, *This is the boy that the girl kicked* and *This is the girl that the boy kicked*); each of the four possible descriptions appeared in a different version of the test. For the control condition there are only two possible descriptions (e.g., *The man chased the woman to the park* and *The woman*

chased the man to the park). These sentences were divided such that if one description (e.g., *the man chased the woman*) appeared in versions 1 and 3, the other description (e.g., *the woman chased the man*) appeared in versions 2 and 4. Ultimately, each participant saw 18 sentences: 6 Active, 6 Subject Relative Clause, and 6 Object Relative Clause with no repeats of the same NP with the same verbs. The order of sentences was randomized for each participant. A complete list of sentences used in one version of the test is given in Appendix I.

4.2.3 Procedure

The experimental session began with participants reading written instructions displayed on a laptop screen. Participants were informed that they would be presented with a series of pairs of pictures with a sentence underneath (see, e.g., fig. 1, above) and that their task was to decide if the sentence corresponded to the picture on the left or that on the right. A complete transcript of the written instructions is given in Appendix II.

Participants responded by pressing keys marked 'Left' and 'Right' on the keypad. Participants pressed 'Left' if they thought the sentence corresponded with the picture on the left) or 'Right' if they thought the sentence corresponded to the picture on the right. The pictures and sentence remained on screen until a participant pressed either 'Left' or 'Right'; they then disappeared and were replaced by a short sign (+++) and shortly afterwards, the next pair of pictures and sentence.

Before the test trials began all instructions were clarified (and concept checked) verbally by the experimenter. Participants then completed four practice trials (using present progressive constructions, e.g., *The sailor is kicking the soldier*). These were supervised by the experimenter to ensure that participants had understood the task. Participants were tested individually, with each testing session lasting approximately 5 minutes. The stimuli were presented using E-prime software (Psychology Software Tool, Pittsburgh, PA), which also recorded the participants' decision accuracy and reaction times.

5. Results

5.1 Decision accuracy

Mean proportion of correct responses and standard deviations for all conditions by groups are summarised in Table 1. As can be seen from the descriptive statistics all groups are at ceiling on the Active and Subject Relative Clause sentences. Furthermore, the ranges and variances for each group are very similar. However, in the objective relative clause condition only the high academic attainment native speakers are at ceiling. The low academic attainment group has the lowest mean proportion of correct responses, with a wider range of scores and greater variation within the group than the high academic participants.

Table 1. *Proportion of correct responses for each condition by group*

Group	Construction		
	Active	SRC	ORC
HAA N (N=31)			
Mean (SD)	95 (9)	96 (8)	95 (10)
(Range)	67-100	67-100	67-100
LAA N (N=27)			
Mean (SD)	95 (8)	95 (11)	71(20)
(Range)	67-100	50-100	15-100
HAA NN (N=27)			
Mean (SD)			
(Range)	97 (8) 67-100	95 (9) 67-100	88 (12) 67-100

The data were analyzed using R version 3.2.5 (R Core Team, 2016) and *lmer* from package *lme4* (<https://cran.r-project.org/web/packages/lme4/lme4.pdf>) using “bobyqa” as optimizer to perform a binary logistic regression analysis of the relationship between accuracy on the one hand, and language and level of education on the other. Participants and Items were entered as random effects. As fixed effects, language and level of education, both with condition as the interaction term, were entered into the model. The Active transitive condition is the reference category: all estimates are in comparison to this condition. Estimates, standard errors, t-values/z-values and p values for the relevant variables are presented in Table 2, below

Table 2. Estimates, standard errors, t-values/z-values and p-values for variables.

	Estimate	Std. Error	t value	p value
(Intercept)	3.284177	0.393162	8.353	<2e-16***
LanguageL2	0.301287	0.611250	0.493	0.622081
Condition ORC	-0.436520	0.473150	-0.923	0.356225
Condition SRC	-0.125503	0.501556	-0.250	0.802412
Educationlow	-0.008305	0.562275	-0.015	0.988216
LanguageL2:Condition ORC	-0.898156	0.708033	-1.269	0.204611

LanguageL2:Condition SRC	-0.371523	0.771173	-0.482	0.629974
Condition	-2.205239	0.639483	-3.448	0.000564***
ORC:Educationlow				
Condition	-0.258852	0.716116	-0.361	0.717751
SRC:Educationlow				
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

The analysis revealed that there is a significant interaction between level of education and decision accuracy, in particular between low level of education and decision accuracy on Object Relative Clauses. That is, the results support the descriptive statistics in Table 1 which indicate that whilst all participants have more difficulty interpreting Object Relative Clauses, it is the low academic group that has most problems with this construction.

5.2 individual differences

As can be seen from the standard deviations and ranges in Table 1, there were considerable individual differences, particularly in the low academic attainment participants' performance on Object Relative Clause sentences. There were 6 Object Relative Clause sentences on the test. According to the binomial distribution ($p < .05$), above chance performance requires 6 out of 6 correct responses, and a score of 2 or less would be below chance. At this criterion, 4 of the low academic attainment participants (i.e. 15%) performed above chance; 21 (79%) were at chance and 2 participants were below chance (7%). By comparison 14 (i.e., 52 %) of high academic attainment NN performed above chance and 13 (i.e., 48%) were at chance. For the high academic attainment native speakers group 22 (i.e., 71%) were above chance and 9 (i.e., 29%) at chance.

5.3 Response Time

Mean response times and standard deviations for all conditions by groups are summarised in Table 3. As can be seen from the descriptive statistics native speakers are faster than non native speakers on all conditions. The non native speaker group also has the widest range of response times and the most variation in response times.

Table 3. *Mean Response Time and Standard Deviations (in milliseconds) of sentences by group*

Group	Construction		
	Active	SRC	ORC
HAA N (N=31)			
Mean (SD)	3240 (815)	3321 (844)	4162 (1510)
Range	2116-5174	2014-5075	2304-8949

LAA N (N=27)			
Mean (SD)	4291 (1155)	4939 (1787)	6332 (2325)
(Range)	2383-7544	1840-8872	2895-10320
HAA NN (N=27)			
Mean (SD)	5438 (1576)	6209 (2096)	7864 (2525)
(Range)	2738-9058	2630-9776	4122-12456

A linear mixed effects model was fit to the response times obtained from the native speakers only with *lmer* from package *lme4* (using optimizer “bobyqa”) in R (R Core Team, 2016). Language was not entered into the model because the L2 response times formed the tail of the distribution. Including the L2 response times meant that a linear model could not be fit and so these were removed. Visual inspection of the response time latencies using quantile-quantile and density plots revealed outliers; reaction times longer than 8000 milliseconds were excluded from further analysis, leaving 967 observations. As random effects, I had intercepts for participants and items; by-subject slope adjustments for the effect of condition did not significantly improve the model. As fixed effects, condition and level of education were entered into the model; their interaction was not significant and was therefore omitted. Estimates, errors, and t-values/z-values for the relevant variables are presented in Table 4, below.

Table 4. Estimates, errors, t-values/z-values for variables. *T-values larger than absolute 1.96 indicate significance.

	Estimate	Std. Error	t value
(Intercept)	8.03687	0.05288	151.97*
Condition ORC	0.15820	0.03529	4.48*
Condition SRC	0.02707	0.03454	0.78
Educationlow	0.27362	0.06895	3.97*

With condition entered into the model as a fixed effect the analysis revealed that only the Object Relative Clause condition is a significant predictor of RTs for the native speakers. That is, the results support the descriptive statistics showing that all participants are slower with Object Relative Clauses than with Active or Subject Relative Clauses. Level of education reveals that in addition to all participants having longer RTs for Object Relative Clauses, the low academic participants are significantly slower.

6. Discussion

The main purpose of the present study was to specifically test two predictions; one derived from usage-based models, the other from the Shallow Structure Hypothesis. Usage-based accounts predict that there should be a processing advantage for Actives and predicate Subject Relative Clause sentences over predicate Object Relative Clause sentences for all participants since, on this account, repeated experience with particular constructions leads to greater entrenchment, which in turn results in faster and more

accurate processing. Usage-based accounts also predict that this processing advantage should be more pronounced in low academic attainment participants since these participants will have had relatively less direct experience of predicate Object Relative Clause constructions. That is, the processing/interpretation of predicate Object Relative Clauses should exhibit regularity x frequency x experience effects. By extending the notion of experience to include type as well as amount of linguistic experience, I further predicted that some non-native high academic attainment participants would outperform native low academic attainment participants, when interpreting predicate Object Relative Clause sentences. By contrast, the Shallow Structure Hypothesis predicts that all native speakers should outperform non-native speakers, certainly on the Subject Relative Clause and Object Relative Clause conditions since these involve complex grammar.

The results reported here support the idea that speakers make use of frequency and experience and that speakers' processing of non-canonical constructions displays regularity x frequency x experience effects. As we have seen, all groups responded faster and more accurately to Active and predicate Subject Relative Clause constructions than to predicate Object Relative Clause constructions. The findings also show that high academic attainment participants, regardless of language background, interpret predicate Object Relative Clause constructions more reliably than low academic attainment native speakers. Furthermore, high academic attainment native speakers also process predicated Object Relative Clause constructions faster than low academic attainment native speakers.

The results suggest that differences between groups lie in the degree of entrenchment of these representations, which in turn is a function of the amount of experience with the predicate Object Relative Clause construction. Object Relative Clauses of this type are much more frequent in formal written texts than in naturalistic speech and since more educated participants tend to read more, their predicate Object Relative Clause constructions are more entrenched, and hence accessed faster and more reliably under test conditions resulting in faster and more accurate performance. The results also suggest that degree of entrenchment is a function of type of linguistic experience. The high academic attainment non-native participants benefit from having their attention explicitly drawn to form-meaning pairings. Although the high academic attainment non-native participants are slower as a group on all the sentence types than the native speakers, this is attributable to other factors. For example, it is well established that orthography can affect L2 processing (see e.g., Frenck-Mestre & Pynte 1997).

The findings are consistent with the idea that frequency and experience are key factors in processing and acquisition and continue into adulthood (MacDonald, et al. 1994; MacDonald & Seidenberg, 2006; Trueswell & Tanenhaus, 1994, MacDonald & Christiansen 2002, Street & Dąbrowska 2014). The findings also replicate earlier research. The overall performance on predicate Object Relative Clauses in the low academic attainment group is similar to that observed in studies which have tested low academic attainment participants processing of implausible and reversible passive constructions (e.g., Dąbrowska & Street 2006, Street & Dąbrowska 2010). The authors of those studies explained the performance of the low academic attainment participants in

terms of entrenchment, arguing that the less educated participants had a less well-entrenched representation of these constructions. Entrenchment, however, is a matter of degree, and thus, performance on relatively infrequent structures (e.g., predicate Object Relative Clauses, passives) varies considerably, particularly in the low academic attainment group.

By contrast the results of the present study raise issues for the Shallow Structure Hypothesis since it posits that non-native speakers are restricted to shallow processing and as such predicts that native speakers will outperform non-native speakers on tasks tapping knowledge of complex grammatical structures such as relative clauses¹. Nevertheless, that is not to say that the central claim of the Shallow Structure Hypothesis regarding second language learners' processing is not correct per se: it is most likely the case that non-native speakers rely more on other 'non syntactic' cues (e.g., context, pragmatic cues, world knowledge) when processing complex grammatical structures than native speakers. However, this is when they are compared to highly educated, highly literate native speakers who are skilled readers. When they are compared to native speakers who have low academic attainment, who do not read or who have low-reading span, a different picture emerges. There are some native speakers who rely on non-syntactic cues when processing decontextualized sentences containing relatively infrequent non-canonical constructions for which they have relatively little direct experience. That is, for some areas of grammar some native speakers are also restricted (in Shallow Structure Hypothesis terms) to shallow processing.

When non-native speakers are compared to these native speakers, the sharp distinction between native and non-native speakers when interpreting complex grammatical constructions is less clear, suggesting that native speaker status is not the only factor in sentence processing and that differences between native and non-native language processing is not qualitative. In fact, there is evidence of considerable overlap of processing performance between native and non-native speakers on online tasks processing less complex non-canonical constructions (see, e.g., Dąbrowska, Street & Farmer, submitted). The results of the present study suggest large education-related differences in the ability to correctly interpret predicate Object Relative Clause sentences, with the highly educated participants interpreting sentences correctly more consistently than the lower educated participants, and more individual variation in the less-educated group. It is, however, possible to argue that these results are a consequence of other non-linguistic factors.

6.1 Working memory / performance factors

It is possible to argue that the results of the present study are a consequence of linguistically irrelevant performance factors such as willingness to cooperate with the experimenter, lack of experience with formal testing or ability to perform the experimental task. However, as argued elsewhere (e.g., Dąbrowska & Street 2006, Street & Dąbrowska 2010), these explanations are unsatisfactory. It is also possible to explain

¹ Although Clahsen and Felser (2006) concede that some non-native speakers may be able to process complex grammar like native speakers

poor performance on Object Relative Clauses by appealing to limitations in processing capacity. Object Relative Clauses are well known to be difficult to process. Their non-canonical word order and complex syntax (e.g., embedding) is thought to place heavier demands on the processing system. Furthermore, there is evidence of a relationship between ability to interpret complex syntactic constructions and Working Memory capacity to the extent that some researchers (e.g., Just & Carpenter 1992, Waters & Caplan 1996) have suggested that individuals with low Working Memory capacity may have difficulty processing more complex structures such as Object Relative Clauses.

However, findings from studies indicating that comprehension training improves performance (e.g., Chipere 2001, Wells et al. 2009) make the Working Memory explanation problematic. For example, Wells et al. exposed undergraduate students to 160 sentences containing Subject Relative Clauses and Object Relative Clauses in two training sessions. A post-test administered four days after the second training session revealed that reading times at the main verbs for Object Relative Clauses decreased as a result of training, while there was no analogous effect in the control group who had been exposed to different types of sentences. This is consistent with the hypothesis that individual differences in the ability to learn from experience by way of statistical learning contribute to variations in language performance (see, e.g., Misyak & Christiansen 2012, Kidd & Arciuli 2016) as well as the idea that the individual differences in the processing of Object Relative Clauses observed in earlier studies are attributable to differences in the amount and type of experience with this construction.

6.2 Quantitative & Qualitative differences in linguistic experience

Differences in amount and type of linguistic experience may also explain the observed relationship between educational attainment and grammatical knowledge. In addition to more direct experience with non-canonical constructions, more educated speakers are likely to have more experience with language in general; they are likely to have more exposure to written language and consequently are more likely to be skilled readers. It is, therefore, possible that exposure to print, particularly more formal 'academic' texts, may play a key role in some individuals being better language learners overall. This is consistent with some of the findings from first language reading research which indicates that in general print uses more unusual words and more complex grammatical structures than speech (Sparks 2012). There is also empirical evidence which shows that print exposure accounts for a significant proportion of unique variance in vocabulary and overall language skill (Cunningham & Stanovich 1998, Stanovich 2000, see Dąbrowska 2012). Furthermore, there is evidence that high academic attainment adults have broader vocabularies than low academic attainment adults and that vocabulary size is a key predictor of performance on tasks tapping underlying syntactic representations (e.g., Dąbrowska, Street & Farmer, submitted).

Nevertheless, given the non-native speaker participants' performance, the overall number of predicate Object Relative Clauses in a speaker's linguistic experience cannot be the only relevant factor. Type of linguistic experience also matters. One possible reason for this is that experience with decontextualised language helps to increase learners'

metalinguistic awareness, which in turn leads language users to pay more attention to formal cues. Second language learners, in particular, are more likely to have their attention explicitly drawn to form-meaning pairings. As a consequence of explicit instruction metalinguistic skills may be more developed in the non-native group than the low academic attainment native speaker group. It is widely acknowledged that explicit learning plays a significant role in L2 learning (e.g., Schmidt 1990) and work on second language acquisition indicates that explicit instruction can ‘jump start’ implicit learning (see Ellis, 2005). However, it may be the case that similar processes (i.e., explicit knowledge and noticing) play an important role in L1 acquisition. There is evidence that children (both first language and second language learners) do make use of metalinguistic information in learning grammar (e.g., Smoczynska, 1985, Ammar et al. 2010). It is also possible that the more educated native speaker participants may have been exposed to more explicit (though more subtle) ‘explanations’ of various linguistic phenomena earlier in childhood. Furthermore, there is the possibility that the observed results are attributable to characteristics of the learner rather than the external environment (see Dąbrowska 2012 for further discussion).

7. Conclusion

The results discussed in this paper have several theoretical and methodological implications for the language sciences. That some native speaker adults perform at chance on a task tapping comprehension of predicate Object Relative Clause sentences is problematic for theories which claim first language convergence and that all first language learners master the constructions of their language at a young age. By contrast the results support usage-based theories which consider systematic differences in comprehension accuracy and processing speed as a reflection of differences in entrenchment, and hence facts about speakers’ linguistic representations, not just their use of these representations in processing.

In second language acquisition research many studies comparing first and second language learners’ performance on task tapping morpho-syntactic knowledge make claim to the construct of a native speaker ‘norm’ against which the performance of second language learners is measured/compared. However, in the vast majority of these studies the native speaker control group are typically university students who invariably show the highest levels of educational attainment and greatest amount of convergence. The results here show considerable divergence in performance within the low academic attainment group. This not only raises issues for the construct of a native speaker norm, it also raises the possibility that the observed divergence in performance of second language learners may be related to levels of educational attainment (schooling) rather than age of acquisition effects per se. There is evidence that this may well be the case (e.g., Frege et al. 1999).

Furthermore, some researchers regard second language processing as being qualitatively different from first language processing with non-native speakers relying more on probabilistic cues than native speakers. The results of present study (see also Dąbrowska, Street & Farmer) suggest that processing differences between first and second language

speakers may be overstated and that differences between first- and second-language grammars may be more quantitative than qualitative. Clearly there is need for further research. However, the results of this study lend support to previous research suggesting that we may need to revise our views on the role of explicit learning and teaching in first language development; some first language learners need more linguistic experience, and/or a different type of linguistic experience, than many theorists in the language sciences usually assume is necessary. The results also suggest that first and second language processing and attainment may not be as different as is often assumed.

Appendix I

List of sentences used in one version of the test

This is the man that photographed the woman.

This is the girl that carried the boy.

The man chased the woman to the park

This is the man that the woman fed.

This is the boy that hit the girl.

The girl photographed the boy in the park

This is the girl that the boy pushed.

This is the woman that hugged the man.

The sailor pushed the soldier in the street

This is the boy that the girl chased.

This is the boy that the man frightened.

The woman kissed the man on the cheek

This is the boy that pulled the girl.

This is the girl that kissed the boy.

The soldier hit the sailor in the chest

This is the boy that the girl kicked.

This is the girl that the boy grabbed.

The sailor kicked the soldier on the knee

Appendix II

Written instructions

You will see a sentence on the screen. Above the sentences will be two pictures; one on the left, one on the right.

Your task is to read each sentence and decide whether it matches the picture on the left OR the picture on the right. If you think the sentence matches the picture on the left, press “Left” on the keypad. If you think the sentence matches the picture on the right, press “Right” on the keypad.

The sentence will remain on screen until you select either “Left” or “Right”. But try to answer as quickly as possible

After your selection, you will see this sign +++ for 2 seconds. Then the next sentence will appear.

The first 4 sentences are to practice.

Press SPACEBAR to begin Practice Session.

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