Toward a prenominal syntax? A brief look at statistical alternations*

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This pilot study aims to show that people indeed use subconscious statistical processing to aid in the acquisition of constructions, and frequent form-function mappings emerge as structures that work well together. The current study is a modified replication of Wells et.al. (2009), in which frequency distributions of NL-English speakers' relative clauses were manipulated, causing them to more quickly process a less frequent, irregular form.
The construction under consideration here is the prenominal clause, rare in English, but attested in many primary languages. The hypothesis was that, given minimal exposure to this construction, subjects would statistically re-categorize their linguistic systems.
The infrequent/irregular prenominal phrase was compared with the frequent/regular postnominal RC. Pre- and Post-Tests recorded participants' self-paced reading times. During two brief Experience Blocks, spaced two days apart, subjects received limited exposure to both target structures. Reading times in the prenominal structure decreased *more* than that of the RC, for *each* subject, indicating faster processing. A preliminary analysis of results shows that all subjects reanalyzed the statistical distributions of the prenominal clause.

1. Introduction and Background

Statistical learning in both first- and second-language learners is said to aid in the acquisition of constructions, as frequent form-function mappings emerge as structure types that often work well together. Researchers in psycholinguistics and cognitive linguistics have long shown that input can statistically alter a speaker's language system (e.g., N. Ellis, Kidd, Wells). N. Ellis and Larsen-Freeman have independently and jointly argued that *every* encounter with language input slightly changes the system.

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The way that people learn languages is fascinating. Most of that learning is implicit, with learners abstracting frequencies and regularities from their input, in order to make predictions about the language. As they do this, the representations in their linguistic systems change. Ellis classifies all of usage-based linguistics as research into "likelihoods of occurrence of constructions and the relative probabilities of their mappings" (2005:306). According to both Ellis (2005, in press) and Hamrick (2014), evidence for learning through statistical distributions has been shown in infants and adults, at all levels of language, including speech segmentation, word learning, and syntax. Furthermore, the extraction of distributional regularities extends well beyond the domain of language, to visual and auditory pattern learning, for example.

The body of research looking into distributional cues from input was kick started by Saffran, Newport, & Aslin in the 1990s, when they discovered that people are sensitive to and can compute transitional properties between sounds. In 1996, they published a seminal paper on distributional cues and infants' ability to segment words. Although spoken words rarely have physical, spaced boundaries, infants still manage to discover word boundaries. That same year, the cohort published another paper extending their findings to adults, using an artificial language. In both cases, prosodic cues were removed from the voice stream, so that the only cues participants had were the phonological combinations themselves, providing evidence that regularities were extracted over and learned.

While the Saffran, et. al. studies were on word segmentation – not syntax or sentence structure – this spawned an entire sub-field of work in psycholinguistics that dealt with extractions of regularities from natural language input. Up to this point, distributional cues had been "considered too complex for human learners" (1996:618). More generally, this research gave insight into how infants and children begin to learn language, and also sheds light on how adults can learn a second or foreign language. Moreover, their findings are further generalizable; they claimed in 1996 that it could extend beyond word segmentation, and in the years since, research has been conducted using distributional information in various aspects of first- and second-language acquisition, including sentence processing.

Wells, et. al., (2009) were able to manipulate their subjects' linguistic systems at the sentence level, using relative clauses to show processing and frequency effects. Their study is described further in the next section.

2. Statistical Distributions

As defined by Kidd (2012), implicit statistical learning is the "unconscious process of inducing structure from input following exposure to repeated exemplars" (172). He showed that individuals who were more susceptible to syntactic priming were also better at implicit learning, providing evidence of memory capacity.

Wells, et.al, (2009) point out a previously established statistical pattern in the English lexical system, put forth by Seidenberg (1985). That is that while words that are both frequent and regular are easiest to process, infrequent words that follow the same phonological paradigm are easier to process than frequent words that take an irregular sound structure. For example, frequent and regular words such as *hint* and *mint* are close phonological "neighbors" to irregular *dint*, and the sound pattern aids in processing. *Pint*, on the other hand, while frequent, has very few close neighbors to assist in processing.

	regular	**irregular**
frequent	hint mint	pint
infrequent	dint	

Table 1. Lexical distributions.

Wells, et.al, (2009) take this knowledge of lexical distributions as the basis for support of a study they conducted on the syntactic redistribution of relative clauses. According to these researchers, subject RCs are frequent, and also regular, as they have many structural SVO neighbors. Object RCs, on the other hand, are both infrequent and irregular, as their OVS neighbors are few, as laid out in Table 3.

	regular	**irregular**
frequent	Subject RCs *neighbors:* -SVO - Agent–V–Patient	
infrequent		Object RCs *neighbors:* -OSV - Patient–V–Agent

Table 2. Syntactic distributions of relative clauses.

The researchers of this study predicted that manipulation of relative clause experience would result in a greater decrease in reading times for object relative clauses over subject relative clauses. Indeed, both structures improved from Pre- to Post-Test; but, as predicted, the infrequent object RCs improved *more*. The irregular object RCs don't have any frequent neighbors to aid in processing, but through manipulated input, the participants were able to process them as though they were frequent.

The goal of the current study was to determine whether a similar alteration could be made on native English speakers for short prenominal noun phrases (prenominal relative clauses). Since it is an attested structure in several primary languages, but hardly exists in English, I wondered whether I could alter the response times to the prenominal structure in native English speakers. First I will provide a brief overview of the simple and extended participle, then I'll move into the methodologies employed in the current study, and finally I will discuss implications of the findings, as well as limitations and a need for further research. It's important to note that the current study was conducted as a pilot study; methodologies used were simplistic, and plans for a more elaborate, larger-scale study are discussed later.

The prenominal phrase is a well attested structure in primary languages of the world. It has been extensively discussed in East-Asian languages, namely Korean, Japanese, and Cantonese (though the Cantonese example is more controversial), and I'm told it also exists in Finnish (by a native speaker) and possibly Urhobo (by Edward Keenan, personal communication, July 2013)[1].

Furthermore, prenominalization is an optional relativization strategy in German, though as far as I can tell, not in any of German's close relatives. I use German here, since it is a language I am familiar with, to demonstrate what the prenominal phrase looks like. German and English share the capacity for simple participles. You can have, for example, *die kochende Frau* / *the cooking woman*, or *die gekochte Frau* / *the cooked woman*. In German, the modifier can be extended, as in (1) and (2) below.

(1) die [mit dem Jungen kochende] Frau
the [with the boy cooking] woman

(2) die [von den Kindern gekochte] Frau
the [by the children cooked] woman

[1] For a detailed study of the prenominal structure in East Asian languages, see the 2007 special issue of *Studies in Second Language Acquisition*, Volume 29.

In English, we would be required to use a formal postnominal relative clause to express *the woman [who is cooking with the boy]*. This is also German's preferred form for casual speech. But in technical and literary work, it optionally functions more like Japanese and Korean, prenominalizing the RC. There is evidence that the form is becoming increasingly more common, even in spoken language, in newscasts as well as impromptu speech (Wipf 2004). According to Crean (1969), the construction had been used "for decades" (some 45 years ago) in German and is "working its way into" English (272). This tells us that the form was somehow introduced into or developed from within the German language, independently of other West-Germanic languages. Extended modifiers in German and in English are not reserved to participles, and some examples in English include *early evening thundershowers*, *longer-than-one-page letter*, *cradle-to-early-grave phenomenon*, and of course the participle form: *five-times-married actress Gloria Swanson* (Crean 1969).

For simplicity's sake, I limited the focus of this study to simple participles. Furthermore, I do not take any intransitive (unaccusative or unergative) verbs into account, and I focus solely on present participles. The bolded clause in Figure 1, and given in (3), is the type of clause I look at in this study.

(3) the [soup cooking] woman
die [Suppe kochende] Frau

		Participle	RC
unaccusative	Pres	the falling building	the building that is falling
	Past	the fallen building	the building that was falling
unergative	Pres	the screaming victim	the victim who / that is screaming
	Past	*the screamed victim	the victim who / that was screaming
accusative	Pres	**the soup cooking woman**	the woman who / that is cooking soup
	Past	≠ the cooked woman	the woman who / that was cooked

Figure 1. Types of verbs and their participles.

> **Hypothesis:** NL-English speakers will improve reading times on prenominal noun phrases (prenominal RCs) after just two exposure sessions.

That is, the subjects will statistically re-categorize their linguistic systems when exposed to these types of clauses. It is *not* short-term priming I am looking at, but rather true statistical restructuring. Priming effects last only seconds, while the post test in this study did not occur until two days after the second exposure session.

As Wells, et.al, were able to use input to manipulate their subjects' language systems, so I wanted to try the same with a different syntactic structure. Like in the tables above, Table 4 also shows subject relative clauses in the regular/frequent box. Important to my study are both features in the irregular column. The frequent variable is the simple participle, such as *the cooking woman*. I currently have no data to show actual frequency distributions, but this seems to be a quite common construction type in English. If we consider the participle a verb (and I believe it shares its underlying syntactic features with verbs), then its neighbors are the VS word order, such that English has in questions and commands. Again lacking empirical data, it is easy to say that the prenominal phrase, such as the *soup cooking woman*, is much less frequent than the simple participle. These share the same irregular OVS-order neighbors as the object relative clauses discussed above. These features are displayed in Table 3.

	regular	**irregular**
frequent	Subject RC *neighbors:* -SVO -Agent–V–Patient	simple participle *neighbors:* -VS -V–Agent
infrequent		prenominal NP *neighbors:* -OVS -Patient–V–Agent

Table 3. Syntactic distributions of noun phrases.

Through manipulated input in the two Experience Blocks, I aimed to change my subjects' linguistic distributions, such that the prenominal phrases were processed more quickly.

3. Methodologies

Target items were full sentences that contained either a formal, postnominal relative clause, or the prenominal phrase construction under investigation here. All of my target transitive verbs came from an online database (Linguasorb) of the 100 most frequent verbs in American English. The verbs were chosen for transitivity and ability to take modified objects. Objects were chosen by frequency from an online database (Just the Word) that matches strings of words. For example, the transitive verb *find* is one of the 100 most frequent verbs, and the most frequent object to follow it is *body*. (Apparently, what most people *find*, is *bodies*.) I rearranged the order such that the object became part of the prenominal modifier, and chose a subject I thought would fit, and came up with the phrase in (4), from which I designed the target sentences given in (5) and (6). Frequent collocations such as "award winning" and "cost cutting" were avoided.

(4) *the body finding investigator*
(5) *The investigator who finds bodies hates his job.*
(6) *The body finding investigator hates his job.*

3.1. Subjects

The study involved five university-educated subjects, three males and two females, all students or alums of the University of Wisconsin-Milwaukee. All subjects were in their 20s. Two subjects were uncompensated volunteers, and three were students in low-level German classes, receiving extra credit for their participation. None of the subjects was familiar with the prenominal structure in German or in any other language. The German students were a matter of convenience, and university students with no foreign language exposure are rare. But in future studies, an effort should be made to use subjects who are as near to monolingual as possible, and not enrolled in any foreign language class.

3.2. Sessions

I met with each of the subjects three times, with at least a full day between each session. The first session involved both a Pre-Test and the first Experience Block. In the second session, subjects were exposed to the second Experience Block, and in the third session they performed a Post-Test. Figure 2 illustrates the tasks elicited during each session.

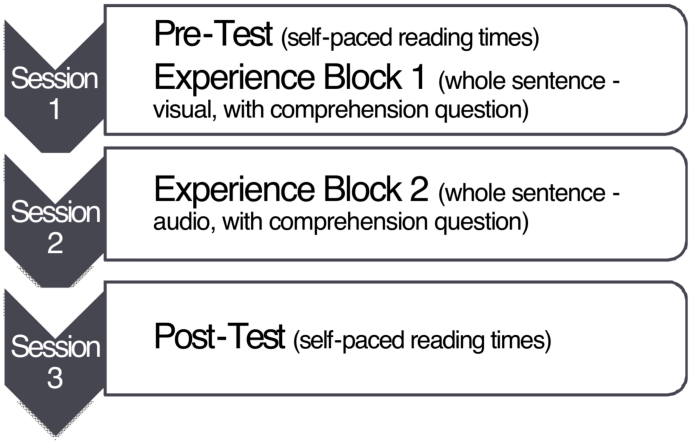

Figure 2. Sessions.

Each set of sentences – both pre- and post-tests, and both experience blocks – contained an equal number of target prenominals and relative clauses, matched across lists. My sample size wasn't large enough to justify exposing them to different lists, so they each saw the matched prenominal/RC pairs in different sessions, *e.g.*, *The research that is meeting requirements will get the funding* is the prenominal sentence that matched to the postnominal *The requirement meeting research will get the funding*. Also equally matched among the targets were subject and object sentences. For example, *The requirement meeting research will get the funding* contains a subject NP, while *The doctor is afraid of the hearing voices patient* contains an object NP. Finally, all target sentences were thirteen syllables in length.

In all four sessions, written and spoken instructions were provided, and subjects were asked if they had any questions. The Pre-Test was a self-paced reading task. Sentences consisted of four prenominal phrases and four relative clauses, for a total of eight target sentences. There were also 16 filler sentences. The first two and last two sentences were fillers, and target sentences never appeared one after the other.

Subjects saw sentences, arranged one word at a time, presented in Power Point. They clicked through each word at their own pace. At the end of each sentence was a plain black screen, after which was a white screen with the word "ready," to prepare them for the next sentence. Subjects were instructed to read at their normal pace, and that it was not a race.

The reading task was recorded using Jing, a free screencapture software that includes times to the whole second. After subjects had completed the Pre-Test, I went back and calculated how long it had taken each subject to get from the first word of each sentence to the blank screen. The whole-

second recording time is far from ideal, but the pilot was restricted by the time and resources available. In the future, I will use a more precise system, and one that involves eye tracking.

The Experience Blocks contained six, rather than four, prenominal phrases, and six, rather than four, matching RCs, for a total of twelve target sentences. There were also 20 fillers in each. The first Experience Block took place immediately after the Pre-Test (with the option of a break in between). In Experience Block 1, subjects were again exposed to a similar set of sentences in a Power Point slideshow, but this time they saw a full sentence on the slide. After each sentence, they saw a question asking about the sentence, to which they orally responded; their answers were recorded manually. The purpose of the question was simply to keep them on task and attentive to the situation. Experience Block 2, which took place two days later, similarly contained the same types of sentences and comprehension questions, but the exposure was auditory, and the questions were answered in writing.

Finally, the Post-Test, two days after Experience Block 2, was set up identically to the Pre-Test, with the only exception that they again saw different sentences.

4. Results & Discussion

Each subject read at his and her own pace, and some were clearly faster readers than others. I am not interested in between-subject data, but rather in changes in within-subject scores. Table 5 reports individual Pre- and Post-Test reading times.

	Subjects				
Pre-Test Target Sentences	**CP**	**KJ**	**KP**	**KR**	**JH**
The body finding investigator hates his job.	3s	7s	4s	6s	5s
The question asking students learned the material.	2s	6s	4s	6s	4s
He despises the noise making trucks outside his house.	4s	7s	4s	7s	4s
All the young schoolboys admire the message sending girls.	3s	7s	5s	6s	4s
	Subjects				
Post-Test Target Sentences	**CP**	**KJ**	**KP**	**KR**	**JH**
The letter writing citizens worry about this.	2s	5s	5s	4s	4s
The pain feeling athlete tore his ACL muscle.	2s	4s	4s	3s	3s
The nanny ignored the television watching kids.	2s	5s	4s	3s	4s
Tenagers appreciate their car buying parents.	2s	4s	3s	4s	3s

Table 5. Self-paced reading times for Pre- and Post-Tests on Prenominal Phrases.

Since the sentences in each trial are different, I did not look at scores from individual sentences. Rather, I compared average Pre-Test reading times to average Post-Test reading times, for each individual. Table 6 shows these averages.

	Subjects				
Pretest	CP	KJ	KP	KR	JH
	3	7	4	6	5
	2	6	4	6	4
	4	7	4	7	4
	3	7	5	6	4
Avg.	**3**	**6.75**	**4.25**	**6.25**	**4.25**
	Subjects				
Posttest	CP	KJ	KP	KR	JH
	2	5	5	4	4
	2	4	4	3	3
	2	5	4	3	4
	2	4	3	4.5	3
Avg.	**2**	**4.25**	**4**	**3.33**	**3.5**

Table 6. Individual averages of prenominal clauses for Pre- and Post-Tests.

Each of the five subjects improved their scores from the Pre- to the Post-Test reading tasks. Some did so more dramatically than others, but the fact that across all five subjects, not one remained the same or declined, the findings look initially greater than chance. While my sample size was too small to test for statistical significance, the results appear robust.

The decrease in both structures may indicate training of task effects. However, there was also an interaction between the two structure types: Reading times in the uncommon structure decreased *more than* that of the common structure, for each subject, indicating faster processing, which can be explained by an acquired ease of processing for the target structure. Even without a control group, the fact that each subject improved more on one structure type than the other is sufficient to show this interaction.

The numbers of target sentences are too small to make strong claims; but on the other hand, a trend with the limited number targets shows that even a very small amount of implicit learning had an effect on their sensitivities to frequencies and probabilities.

5. Conclusions

A small sample of subjects reanalyzed the distributions of a structure to which they had had no prior experience. With very limited exposure during two brief Experience Blocks, each subject's self-paced reading times improved from the Pre- to the Post-Test on prenominal noun phrases (prenominal relative clauses).

The *regularity* x *frequency* x *experience* effects showed an important interaction: Both the regular/frequent control structure, as well as the irregular/infrequent test structure improved with experience. This was an expected task-effect. However, it was the processing of the prenominal structure that improved *more than* the control, indicating statistical restructuring of the linguistic system. Subjects changed their distributional patterns (what they know implicitly) and applied the updated probabilistic constraints.

Today it is largely agreed upon that statistical learning takes place, and that it is fundamentally tied to implicit learning (Kidd, N. C. Ellis, Rebuschat & Williams, etc).

> "[I]t is widely accepted that the process of statistical learning can occur incidentally, i.e. subjects can acquire the statistical structure of language without the conscious intention to learn, making the process of statistical learning analogous to that of implicit learning" (Rebuschat & Williams 2012:3).

6. Further study: Beyond the Pilot

Taking this small study as a pilot, there are some fairly easy things that would need to be adjusted in the next set of experiments. First, I would recruit more subjects, including a control group. Second, it would be important to seek out English-speaking participants who are as near monolingual as possible. Third, I would need more than eight target sentences in the Pre- and Post-Tests (and implicationally, more than four prenominal phrases). Fourth, while all target sentences, in both Tests and in Experience Blocks, contained thirteen syllables, it may be important to balance their visual length, as well. It may also be unnecessary or even somewhat detrimental to use the thirteen-syllable balance in the Experience Blocks. It was suggested to me to include hyphens in the prenominal phrases. *Soup cooking* should instead be *soup-cooking*.

Another important change would be to use a program to accurately record a precise time on the self-paced reading times. Times need to be tracked to the millisecond. And whereas this pilot accounted only for whole-sentence reading times, a crucial piece of evidence would come from looking at the times within sentence regions; presumably it is at the participle itself where the processing time becomes extended. Furthermore, Witzel, Witzel, & Nicol (2011) have shown that eye-tracking studies yield more accurate reaction time results than more basic self-paced methodologies.

Something to try developing further would be a method to accurately report the frequencies of the prenominal structures used. It is less the regular-irregular variable at play, and more the contrast in frequency that plays into the research question at hand. It would be important to establish not only the frequencies in English of the OVS / direct object – transitive verb – subject prenominal noun phrase, but also that of matching simple participles. How frequent is *the cooking woman*, and how frequent is *the soup cooking woman*? Clearly the first is much more frequent than the second, but what about *award winning actors*, or *cost cutting methods*? How is it that such forms have become normalized in English, while most are still extremely odd? Then again, the how and why is another question altogether.

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