THE ROLES OF METALINGUISTIC AWARENESS AND SEMANTIC INTERPRETABILITY IN THE PROCESSING OF NOVEL PSEUDOWORDS IN ENGLISH[*]

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1. Introduction

While many words can enter a language as borrowings, novel words can also be created language internally through the use of derivational morphology. Upon encountering such words, speakers are able to interpret their meaning even when they have no previous experience decoding them. But how is this accomplished, and what factors influence the ease with which novel words are understood? Semantic interpretability, the degree to which a novel word 'makes sense,' is of great importance (e.g., Burani, Dovetto, Spuntarelli, & Thornton, 1999), as might be expected. However, there are also structural constraints on word formation (e.g., Plag, 2003), which might in turn affect the processing of novel words as they are experienced. For example, *magnetize* is an existing word in English that is composed of the noun *magnet* and the suffix *-ize*, with *-ize* combining with nouns to form verbs. Another suffix, *-ify*, can also combine with nouns to form verbs, so that an item such as *magnet+ify*, which does not exist in English, is still interpretable. However, one would not expect the suffix *–ness*, which typically does not combine with nouns, to be used to create the novel item **magnet+ness*, because the word *magnet* is a noun. Structurally, we can say that there is a difference between the pseudowords *magnet+ify* and **magnet+ness* that is based on the lexical category of the root and the attachment preferences of the affix. This structurally defined pattern is a *selectional restriction* that governs morpheme combinations within English. Presented here is an investigation of the role of selectional restrictions in the processing of novel words.

There is evidence to suggest that speakers are sensitive to selectional restrictions during online processing. Libben (1993) created a set of morphologically complex nonwords by combining nonword roots (e.g., *talf*) with existing English prefixes and suffixes. Each nonword root was four letters in length and conformed to phonotactic constraints in English. The critical stimuli in this experiment were structurally trimorphemic nonwords, constructed using one of each of the aforementioned components (nonsense root, prefix,

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suffix). Half of the target items had morphologically legal structures (Fig. 1b), corresponding to selectional restrictions governing word formation in English. In these items, the lexical category of the nonword root, as determined by the affixes, was unambiguous. For example, in Figure 1b, the nonword *talf* is used as a noun, as can be determined based on the morphological structure of the nonword. To derive the item, *re+talf+ify*, the suffix *-ify* is first combined with a nominal root to create a verb, *talf+ify*. This verb can then be combined with the prefix *re-*, a prefix which combines primarily with verbs to indicate repetition of an action. The alternative structure, where the verb *talf* is prefixed with *re-* to form *re+talf*, and is then combined with *–ify* is not preferred, because *–ify* does not typically combine with verbs.

The remaining critical items had morphologically illegal structures, where the lexical category of the root was not interpretable (Fig. 1a). For example, in the first possible structure in Figure 1a, the adjective *talf* is combined with *-ity* to form a noun, which creates a problem when the prefix *re-* is applied, as it should only combine with verbs. In the second possible structure, the prefix *re-* combines with the verb *talf* to form *re+talf*, which then must combine with *–ity*, to form *re+talf+ity*. Since *–ity* attaches to adjectives, and not verbs, while *re-* attaches to verbs, but not nouns, both structures in Figure 1a are examples of morphologically illegal structures in English.

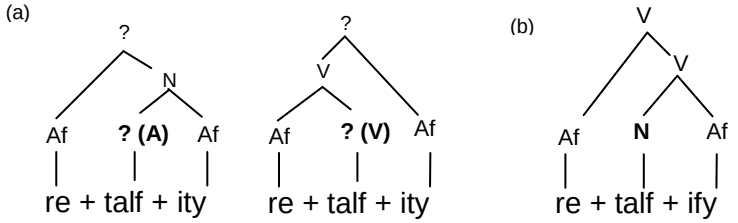

Figure 1: Morphological structure of critical nonword stimuli used in Libben (1993)

During a naming task, participants were significantly slower in the production of items that contained uninterpretable morphological structures (e.g., Fig. 1a) than items with an interpretable morphological structure (e.g., Fig. 1b). Selectional restrictions were found to influence reaction times, suggesting that native speakers of English are sensitive to morphological structure. One of the major strength of this study was its use of nonsense roots. The morphological structure was emphasized and potential interference from semantic interpretability was avoided. Indeed, in studies that make use of existing words, semantic interpretability is revealed to strongly influence processing. Burani et al. (1999) found that native Italian speakers were sensitive to semantic interpretability when novel words were created by combining roots

and suffixes, but that the legality of the morphological structure did not influence their behavioural responses.

2. The Present Study

The goal of the present study was to investigate the processing of novel words in English that were composed of real roots and suffixes combined to form morphologically legal and illegal pseudowords. Libben (1993) showed that native English speakers can be shown to be sensitive to selection restrictions under certain conditions. If speakers are sensitive to selectional restrictions when presented with items composed of real morphemes, then this sensitivity could be reflected in decision latencies or error rates. If they are insensitive to selectional restrictions, or if they are more sensitive to other factors such as semantic interpretability (e.g., Burani, 1999), then no differences should be expected to be observed.

2.1 Lexical Decision

The first experiment was a simple lexical decision task, in which participants were asked to decide whether or not an item they viewed on a screen was a real word in English. Reaction times and error rates were recorded.

Participants Thirty-two individuals participated in this experiment. Participants were drawn primarily from the University of Alberta undergraduate population. Two participants were removed because their overall reaction times were significantly longer than the average (over 2 standard deviations from the mean RT).

Apparatus Experiments were presented on an Apple Macintosh computer and were scripted in PsyScope 1.2.5.

Materials Critical stimuli were created by combining real roots and suffixes to form novel combinations. All lexical roots had a CVCC structure in written Canadian English and could occur as free-standing morphemes either as verbs or nouns. Roots were assessed using the CELEX lexical database (Baayen, Piepenbrock & Gulikers, 1995) for their ability to undergo conversion (noun to verb or verb to noun). While every attempt was made to use roots that were unambiguously nouns or verbs, this was not possible in all cases. Roots with both verbal and nominal readings were only used when one of the two readings occurred significantly more frequently than the other. Some combinations of root and affix were morphological legal, in that they followed structurally defined selectional restrictions and some were illegal, in that they did not follow expected selectional restrictions. For example, one of the nominal roots was *bird*. *Bird* was combined with the suffixes *–ify* and *–ment* to form the target stimuli *bird+ify* and *bird+ment*, with the former being morphologically legal and the latter being morphologically illegal. Although not attested in English, the suffix *–ify*, which attaches to nouns, can combine with *bird* to form the verb *birdify*, which might be interpreted as "to make something bird-like/into a bird." Meanwhile, **birdment* should not be expected to occur and is considered

morphologically illegal because the suffix *–ment* does not typically combine with nouns, instead combining with verbs to form nouns. These structural selectional restrictions were very broad, at the level of lexical word class. A total of 37 suffixes were combined with 65 nouns and 37 verbs. Each stimulus list contained two instances of each suffix. One of these instances violated selectional restrictions and one did not. Fillers were composed of existing words in English and phonologically possible nonwords without an internal morphological structure.

Procedure Participants were seated at a computer and were given verbal and written instructions. Stimuli were presented, one at a time, in the centre of the computer screen. Participants were asked to decide whether the item shown on the screen was a real word in English, as quickly and accurately as possible. Choices were indicated by pressing a labeled red key ("z") for 'not a real word' or a green key ("/") for 'a real word.'

Results & Discussion Before the data were analyzed, items with reaction times exceeding 3000 milliseconds or falling under 350 milliseconds were removed. These items were considered to be procedural errors. Participants in this experiment did not appear to be sensitive to the morphological structure of the target pseudowords. There was no significant difference between accuracy rates for morphologically legal and illegal items. Likewise, there was no significant difference in reaction times based on whether items were morphologically legal or illegal. Participants rejected all target pseudowords without showing an observable preference for morphological legality in error rates or reaction times. These results are similar to those reported by Burani et al. (1999), which suggests that semantic factors may have influenced English speaking participants in the same way they influenced Italian speaking participants, while making use of a lexical decision task. It is also possible that the lexical decision task used was not sensitive enough to track responses to morphological structure when combined with semantic information.

2.2 Category Decision

The lexical decision experiment did not reveal any significant effects of selectional restrictions. However, Libben (1993) showed that native English speakers are sensitive to selectional restrictions under certain conditions. To test whether the lexical decision experiment was not sensitive enough to pick up on sensitivity to selectional restrictions, a change of tasks was in order. An online task that, like lexical decision, measures reaction time and accuracy is a category decision task. In a category decision task, the participant is asked to determine the lexical category of a given item. This type of task has been found to be sensitive to internal morphological structure (see Järvikivi & Niemi, 1999), so if there is an effect of selectional restrictions that is not observable in a lexical decision task, it might be revealed in a category decision task.

Participants Participants were drawn from the same pool as in Experiment 1. There were 38 participants in total, with one removed for

excessively long reaction times (more than 3 standard deviations from the mean).

Apparatus This experiment used the same equipment as Experiment 1.

Materials Materials were the same as used in Experiment 1.

Procedure As in Experiment 1, participants were seated comfortably at a computer and given instructions verbally and in writing and stimuli were presented one at a time in the middle of the computer screen. Participants were asked to decide on the lexical category of each item. There were three possible answers: noun, verb, and adjective, each associated with a different key on the keyboard ("z", "/", and "spacebar," respectively). Participants were told that some of the items might appear strange, but to try to place them in a category even if they were unfamiliar with them. They were asked to make their decisions as quickly as possible while minimizing errors.

Results & Discussion Reaction times in this experiment were longer than those typically observed in standard lexical decision experiments. As in the lexical decision experiment, there was no effect of selectional restrictions found in either the analysis of error rates or reaction times. The results reported thus far do not suggest a role for selectional restrictions in the processing of novel English words.

These results are surprising, given that Libben (1993, 1994) found an effect of selectional restrictions in English with native English speakers. The difference may be in the nature of the stimuli. Libben (1993, 1994) used real prefixes and suffixes, but did not use real English roots. Instead, phonotactically plausible nonsense roots were used. Nonsense roots do not carry any semantic information. For example, the item *re+talf+ify* holds no more meaning than *re+talf+ity*. Being devoid of meaning, such items do not allow for any semantic interpretation on the part of the speaker. The crucial difference between them is structural: the former is morphologically legal and the latter is morphologically illegal. This difference was reflected in naming latencies, which suggests that selectional restrictions *can* play a role in morphological processing. When semantic content is added, however, this role may be obscured or may be less important to speakers than the semantic interpretability of the novel items. Results from Burani et al. (1999) are compatible with this possibility.

The category decision task was more difficult than a standard lexical decision task, with its reliance metalinguistic knowledge that might not be accessible to all speakers. A follow-up offline test was conducted to directly assess participant knowledge of affixes and selectional restrictions.

2.3 Offline Knowledge Test & Semantic Ratings

Selectional restrictions tested here are structural. They depend on the lexical categories of their roots and on the combinatorial properties of specific affixes. For example, *-ness* is expected to combine with adjectives to form nouns, and is not generally expected to combine with other nouns. To determine whether participants were aware of these patterns, an offline test was administered following Experiment 2. Of interest was whether participants had knowledge of

affix patterns, or selectional restrictions, and if so, whether this knowledge influenced their behaviour in the online tasks.

Participants All participants from Experiment 2 took part in this offline task.

Apparatus This offline task was completed using a pencil and a copy of the test paper. No special equipment was required.

Materials Test items consisted of the 37 suffixes used in the creation of novel pseudowords in Experiments 1 and 2. Suffixes were given in alphabetical order.

Procedure Participants were given a list of suffixes, with each suffix followed by "noun," "verb," and "adjective". They were asked to indicate the part of speech (noun, verb, or adjective) with which they thought each suffix combined and were to do so by circling the appropriate lexical category. They were given the option of leaving questions blank if they were unsure of an answer, and were told to circle all answers that were applicable.

Results & Discussion Performance on this test varied widely, with accuracy ranging from 30 - 95%. Explicit knowledge of the broad selectional restrictions investigated in this study does not appear to be constant within an unimpaired population of English speakers. This variability might influence participant behaviour in online tasks, such as lexical decision. To determine whether a participant's overt knowledge of selectional restrictions and root – suffix pairings influenced online behaviour, accuracy on the offline test was compared to accuracy in the online experiments.

There was no correlation between online accuracy in the lexical decision task and offline accuracy on the knowledge test, r=.09, p=.63 (Fig. 2). This result should not be surprising, because the lexical decision task only asks participants to decide whether a given item is a word in English. All of the critical stimuli in this experiment were pseudowords, and while they were composed of existing English morphemes, they were not arranged to form existing English words. Within the context of a lexical decision experiment, the critical stimuli would be assigned "no" values, meaning that participants are expected to answer that they are not words in English. Participants were generally good at determining that the presented pseudowords were not words in English, but knowing that a word does or does not exist in English does not require knowledge of morphological structure.

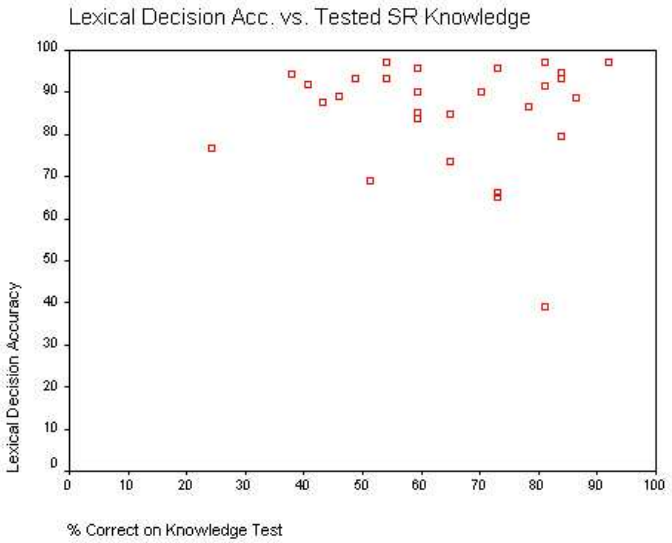

Figure 2: Lexical Decision Accuracy (%) compared to Accuracy on Knowledge Test (%). The correlation between error rates and explicit knowledge of selectional restrictions did not reach significance in the lexical decision task, r=.09, p=.63.

This is unlike the case of the category decision task, where participants are asked to select the lexical category to which a stimulus belongs. In English, knowledge of suffixes can be used to determine the lexical category of novel items. Offline accuracy correlated with error rates in the Category Decision Task, r=.505, p<.001 (Fig. 3). Participants who showed overt knowledge of selectional restrictions on the offline knowledge test performed with a higher degree of accuracy on the Category Decision Task, where they were asked to determine to which lexical category a stimulus belonged. However, when reaction times to critical stimuli in both the lexical decision and category decision tasks were compared to accuracy on the offline knowledge test, there were no correlations in either task. Participants who showed greater awareness of suffix patterning performed better on the online category decision task and they did so at the same speed as participants who performed at lower levels of accuracy. This result suggests that those participants with greater awareness of selectional restrictions were not taking more time to apply their knowledge during online tasks.

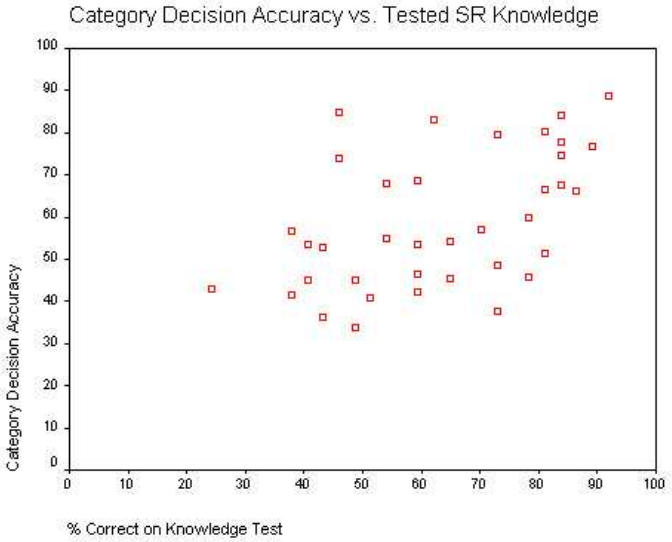

Figure 3. Category Decision Accuracy (%) compared to Accuracy on Knowledge Test (%).The correlation between error rates and explicit knowledge of selectional restrictions was significant in the category decision task, r=.505, $p<.001$.

These results indicate that the category decision task was more sensitive to morphological structure than the lexical decision task, but does not address the notion of semantic interpretability. Burani et al. (1999) found that Italian speakers did not appear to be influenced by violations of selectional restrictions, but that they were influenced by the ease with which meaning could be derived from the target items. A continuation of the present study includes the collection of word ratings, where participants are asked to rate how meaningful they find the pseudowords used in these experiments. Pseudowords are rated on a scale of 1 to 5, with a rating of 1 indicating that the pseudoword is meaningless, and a rating of 5 indicating that the pseudoword has an easily discernable meaning. Preliminary results are compatible with Italian data. As pseudowords increase in semantic interpretability (meaningfulness), accuracy on the Category Decision task increases and RTs decrease. In other words, targets that are rated as more meaningful show a trend towards more word-like behaviour. This suggests that the extent to which a pseudoword is meaningful appears to be salient, at least in these limited data.

3. General Discussion

This series of experiments was carried out to determine whether native speakers of English are sensitive to selectional restrictions when presented with novel pseudowords composed of existing morphemes. No significant differences between morphologically legal and illegal items were found in error rates or

reaction times in either of the online tasks. Based on these results, it appears that adherence to or deviation from morphological selectional restrictions did not appear to influence participant behaviour.

However, participant knowledge of word structure in English did influence behaviour during online tasks. There was a correlation between overt knowledge of selectional restrictions, as measured through an offline knowledge test, and accuracy on the category decision task. Participants who showed higher levels of metalinguistic awareness, as indicated by performance on the knowledge test, produced fewer errors during the online task. Correlations between early results from pseudoword rating tasks and performance on the category decision task are suggestive of more word-like behaviour when target pseudowords are rated as being meaningful.

Differences in participant behaviour were observed between the two online tasks (lexical decision, category decision). This was most easily observable in the correlations of error rates in the two experiments against the offline knowledge test. Metalinguistic knowledge of selectional restrictions did not correlate with accuracy on the lexical decision task, although it did correlate with accuracy on the category decision task. This difference may be caused by the different requirements of the two tasks, with the lexical decision experiment asking only if a given item is a word, and the category decision task requiring answers that required the use of morphological information. This difference suggests that the detection of purely morphological factors in online processing may be influenced by the experimental task used and by the extent of a speaker's metalinguistic awareness.

While results from Libben (1993) showed that native English speakers are sensitive to selectional restrictions during morphological processing, results from the current research, which used existing morphemes, did not. Taken together, these results suggest that while selectional restrictions may be active during morphological processing, the semantic interpretation of the root+suffix pair may take precedence over morphological legality.

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