DISTRIBUTIONAL LEARNING IN RAPID SYNTACTIC ADAPTATION

Nicole Craycraft, 2014
Adviser: T. Florian Jaeger
Department of Brain and Cognitive Sciences (Psycholinguistics), University of Rochester

One of the fundamental aspects of language is variability. Far from being consistent across or even within individuals, each user of language is shaped by previous experience and expectations. This variance is found on all levels of linguistic representation. On the phonetic level, speakers must be able to resolve the “lack of invariance” problem, in which a given phoneme (sound category) is actually produced differently by speakers that share the same language (Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967). This problem is very evident within the context of grammar, as the age, gender, and social status of a speaker influences whether he uses the active voice (“The boy hit the ball”) or the passive voice (“The ball was hit by the boy”) (Weiner and Labov, 1983).

Given that communication occurs in spite of the variability of grammar, there exist mechanisms to compensate for the issues that this variability can pose. One account of such mechanisms is the constraint satisfaction approach (MacDonald, Pearlmuter, & Seidenberg, 1994; McRae, Spivey, Knowlton, & Tanenhaus, 1998), which makes use of individuals’ sensitivity to the various probabilities of their linguistic environment. Constraint satisfaction theories hold that initial language processing activates in parallel all potential interpretations of a sentence. Statistical information is used to track the relative frequencies of syntactic structures (Juraisky, 1996). More probable interpretations receive more activation and temporarily inhibit less probable interpretations. Likelihood is determined by the probabilistic expectations of a structure, given an individual’s past experiences. Another account of such compensating mechanisms, proposed by Kaschak & Glenberg (2004), is an episodic-processing approach. This approach suggests that in encoding a stimulus, the processing methods applied to the stimulus are incorporated into the encoding. For example, if one were asked to perform two different tasks to a word, those different processes would lead to two different memories of the word. Crucial episodic-processing theories pose a model where individuals are sensitive to both the probabilistic likelihood of a structure and how processing occurred on the structure. This is crucial to how such mechanisms influence sentence processing. Many such mechanisms for episodic-processing approaches are consistent with constraint satisfaction approaches, but the differences between them lead to different testable predictions about behaviors in linguistic environments.

This paper focuses on syntactic adaptation. Adaptation is described in Fine, Qian, Jaeger, & Jacobs (2010) as “how language users maintain or update their representations of the probability distributions relevant to language use, given new evidence” – essentially, how language users utilize their expectations of how language will be used, and how they refine those expectations in the face of new or conflicting evidence. Syntactic adaptation examines how language users employ expectations of the various syntactic structures to comprehend any given sentence. For example, in (1) the first verb encountered can either be the matrix verb in the sentence (MV), or a descriptor in a conditioned relative clause (RC).

(1) The flowers bloomed ten days ago...
   MV: ...in the spring garden.
   RC: ...were cut by the florist.

The sentence in (1) is ambiguous until the phrase “were cut” is encountered, which rules out the MV interpretation; “were cut” is thus the disambiguation point. If readers expect the MV interpretation more than they expect the RC interpretation, reading times at the disambiguation point will be longer. This is known as the garden path effect. Expectations are formed based on a priori experience with language. In this particular example, MV sentences are more frequent than RC sentences. Syntactic adaptation is the ability of language users to adjust to the statistics of the current linguistic environment and eliminate the garden path effect.

In a constraint satisfaction approach, the a priori expectations form the initial basis for a linguistic environment. These would be the accumulation of an individual’s entire previous experience with language. For the structures studied in this paper, a priori expectations are those MV structures that are more common than RC structures. When encountering an example of an ambiguous RC, individuals will expect an MV until reaching the disambiguation point, where the garden path effect occurs. However, as the individual encounters more RC structures, the probability of an RC increases and the individual begins to select the RC interpretation more often. As this theory relies on probabilistic weighting, if the infrequent structure is weighted higher, then the
frequent structure (or more frequent structures, as oftentimes there are more than two potential structures a sentence can take) must be correspondingly weighted lower. This leads to difficulty in processing the more frequent structure, which was previously processed with no issue. This would manifest as ambiguous MV reading times increasing as RC reading times decrease.

Many factors remain the same between the constraint satisfaction approach and the episodic-processing approach. Initial processing difficulty is incurred by the infrequent structure; individuals favor the more frequent structures and are forced to revise. Over time, the infrequent structure becomes more expected, and the processing difficulty vanishes. However, in the episodic model, when encountering the more frequent structure, the individual has the structure already partially activated from when it was incorrectly selected as the interpretation of the sentences involving the infrequent structure. Rather than incurring a processing cost due to exposure to the infrequent structure, the more frequent structure is facilitated and comprehended more easily. Put more concretely, as readers encounter an ambiguous MV structure after many exposures to RC structures, the memory trace of the garden path leaves the MV interpretation partially active, which results in no processing difficulties.

Fink, Jaeger, Farmer, & Qian (2012) has shown some difficulty when encountering the MV structures later in the experiment. This paper is focused on examining how sensitive language users are to the environmental statistics by varying them. What percentage of the less common structure must be present to overcome the a priori expectations and have adaptation occur? Also, by strongly biasing participants toward one interpretation or another, can evidence of either facilitation or difficulty for the more frequent structure be shown?

**EXPERIMENT 1**

In Experiment 1, subjects were presented with 4 different conditions of an experimental item in a 2x2 within-participant design: each item was either a matrix verb (MV) or relative clause (RC), and was either temporarily ambiguous (A) or was unambiguous (UA). An example of the same item in the four different conditions is shown below in (2). The different verbs are italicized and the disambiguating region is underlined.

(2) The experienced soldiers... UAMV—wrote about the dangers / before the midnight / raid on the enemy.
AMV—cautioned about the dangers / before the midnight / raid on the enemy.
ARC—cautioned about the dangers / conducted the midnight / raid on the enemy.
UAARC—who were cautioned about the dangers / conducted the midnight / raid on the enemy.

So far, this is essentially a replication of previous syntactic adaptation work, such as MacDonald et al. (1992) and Fink et al. (2010). However, we added an additional between-participant manipulation to the basic within-participant design. Experiment 1 was split into a training session and a test session, with no visible break between the two sessions. The training session contained 72 stimuli; of those, 28 were items and 44 were fillers. The test session contained 22 stimuli; of those, 8 were items and 14 were fillers. Participants saw one of 3 types of training sessions:

a) 50% RC Condition: a uniform distribution of the four conditions (7 items in each condition) during the training session.
b) 100% RC Condition: a 50/50 distribution of the two RC conditions (14 ambiguous, 14 unambiguous) during the training session.
c) 0% RC Condition: a 50/50 distribution of the two MV conditions (14 ambiguous, 14 unambiguous) during the training session.

After exposure to the training session, participants saw the test session, which was consistent across all conditions and contained 2 instances of each of the four conditions (for the 8 items total).

A constraint satisfaction approach has multiple hypotheses. Firstly, it is predicted that previous research on garden paths in sentence processing should replicate experiment 1: the ambiguous stimuli should elicit longer reading times in the disambiguating region than the unambiguous stimuli, the effect of ambiguity should be larger for the less frequent structure (in this case, the ARC condition should have the largest reading time), and the less frequent structure might take longer to read. Secondly, the effects seen in Fine et al. (2012) should replicate this. The more exposure to the less frequent structure during the training session, the smaller the ambiguity effect should be for that structure in the test
phase; conversely, the less exposure to the more frequent structure during the training session, the larger the ambiguity effect should be during the test session. In other words, the reading times for RC structures should be fastest, and the reading times for ambiguous MV structures slowest, in the 100% RC condition, where the most exposures of the infrequent structure and the least of the frequent structure occur. The 0% RC condition should have the fastest reading times for the MV structures and the slowest for the ambiguous RC structures, with the 50% RC conditions falling between the two extremes.

An episodic-processing approach would hold most of the same hypotheses: ambiguous stimuli take longer to read than unambiguous stimuli, the less frequent structures initially take longer to read than the more frequent structures, and adaptation to the infrequent structures will occur. However, there are some hypotheses specific to this approach, among them that exposure to the less frequent structure will facilitate the reading of the more frequent structure. The 0% RC group should have the fastest reading times for the MV structures and the slowest for the RC structures, because the MV structure is the initial assumption. The 50% RC and 100% RC groups should have faster reading times for both RC and MV structures as the experiment progresses, with the 50% RC group showing the fastest reading times for the ambiguous MV structure. This is due to its presence in the probabilistic environment as well as the partial activation from the RC structures. The 100% RC group should have the fastest reading time for RC structures, because that group had the highest exposure to the RC structures.

**METHOD**

**Subjects.** 144 monolingual native American English speakers participated in this study as part of a subject pool recruited through Amazon’s crowd-sourcing platform, Mechanical Turk (Mason & Suri, 2011). All subjects gave informed consent and were compensated monetarily.

**Materials.** The materials in Experiment 1 were a modified version of those used in MacDonald, Just, and Carpenter (1992), Fine et al. (2012) and Farmer et al. (2011). In the MacDonald et al. (1992) materials, 24 items were created from verb triplets, with 3 items per triplet. Of the three verbs, one would be used in both ambiguous conditions (ARC and AMV), one would be used in the UARC condition, and one would be used in the UAMV condition. Fine et al. (2012) and Farmer et al. (2011) created and added 12 additional items, following the same verb triplet format. This yielded the total of 36 items. The fillers were the same as in Fine et al. (2012).

However, the stimuli used in this experiment diverge from previous experiments in a few important ways. The sentences were lengthened, to allow the disambiguating region to occur earlier in the sentence. All experimental items had the same number of words per condition. The forms of the RC disambiguating region were standardized to a few different varieties: a verb/conjunction/verb phrase, an auxiliary verb followed by a main verb and noun phrase, or a verb followed by a noun phrase. This increased the variety of the items in a consistent manner, and helped eliminate any potential confounding variables associated with reusing the same structure. For each item, the same verb was used in three conditions: AMV, ARC, and UARC. This made direct comparisons of the reading times and deviations easier by using the same verb in all applicable cases, instead of potentially skewing the results by having the UARC condition use a unique verb.

Most importantly, any and all lexical repetition was completely eliminated. Each item used a unique irregular past tense verb form for the UAMV condition (which is what makes the sentence unambiguous) and a unique regular past tense verb form for the other three conditions. On two occasions, two items shared UAMV condition verbs. However, the experimental lists were designed in such a way that no subjects saw both items in the UAMV condition, preventing any lexical overlap. This was done because some of the effects found in previous experiments may be due to the lexical repetition of the items.

Each of the three between-participants groups had multiple lists, so each item appears in each condition across all participants. The fillers remained in the same position in all lists. Each training list was paired with the same test list. It is possible to further pair each training list with each test list, but this was logistically impractical. Four lists for each between-participant group (one with each item presented in a different condition) and then the inverse item order for the training session makes for a total of 8 lists per between-participant condition.

**Procedure.** Subjects read sentences in a self-paced moving window display (Just, Carpenter, & Woolley, 1982) in a flash applet hosted on Mechanical Turk. Each word in the stimulus is initially presented as a dash. Subjects were instructed to press the space bar to progress down the stimulus, one word at a time. Durations between space bar presses were recorded. Whenever the space bar was pressed, the previously displayed word was replaced by a dash as the next word was displayed. Both the experimental and filler items were followed by a simple yes/no comprehension question, with half the answers as “yes”. Subjects were presented with practice items before beginning the experiment proper.

**Results.** Data coding and exclusions. All raw reading times (RTs) that were abnormally low (below 100 ms) or abnormally high (above 2000 ms) were removed. Subjects who exhibited below 80% total accuracy on comprehension questions were excluded. 142 subjects were left for analysis. Some items were excluded from analysis due to experimental error from the ambiguous nature of their comprehension questions or errors in question design. Length-corrected RTs (cf. Ferreira & Clifton, 1986) were created by regressing the remaining raw RTs onto word length by means of linear mixed effects regression. This linear mixed model included a single main effect of word length, a random intercept for subject, and a by-subject random slope for length. This allows the model to discount mean differences in reading times across subjects as well as variable word length sensitivity across subjects. Length-corrected (residualized) RTs on the disambiguation region were analyzed using a mixed linear regression with the maximal random effect structure for which the model converged (random by-subject and by-item intercepts and the slopes for the full factorial of Ambiguity and Structure, but no random slopes for Group). The model analyzed the full 2 (Ambiguity) x 2 (Structure) x 3 (Group) factorial design.

**Analysis.** Initially, the sentence was divided into regions, and the average residual reading time in each region was found. Residual reading times track deviations from what would be an expected
reading time, given the word length and the subject's natural reading speed. Regions were consistent across all conditions. The mean reading times for each region in each condition were graphed to track how the times changed throughout the sentence. If the garden path effect was observed, reading times should be higher for the Ambiguous RC condition (ARC) in the disambiguating region than the other conditions. As seen in Figure 2, this effect was found. Reading times for the verb in the Unambiguous RC condition are significantly lower due to the subjects' previous exposure to the disambiguating phrase "who was/were", which allows them to know that the item is a RC.

In analyzing the model, we found a significant main effect of Structure, so that RCs were read more slowly than MVs ($\beta = 21.5$, $t = 2.3$, p < .05). Since sum-coding was used, the coefficient estimate $\beta$ is equivalent to the estimated mean difference in milliseconds of reading time on the disambiguating region between RCs and MVs. There was a marginally significant effect of Structure on Group: relative clauses were read marginally slower in the 100% RC group compared to the other groups ($\beta = 7.7$, $t = 1.8$, p < .06). There also was a significant main effect of Ambiguity on Group: while the interaction between Ambiguity and the 50% and 0% RC groups did not reach significance ($|t| < 6$), the interaction between Ambiguity and the 100% RC group compared to the other groups was significant ($\beta = -12.1$, $t = -2.6$, p < .05). There was a marginally significant effect of Structure on Group: RCs were read marginally slower in the 100% RC group compared to the other groups ($\beta = 7.7$, $t = 1.8$, p < .06). The three-way interaction between Structure, Ambiguity, and Experience Group was marginally significant in the expected direction ($\beta = -18.3$, $t = -2.0$, p < .06): the ambiguity effect for RCs was reduced in the 100% RC group compared to the two other groups. None of the other main effects or interactions reached significance ($|t| < 1.5$). Figure 3 is a representation of the mean residual reading times in the disambiguating region for items in the test phase, across both condition and group. Overlapping error bars indicates a lack of significance. In the 0% RC and 50% RC group, there is still an ambiguity effect for ambiguous RCs, which is numerically reduced in the 50% RC group, although it did not reach significance. However, in the 100% RC group, ambiguous RCs are read faster than they are in any other condition. The reading times for the MV structures do not differ significantly, however, there is a clear trend: such MV structures are read fastest in the 100% RC group, followed by the 50% RC group, then followed by the 0% RC group.

**Discussion**

The expected garden path effect was replicated, as subjects reading ambiguous RC items slower in the disambiguating region than items in other conditions. MVs were numerically read faster, and ambiguous structures were read numerically slower, but these did not reach significance. Also, the ambiguous RC items were read fastest in the 100% RC group, which was predicted by both theories. However, the data was inconclusive with respect to most of the specific predictions for both constraint satisfaction and episodic processing theories. The reading times for MVs across groups did not differ significantly. There was a numerical ambiguity effect for the MV structure in the 0% RC and 50% RC group, but this did not reach significance. This does not allow us to draw any conclusions from most of the data. However, it was confirmed that the larger the amount of RCs the subjects were exposed to, the more easily ambiguous RC structures were read, to the point of eliminating the ambiguity effect by the testing region. It is possible that any effects that are present are masked by general task adaption, the tendency for subjects to get faster through the course of the experiment as they become more familiar with the task.

**Experiment 2**

In Experiment 1, general adaptation to the task confounded the results, making it hard to disentangle what was true syntactic adaptation, and what was merely adapting to the experimental paradigm. As the testing session was at the end, the most relevant data was collected when the participants had the most experience with the procedure. This could have lead to some of the more sensitive effects being masked by the general task adaptation. Our solution to this was to test the participants in multiple phases to get a more accurate read of how the reading times of the different conditions changed throughout the course of the experiment and to use those to infer how the participants' expectations changed. This also provides more of an opportunity to see if the MV structures become impeded or facilitated as the number of exposures to RC structures increases.

In the constraint satisfaction approach, all of the hypotheses presented in Experiment 1 are still expected, with a few additional

---

**Figure 2:** Mean residual reading times across regions for items in Experiment 1. The reading times in the disambiguating region of ambiguous RC items is the highest, indicative of the subjects experiencing the garden path effect.

**Figure 3:** Mean residual reading times in the disambiguating region for test items in Experiment 1. The reading times in the disambiguating region of ambiguous RC items is the fastest in the 100% RC group.
hypotheses: that reading times for RC structures will be faster in the second test phase than the first, and that the reading times for MV structures will be slower in the second test phase than the first. This difference should be greatest in the 100% RC group, followed by the 50% RC group, and the 0% RC group should see the least decrease in reading times for the RC structure and potentially no increase in reading times for the MV structure.

In the episodic-processing approach, the same is true—the hypotheses presented in Experiment 1 are still expected, and the new design invites additional hypotheses: reading times for both types of structures will be faster in the second phase than the first, with the difference being greatest in the 50% RC group, followed by the 100% RC group, followed lastly by the 0% RC group.

**METHOD**

**Subjects.** 292 monolingual native American English speakers participated in this study as part of a subject pool recruited through Amazon’s crowd sourcing platform, Mechanical Turk (Mason & Suri, 2011). All subjects gave informed consent and were compensated monetarily. No subjects who participated in Experiment 1 were able to participate in Experiment 2.

**Materials.** The materials in Experiment 2 were composed of the same stimuli as described in Experiment 1, but arranged differently. Each list for each between-participant group had two training sessions and two test sessions. The first training session was composed of 20 stimuli, with 8 experimental items and 12 fillers. The first test session was composed of 29 stimuli, with 12 experimental items and 17 fillers. The second training session was composed of 23 stimuli, with 8 experimental items and 15 fillers. The second test session was composed of 24 items, with 8 experimental items and 16 fillers. As in Experiment 1, each between-participant group had four lists (one with each item in a different condition) and then the inverse of those lists, but in addition the test phases were also presented in inverse order as well, creating 16 lists instead of the 8 found in experiment 1.

**RESULTS**

Data coding and exclusions. Exclusions were identical to that of Experiment 1: all raw reading times (RTs) that were abnormally low (below 100 ms) or abnormally high (above 2000 ms) were removed. Subjects who exhibited below 80% total accuracy on comprehension questions were excluded. This left 261 subjects to be analyzed. Due to experimental error, some items were excluded from analysis due to either the ambiguous nature of their comprehension questions or errors in question design. As in Experiment 1, Length-corrected RTs (cf. Ferreira & Clifton, 1986) were created by regressing the remaining raw RTs onto word length by means of linear mixed effects regression. This linear mixed model included a single main effect of word length, a random intercept for subject, and a by-subject random slope
for length. This allowed the model to discount mean differences in reading times across subjects as well as variable word length sensitivity across subjects. The model used was identical to that of Experiment 1. Length-corrected (residualized) RTs in the disambiguating region were analyzed using a mixed linear regression with the maximal random effect structure for which the model converged (random by-subject and by-item intercepts and the slopes for the full factorial of Ambiguity and Structure, but no random slopes for Group). The model analyzed the full 2 (Ambiguity) x 2 (Structure) x 3 (Group) factorial design.

**Analysis.** As in Experiment 1, the sentence was divided into regions, and the average residual reading time in each region was found. The mean residual reading times were then graphed. As seen in figure 2, the garden path effect was observed because reading times for the Ambiguous RC condition (ARC) was higher than other regions. In reading times for the verb in the Unambiguous RC condition are significantly lower due to subjects having already been exposed to the disambiguating phrase “who was/were”, which allows them to know that the item is a RC.

**Test 1.** A significant main effect of Structure was found, so that RCs were read more slowly than MVs ($\beta = 41.9, t = 6.0, p < .03$). The coefficient estimate $\beta$ is equivalent to the estimated mean difference in milliseconds of reading time on the disambiguating region between RCs and MVs. Ambiguity also had a main effect: Ambiguous items were read more slowly than unambiguous items ($\beta = 25.6, t = 5.9, p < .03$). The interaction between Ambiguity and Structure trended towards significance in the expected direction: ambiguous items were read more slowly than unambiguous items ($\beta = 26.5, t = 1.6, p < .06$). None of the remaining main effects or interactions reached significance ($|t| < 1.5$).

The mean residual reading times for the disambiguating region for items in the test phase, across both condition and group, is shown in Figure 6. Reading times were significantly higher for ambiguous RCs compared to unambiguous RCs in the 0% RC and 50% RC groups, but were not significantly higher in the 100% RC group. Between MV structures, reading times did not significantly differ but trended towards the slower end for ambiguous MVs; nor did the reading times between groups for MVs significantly differ.

**Test 2.** A significant main effect of Structure was found, so that RCs were read more slowly than MVs ($\beta = 36.4, t = 5.3, p < .03$). Since sum-coding was used, the coefficient estimate $\beta$ is equivalent to the estimated mean difference in milliseconds of reading time on the disambiguating region between RCs and MVs. A significant main effect of Ambiguity was also found: ambiguous items were read more slowly than unambiguous items ($\beta = 15.2, t = 3.1, p < .03$). The interaction between Structure, Ambiguity, and Experience Group approaches marginal significance in the expected direction ($t = -1.64$): the ambiguity effect for RCs was marginally reduced in the 100% RC group compared to the two other groups. None of the remaining main effects or interactions reached significance ($|t| < 1.5$).

Figure 7 is a representation of the mean residual reading times in the disambiguating region for items in the Test 2 phase, across both condition and group. In all three groups, there is no longer a significant difference between ambiguous RCs and unambiguous RCs. The fastest reading times for RC structures is numerically found in the 100% RC group. Ambiguous RCs are read numerically slowest in the 0% RC condition. There is no significant difference between the ambiguous MVs and unambiguous MVs in any condition, but the difference is numerically largest in the 100% RC condition, suggesting a trend to an ambiguity effect. MVs are not read significantly faster in any condition, but the 100% RC condition shows the numerically fastest reading times for MVs in both conditions.

**Discussion**

Experiment 2 showed a replication of the garden path effect: ambiguous RC items had the highest reading times of the conditions. Test 1, occurring after only 8 items, is already showing an effect of group: the ambiguity effect for RCs is gone for the 100% RC group. This supports the conclusion of Experiment 1, where the 100% RC group had the faster reading times for ambiguous RCs. In Test 2, the ambiguity effect is no longer significant in any condition, where the fastest numerical reading times were again in the 100% RC group, but the difference between groups did not reach full significance. In the 100% RC and 50% RC groups, the MVs were read significantly faster than the RCs, and in the 0% RC group this was marginal. Unfortunately, as in Experiment 1, the MVs in all groups in both test phases did not differ significantly. However, some interesting trends did occur. In Test 2 for the 100% RC group, reading times were faster for MV structures despite having been exposed to only 4 MV structures (from Test 1, the 4 total in Test 2 create 8 exposures overall). Furthermore, the numerically largest increase in reading times for MVs happened in the 100% RC group. This is suggestive of what the episodic processing models would expect. However, the ambiguity effect for MVs is also numerically largest in the 100% RC group. This is suggestive of what the constraint satisfaction approach would expect.

One potential source of result confounding is the fact that Test 1 alters significantly the statistical environment for two of the three groups. This rapidly shifting difference in statistics could impact the expectations of the subjects, making it harder to adapt to the desired extent. The labels of “0% RC” and “100% RC” are technically misnomers, because each group saw both MVs and RCs during the test phases.

The fact that some predictions for both theories were apparent but not quite statistically significant suggests a need for further experimentation, perhaps with an altered paradigm in an attempt to...
to discriminate more finely between the theories. What can be conclusively stated is that exposure to a higher percentage of RC structures shifts the expectations of the subjects most rapidly. It shifts it so much that after just 8 exposures the ambiguity effect is not statistically significant. Interestingly, while the ambiguity effect is not statistically significant in Test 1 for the 100% RC group, it is also not statistically significant in Test 2 for the 0% RC group. The 100% RC group by Test 1 and the 0% RC group by the end of Test 2 have both seen 8 examples of RC structures. It is possible there is a potential threshold of exposures that causes adaptation to occur. This would be influenced by the a priori probability of a structure. Perhaps a very uncommon structure such as the reduced relative clause does not need many exposures to have the expectations be adjusted, regardless of the mechanism for adjustment. Adaptation may not just be rapid but also sensitive.

CONCLUSION

Language users are capable of adapting their expectations of the syntactic linguistic environment. Experiment 1 showed that the ambiguous RC items were read fastest in the 100% RC group. Test 1 of Experiment 2 showed that a small number of exposures to the RC structures with no exposures to MVs (i.e., the 100% RC group) could reduce the ambiguity effect to where it was no longer statistically significant. Test 2 in Experiment 2 showed that the ambiguity effect is no longer significant in any condition; this suggests a threshold of exposures beyond which adaptation occurs. The data did not provide any significant insight into the mechanisms by which adaptation was occurring; however, the data did show some trends. To support the constraint satisfaction theories, ambiguity effects trended higher in ambiguous MVs the more RCs a subject was exposed to in Test 2 of Experiment 2. To support the episodic processing theories, MVs were read faster in groups with high RC frequency in Test 2 of Experiment 2. This research is ongoing and hopefully further inquiry will tease out some of these effects.

REFERENCES


