Spring 2017

Syntactic Adaptation to Relative Clause Sentence Processing: Contributions of Experience and Memory

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Contributions of Experience and Memory

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Honors Thesis

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Abstract

One of the most robust findings in psycholinguistics is that object-extracted relative clauses (ORCs) are more difficult to process than subject-extracted relative clauses (SRCs) (Traxler, Morris, & Seely, 2002; King & Just, 1991; Ford, 1983). However, the reasons for this are still controversial. One view attributes this difficulty to experience: ORCs are harder to process because they are more rarely encountered than SRCs (Wells, Christiansen, Race, Acheson, & MacDonald, 2008; Gennari & MacDonald, 2008; MacDonald & Christiansen, 2002). Another view is that the word order of ORCs places a larger burden on working memory than SRCs (Miller & Chomsky, 1963; Grodner & Gibson, 2005; Lewis & Vasishth, 2005). These models predict different loci of processing difficulty along an ORC sentence. Experience-based models predict difficulty at the beginning of the ORC, where the structure can be identified as rare. Memory-based models predict difficulty at the embedded verb, where a long distance dependency must be resolved. There is evidence indicating difficulty in both regions (Staub, 2010). Wells et al., (2009) conducted a relative clause training study, which found that intensive experience with ORCs reduced (but did not eliminate) processing differences. However, the study did not pinpoint the locus of these training effects. The present study aimed to replicate Wells et al., (2009), focusing on the locus of any training effects. On a memory-based account, training should have selectively facilitated processing exclusively at the subject region of the ORC. If instead ORC complexity is primarily a function of experience, then training should have facilitated processing over the entire ORC. Training only facilitated processing over the subject of the ORC. In contrast, difficulty at the embedded verb actually increased with training. Though methodological issues discourage definitive conclusions, the results suggest that the role of experience is limited and intrinsic memory constraints underlie ORC complexity.

Keywords: Sentence processing, relative clauses, statistical learning, working memory, syntax

Syntactic Adaptation to Relative Clause Sentence Processing:

Contributions of Experience and Memory

How people process relative clauses has been a central focus of psycholinguistic research. Subject-extracted relative clause sentences (SRCs) (e.g., *The reporter that attacked the senator admitted the error.*) feature the subject of the main clause (e.g., *The reporter*) as the subject of the relative clause verb (e.g., *attacked*). By contrast, in object extracted relative clause sentences (ORCs) (e.g., *The reporter that the senator attacked admitted the error.*), the subject of the main clause is the object of the relative clause verb (e.g., *attacked*). ORCs are reliably more difficult to process than SRCs (Traxler, Morris, & Seely, 2002; King & Just, 1991; Ford, 1983). This difficulty with ORC sentence processing has been explored in many studies investigating topics ranging from the role of working memory in sentence processing (Grodner & Gibson, 2005; Gordon, Hendrick, & Johnson, 2001; King & Just, 1991) to language acquisition in children (Kidd, Brandt, Lieven, & Tomasello, 2007; Booth, MacWhinney, & Harasaki, 2000) and language decline in elderly adults (Wingfield, Peelle, & Grossman, 2003).

The source of the ORC processing difficulty is controversial in psycholinguistics and cognitive psychology. Given that a pair of SRC and ORC sentences can contain the same words and still generate a processing difference, the difficulty with ORCs is unlikely to be due to lexical factors alone (Staub, 2010; Gennari & MacDonald, 2008). There are currently two families of explanation for ORC processing difficulty. Experience-based theories propose that linguistic structures that are rarely encountered are more difficult to process, (Wells et al., 2009; Gennari & MacDonald, 2008; MacDonald & Christiansen, 2002). Memory-based theories propose that certain linguistic structures impose an inherently larger burden on working memory and make processing more difficult (Miller & Chomsky, 1963; Grodner & Gibson, 2005).

The experience-based model (Wells et al., 2009; Gennari & MacDonald, 2008; MacDonald & Christiansen, 2002) argues that statistical learning is not limited to language acquisition in children (Werker & Yeung, 2005; Saffran, 2003), but that it is also a critical tool for sentence processing in adults (Myslin & Levy, 2016; Karuza, Farmer, Fine, Smith, & Jaeger, 2014; Fine, Jaeger, Farmer, Qian, 2013). Essentially, the experience-based model proposes that adult language users rely on their linguistic experience to generate probabilistic constraints that support efficient sentence processing (Wells et al., 2009). Since language users predict the most likely sentence structures from their experience, they are surprised when a syntactic structure appears that is inconsistent with their expectations. This surprise should be immediately reflected in a processing difficulty (Hale, 2003; Levy, 2008). In the case of SRCs and ORCs, an SRC is more likely than an ORC following the relative pronoun *that*. As a result, when an ORC subject is present after the relative pronoun, it is surprising and difficult to process (Grodner & Gibson, 2005).

Support for the experience-based model of relative clause sentence processing is theoretically provided by computational modeling (MacDonald & Christiansen, 2002) and empirically provided by a self-paced reading study (Gennari & MacDonald, 2008). The theoretical argument for the experience-based model is based on the *Frequency X Regularity* interaction in word recognition, where *frequency* is defined as the number of times a word is used in a language and *regularity* refers to the probability of that word's phonological-orthographical pairing (e.g., *mint*, *lint*, and *tint* versus *pint*). Frequency affects reading speed and accuracy for irregular language forms, but not regular language forms. This is because regular forms obey common patterns across the language, so their individual frequencies are immaterial to learning how they are used. By contrast, irregular forms oppose the patterns of the language,

so experience with individual examples of those forms in the language is crucial for ease of processing (Seidenberg, 1985).

MacDonald and Christiansen (2002) propose a *Frequency X Regularity* interaction to explain why ORCs are more difficult to process than SRCs. In English, the general word order is Subject-Verb-Object. SRCs obey this order because the lexical material of the subject precedes the embedded verb and the object follows the verb. However, ORCs possess an irregular Object-Subject-Verb word order, where the lexical content of the object precedes the relative clause subject. Because ORCs are structurally irregular in this way, the frequency with which they are observed should have a greater effect on processing than with SRCs.

Based on this framework, MacDonald and Christiansen (2002) expand on the *Frequency X Regularity* interaction to argue to that the language user's experience with ORCs is critical for ORC learning and that a *Frequency X Regularity X Experience* interaction underlies ORC sentence processing. MacDonald and Christiansen (2002) found theoretical support for the hypothesis that experience influenced ORC processing more than SRC processing using a computational model. Subsequently, Gennari and MacDonald (2008) provided stronger evidence for the role of experience in ORC processing using a self-paced reading study. Evaluating participant reading times for ORC sentences that varied by the animacy of the head noun and/or voice (i.e., active or passive), Gennari and MacDonald (2008) found that active ORCs with animate head nouns were particularly difficult to process in terms of reading time and responses to comprehension questions. This is consistent with the relative frequency of such relative clause types. Critically for our study, Gennari and MacDonald (2008) found that the processing difficulties appeared at the relative clause noun phrase before intensifying over the relative clause verb. That said, it is important to recognize a limitation of Gennari and MacDonald

(2008). They did compare ORC to SRC sentences to evaluate differences in relative clause sentence processing between the two categories, but they only demonstrated that when sentence structures are tightly controlled, other factors like animacy and voice can influence ORC processing.

Departing from the experience-based view, Grodner and Gibson's (2005) memory-based view provides an alternative explanation for the difficulty of ORC sentence processing. As mentioned above, Grodner and Gibson (2005) propose that certain linguistic structures, such as ORCs, impose a considerable memory burden that impairs processing. Grodner and Gibson (2005) provided evidence for the memory-based view using a self-paced reading study that compared ORC and SRC reading times. They found a significant difference in reading times between the two relative clause sentence types at the relative clause verb, but not at the relative clause noun – a critical locus of difficulty for the experience-based view (Grodner & Gibson, 2005). Here, Grodner and Gibson (2005) explained the observed difficulty at the relative clause verb in terms of working memory constraints. Specifically, when processing an ORC sentence, it is difficult for the reader to hold the sentence's main subject in working memory over the relative clause noun until it can be identified as the object of the relative clause verb. A secondary experiment by Grodner and Gibson (2005) supported this explanation, as participant's reading times at the relative clause verb increased with the amount of embedded information included between the main subject and the relative clause verb.

Given the conflict between the experience-based and memory-based models of relative clause sentence processing, Wells et al., (2009) implemented a training study based on MacDonald and Christiansen (2002) that aimed to support the experience-based model. In Wells and colleagues' (2009) study, half of the participants were given intensive training on SRCs and

ORCs, while the other half received intensive training on sentential complement and conjoined sentences. Wells et al., (2009) predicted that the difference in self-paced reading times between SRCs and ORCs would decrease with training. This is because the irregular linguistic pattern of the ORCs would be more susceptible to experience-associated training effects than the SRCs that followed a regular pattern, which would make experience less influential during sentence processing. Indeed, this is what Wells et al., (2009) reported.

While Wells et al., (2009) found that training was particularly beneficial for ORC processing, reliable effects were only found at the main verb. This finding was inconsistent with a strict interpretation of the experience-based view, which would predict a training-associated decline in processing difficulty much earlier, at the ORC subject. Importantly, Wells et al.,'s (2009) regions of analysis (depicted in (1)) make it impossible to determine if there was a selective training effect at that critical noun phrase because they did not separate the main noun and ORC noun into separate regions of interest.

(1a) SRC: The clerk that trained the | typist | told | the truth.

(1b) ORC: The clerk that the typist | trained | told | the truth.

Wells et al., (2009) did not find a reliable interaction at the relative clause verb and the difference in reading times between ORCs and SRCs was not completely eliminated. These results supported the memory-based view, which argues that experience cannot train away certain difficulties with ORC sentence processing (Grodner & Gibson, 2005).

In a more recent study addressing the experience and memory controversy, Staub (2010) used eye tracking to measure sentence processing difficulties in relative clause sentences. Comparing participant's eye movements while reading SRC and ORC sentences, Staub (2010)

found that ORC readers were more likely to regress back to a previous portion of the sentence than SRC readers. This effect was localized to the ORC noun phrase. Staub (2010) also reported that ORC readers exhibited longer first fixations and gaze durations – measurements associated with reading time – than SRC readers. However, these effects were observed at the ORC verb. The respective locations of these results support both the experience-based and memory-based views of ORC sentence processing. Interestingly, the eye movements were also different in kind at the ORC noun phrase and ORC verb (i.e., regressions vs. fixations), suggesting that the processing difficulties experienced at those loci were linked to distinct cognitive processes.

The current study investigates this possibility by exploring whether the complexity effects at these two regions are differentially affected by training. We aimed to replicate the Wells et al., (2009) training study, using the more rigorous stimuli and the sentence-level regions of interest employed by Staub (2010), to assess both the reliability of the relative clause training effect and its locus in relative clause sentences. Several hypotheses can be generated from prior research. If ORC difficulty is primarily a function of experience-tuned expectations, sufficient exposure to ORCs will alter structural predictions and eliminate (or even reverse) ORC difficulty across all regions of the ORC. If instead ORC difficulty is due to the intrinsic memory constraints on processing long distance dependencies, it should be difficult to overcome difficulty at the embedded verb. On this view, training effects would be expected to be prominent only at the relative clause noun phrase.

<div align="center">Methods</div>

Participants

131 participants were recruited through Amazon's Mechanical Turk to complete a three-session reading study. Participants were informed that the study was "investigating how people

communicate, reason, and understand language," and that the study would ask them to read and

answer questions about sentences and read and remember letters. Participants received monetary

compensation for each of the three sessions they completed. They were paid $3.00 for

completing the first session, $4.00 for the second, and $8.00 for the third. Before each session,

participants provided written informed consent in accordance with Swarthmore College's

Institutional Review Board protocol.

Of these 131 total participants, 13 were eliminated after the first session for unnaturally

fast average reading times (average <200 ms/word). These reading times were too fast to reflect

natural reading processes. This was supported by the fact that none of these participants had

accuracy rates above 75% on their comprehension questions. An additional 20 participants were

eliminated for failing to answer at least 70% of the comprehension questions correctly during

their first training session. Beyond these exclusions, an additional 14 participants failed to

complete Sessions 2 and 3, leaving 84 participants who completed all sessions.

Materials and Design

Participants completed a relative clause sentence training study based Wells et al.,

(2009). This study followed a 2 x 2 x 2 design to investigate effects of sentence structure (ORC

vs. SRC), session (Pre-test vs. Post-test), and training (relative clause experience vs. non-relative

clause control) on relative clause sentence processing. Participants were randomly assigned to

either the relative clause training group, which was trained on ORC and SRC sentences, or the

control training group, which was trained on sentential complement (e.g., *The senator assumed*

that the President supported the major education bill.) and conjoined clause sentences (e.g., *The*

senator supported the President then presented him with a defense bill to sign.). The study

consisted of three sessions that participants completed at specified times over one week. Participants accessed each session through a link to the Ibex Farm online experiment hosting platform (Drummond, n.d.) provided by the researchers.

The first session included a reading span task based on Daneman and Carpenter (1980), followed by a relative clause processing pre-test and the first training block with either relative clause sentences or control sentences, depending on the participant's group assignment. The second session was completed four days after the first session and included two additional training blocks with either relative clause sentences or control sentences. The third session was completed three days after the second session and included a final training block and a relative clause processing post-test.

Reading Span Task

The reading span task included 90 narrative-style sentences based on Daneman and Carpenter (1980). The sentences were organized into five sets with the number of sentences in each set increasing sequentially from three to six. That is, there were five sets of three sentences each, then five sets of four sentences each, and then five sets of five and six sentences each, respectively. A practice session with two sets of two sentences each was presented at the start of the reading span task.

Each sentence in the task contained between 11 and 17 words and was presented automatically and in its entirety on the participants' computer screen at 20-point font. The prompt "Does this sentence make sense?" was presented below each sentence, along with the instruction to press *F* for "Yes" or *J* for "No." Each sentence was presented for 5200 ms before a progress bar and feedback automatically appeared. The feedback was presented for 1000 ms in response to the participant's sense-nonsense judgment, stating either "Correct" or "Oops. Wrong

answer." Following the feedback, a capital letter at 36-point font was automatically presented in the center of the participants' screen for 1000 ms. Participants had been instructed to remember the letter.

The cycle of sentence presentation followed by feedback and a single letter occurred with each sentence set. At the end of every set, a box appeared on the participant's screen to allow them to enter all of the letters from the set of sentence letter pairs they had just completed in the order they appeared. Before each set of sentences, participant were told how many sentences – from three to six - were in the next set. The reading span task continued through the six-sentence sets and did not terminate in response to participant performance. Reading span scores were determined according to Wells et al., (2009) and reflected the highest level at which a participant correctly recalled the letters associated with three out of the five sets.

In analyzing participant's reading spans by training group, there was a nearly significant main effect of training group on reading span ($F_1(1,88) = 3.84$, $p<.06$) with control training participants having a higher mean reading span than relative clause training participants. This is contrary to Wells et al., (2009) and indicates that our training groups were not evenly matched for reading ability before beginning the study.

Relative Clause Pre-Test and Post-Test

Forty-eight critical items were created with SRC and ORC variants that were both intuitively plausible (e.g., SRC: *The employee that noticed the fireman hurried across the open field.*; ORC: *The employee that the fireman noticed hurried across the open field.*) Half of these items were assigned to the pre-test and half were assigned to the post test. In alignment with Wells et al., (2009), each SRC's head noun was structured as *The noun that verbed the noun* and each ORC's head noun was structured as *The noun that the noun verbed.* Additionally, the main

verb (e.g., *hurried*) was the seventh word in each sentence and the matrix object following the main verb made sense with the preceding portion of the sentence and contained at least four words. The sentences were also controlled for other semantic variables based on Wells et al., (2009) and Gennari and MacDonald (2008). The head nouns and relative clause nouns were animate and often job descriptions (Gennari & MacDonald, 2008). Voice was also controlled (Gennari & MacDonald, 2008), with all ORCs using active voice. Lastly, pronouns were not included, except for the relative pronoun *that*, in any SRC/ORC pairs.

In addition to the SRC/ORC pairs, the pre- and post-tests each included 40 filler sentences (80 total) that were similar in length and complexity to the SRCs and ORCs, but did not contain relative clauses. One fourth of the fillers were sentences with multiple prepositions in the subject (e.g., *The bush by the cemetery tower with the steep stairs was pruned by the groundskeeper.*), one fourth were sentences with multiple prepositions in the object (e.g., *The flower impressed the visitor outside the large greenhouse inside the botanical garden.*), and half were sentences containing sentential complements (e.g., *The editor noticed that the reporter attacked the politician for taking campaign donations from oil companies.*).

The relative clause pre- and post-tests used a Latin square design to generate two pre-test scripts and two post-test scripts. Thus each script contained 12 SRCs, 12 ORCs, and 40 fillers (See Appendix A). These were presented in a different pseudorandom order for each participant, such that all critical items were separated by at least one filler and the SRCs and ORCs were evenly distributed throughout the list.

Addressing presentation of the pre-test and post-test, both were completed online using the Ibex experimental hosting platform (Drummond, n.d.). All sentences were presented using a self-paced reading paradigm. Following each sentence, a two-choice comprehension question

appeared with the prompt to press *F* for "Yes" or *J* for "No." The comprehension question was followed by a feedback screen with a progress bar and a message that either said "Correct!" or "Oops. That answer was incorrect. Try again next time." depending on the participant's response.

Sentence Training

The sentence training paradigm was an intensive version of Wells et al., (2009) with four training blocks in a week. As with Wells et al., (2009), the training paradigm included separate scripts for the two participant groups: The Relative Clause experience group and the Control experience group. Wells et al., (2009) collected the relative clause training stimuli using automated searches through parsed corpora. As a result, the training stimuli were longer and much more variable than the testing stimuli. In the present study, the training stimuli were generated to have an identical form to the test stimuli (See Appendix B). The Relative Clause experience stimuli were 128 SRC/ORC sentence pairs divided into four training blocks with 32 sentence pairs each. As with the pre- and post-test, a Latin square design ensured that each participant only saw the SRC or ORC member of a pair. Also, as with the pre- and post-test sentences, the ORC/SRC training sentences included animate head and relative clause nouns. SRCs remained structured as *The noun that verbed the noun* and ORCs remained structured as *The noun that the noun verbed.* The Relative Clause experience stimuli also included 64 filler sentences divided into four separate training scripts with 16 sentences each. These fillers were evenly divided between two forms of conjoined sentences where the conjunction was in either the first clause (e.g., *Because the surgeon required the anesthesiologist, he objected to the plan for the operation.*) or second clause (e.g., *The watchmaker explained his work for several hours although it bored the customer.*).

The Control experience sentences consisted of 128 sentential complement/conjoined sentence pairs. Just as with the RC-training stimuli, the control training stimuli were divided into four separate training scripts with 32 sentences each. A Latin square design ensured that each participant only saw either the sentential complement or conjoined version of a given sentence pair. The control sentences were based on the SRC/ORC sentences. The sentential complement sentences shared their animate head nouns and embedded nouns with their SRC/ORC counterparts. Additionally, the main verbs of the sentential complements were the relative clause verbs of their SRC/ORC counterparts. The conjoined sentences shared the animate head nouns, embedded nouns, main verbs, and relative clause verbs of their SRC/ORC counterparts. The 64 Control training fillers were identical to those shown to the Relative Clause training group. As a result, the Control trained group encountered the same noun phrases and verbs as the Relative Clause trained group, so that any differences in experience would be the result of exposure to different syntactic arrangements. This is a potentially significant change from Wells et al., (2009).

Just as with the pre- and post-test, sentence training used an online self-paced reading paradigm and two-choice comprehension questions followed each sentence.

Procedure

Participants completed three online sessions in this study over one week. All participants were invited to join the study through Amazon's Mechanical Turk system. After signing-up, they received a link to the reading span task at the beginning of Session 1.

Session 1

Session 1 lasted approximately 55 minutes and asked participants to complete a reading span task, a relative clause sentence pre-test, and an initial training block with either SRC/ORC

or sentential complement/conjoined sentences. Participants received links to either the relative clause reading span task or control reading span task, although the tasks themselves were identical. At the beginning of the reading span task, participants reviewed on-screen instructions explaining that the task included two activities – a sentence comprehension activity and a letter recall activity – and that they would practice both activities separately and then simultaneously prior to starting the task.

Participants first practiced the letter recall activity. Before the first practice item, participants were instructed that they would see several letters appear one at a time on their computer screen. They were to remember the letters in order and type them into the box when it appeared. If the participants could not remember a letter, they were instructed to type a question mark. They were also told that upper case and lower case letters were acceptable and that they should not leave spaces between the letters. The participants then practiced the letter recall activity with two practice sets of three letters each.

Following the letter recall practice sets, participants practiced the sentence comprehension activity. Participants were instructed that they would see several sentences one at a time and that they were expected to decide if they made sense. If the sentence made sense, participants were to press *F*. If not, they were to press *J*. Participants were told that they would have five seconds to make their decision and that they would receive feedback based on their responses. Participants then saw an example of a sentence that made sense (*John likes to run in the park every day after work*) and one that did not make sense (*John likes to run in the bread every day after work*) before making their own sense-nonsense judgments with two practice sentences.

After the sentence comprehension practice, participants practiced both the letter recall activity and sentence comprehension activity simultaneously using two two-sentence sets that included a letter after each sentence and a letter recall prompt after each set.

Participants then completed the full reading span task. They proceeded from five three-sentence sets to five six-sentence sets sequentially with a comprehension question after each sentence and a letter recall task following each set. After each sentence, participants were given feedback on the accuracy of their sentence comprehension judgments. Following every letter recall task, participants were presented with a progress bar and a statement indicating the number of sentences in the next set. Participants completed all levels of the reading span task. Following completion of the reading span task, participants clicked on a link to begin the relative clause sentence pre-test.

Before beginning the relative clause sentence pre-test, participants were instructed that they would see a series of dashes on the computer screen and that they were to press the space bar to move from word to word through the sentence. Participants were urged to read at a comfortable pace. The participants were also told to press the space bar at the end of each sentence to reveal a question about the sentence they had just read. They were to answer the question as accurately as possible using either *F* for "yes" or *J* for "no" on their keyboard. After answering the question, participants were instructed that the next sentence would appear automatically. Participants completed several practice items before the pre-test began. The first two items presented dashed sentences, the second of which was followed by a two-choice comprehension question. Participants read these sentences and answered the question as appropriate. They then continued to read and respond to six additional practice questions that were designed like the experimental questions before starting the pre-test.

During the pre-test, participants read a series of 64 sentences that contained 12 SRCs, 12 ORCs, and 40 fillers. Participants completed a two-choice comprehension question after each sentence.

Following the pre-test, participants used another link to access their first training block. The participants were then instructed that they would complete a task that was the same as the one they had just completed. After completing four practice items, participants read and responded to 48 sentences. These included SRCs, ORCs, sentential complements, conjoined sentences, or fillers selected and presented at random for each participant based on their group assignment. Following the first training block, participants were informed that they had completed the first session and received compensation.

Session 2

Session 2 lasted approximately 25 minutes and occurred four days after Session 1. During the second session, participants completed two training blocks according to their group assignment. All items were presented as described above and participants used the provided link to proceed from their first to second training block within the session. Following the second of the two training blocks, participants were told that they had completed the second session and received compensation.

Session 3

Session 3 lasted approximately 35 minutes and occurred three days after Session 2. Participants began with their fourth and final training block as described above. After completing their training, participants used a link to access the relative clause sentence post-test. Unlike the pre-test, participants completed just four practice items. Apart from the practice items, the post-test proceeded like the pre-test. Participants read and responded to 12 SRCs, 12 ORCs, and 40

fillers selected at random. When the participants completed the post-test, they were informed that

they had completed the study and received compensation.

<div align="center">Results</div>

Individual word reading times less than 125 ms or greater than 4000 ms were trimmed

and replaced with 125 ms or 4000 ms, as appropriate. This affected <1% of the data. Two

participants were removed because more than 10% of their reading times were aberrant and had

to be adjusted in this way. Following these exclusions, the relative clause training group included

37 participants (20 female) with a mean age of 37, and the control training group included 45

participants (27 female) with a mean age of 38. Analyses were performed on word-length

adjusted residual reading times (Ferreira & Clifton, 1986). Following Wells et al., (2009),

individual residual reading times greater than three standard deviations from the mean value for

each word position and condition were removed from analysis. This affected <2% of the data.

For graphing, the relative clause sentences were divided into the regions of interest used

in Wells et al., (2009) as depicted in Figures 1 and 2 and into regions used by Grodner and

Gibson (2005) and Staub (2010) depicted in Figures 3 and 4.

SRC: The clerk that trained the | typist | told | the truth.
ORC: The clerk that the typist | trained | told | the truth.

Figure 1. Regions of interest for subject relative clause (SRC) and object relative clause (ORC) sentences from Wells et al., (2009). SRC Region 1 included the head noun, relative pronoun, relative clause verb, and determiner of the relative clause noun. ORC Region 1 included the head noun, relative pronoun, determiner of the relative clause noun, and the relative clause noun. Region 2 included either the relative clause noun for SRCs or the relative clause verb for ORCs. Region 3 included the main verb and Region 4 included the remaining words for both SRCs and ORCs.

Preliminary evaluation of length-adjusted reading times (ms) within three standard

deviations of the mean indicated several trends in our regions of interest (Figure 2).
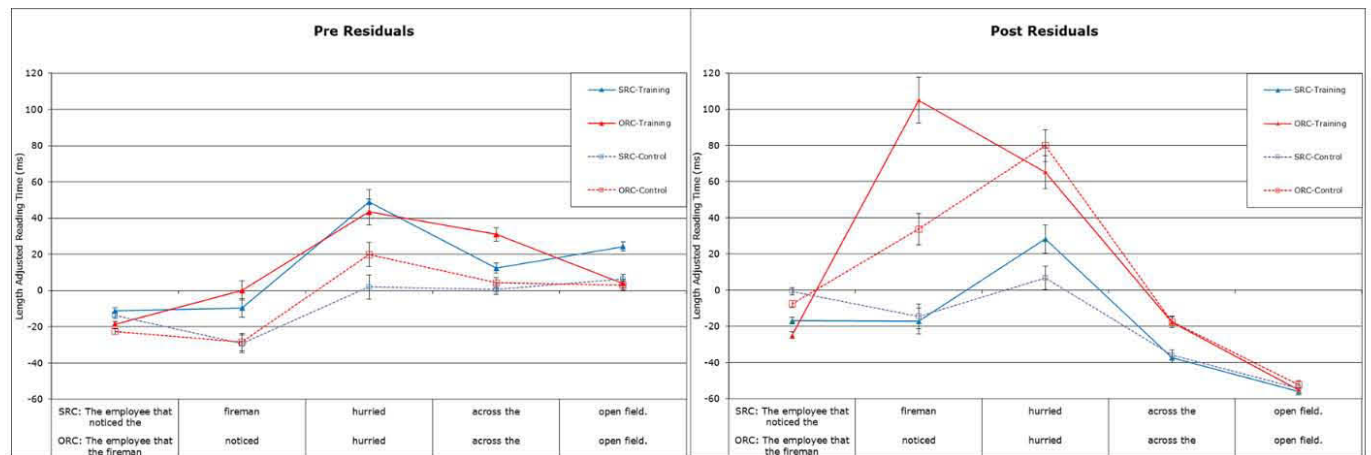
Figure 2. Length-adjusted reading times for SRC and ORC sentences pre- and post-test with regions of interest from Wells et al., (2009). The left graph displays performance before Relative Clause and Control training with SRCs and ORCs. The right graph displays performance after Relative Clause and Control training with SRCs and ORCs. All reading times fall within three standard deviations of the mean.

Analyses were performed using the latter set of regions: The relative clause noun phrase (e.g., *the fireman*), the relative clause verb (e.g., *noticed*), the main verb (e.g., *hurried*), and the spillover region (i.e., the two words following the main verb, such as *across the*). For each region, a 2x2x2 ANOVA was performed crossing the structure of the relative clause sentence (SRC or ORC), the session (pre-test or post-test), and the participant's training (RC or Control).

SRC: The employee | that | noticed| the fireman | hurried | across the | open field | …
ORC: The employee | that | the fireman | noticed | hurried | across the | open field | …

Figure 3. Regions of interest for subject relative clause (SRC) and object relative clause (ORC) sentences based on Staub (2010). SRC and ORC Region 1 included the head noun. SRC and ORC Region 2 included the relative pronoun *that*. SRC Region 3 included the relative clause verb and ORC Region 3 included the relative clause noun. SRC Region 4 included the relative clause noun and ORC Region 4 included the relative clause verb. SRC and ORC Regions 5-9 were identical.

By-participant analyses were conducted to determine if effects were generalizable to the population of adult English-speakers (F_1) and by-item analyses were conducted to determine if effects were generalizable to the population of relative clause sentences (F_2). The results of these analyses are depicted in Table 1.
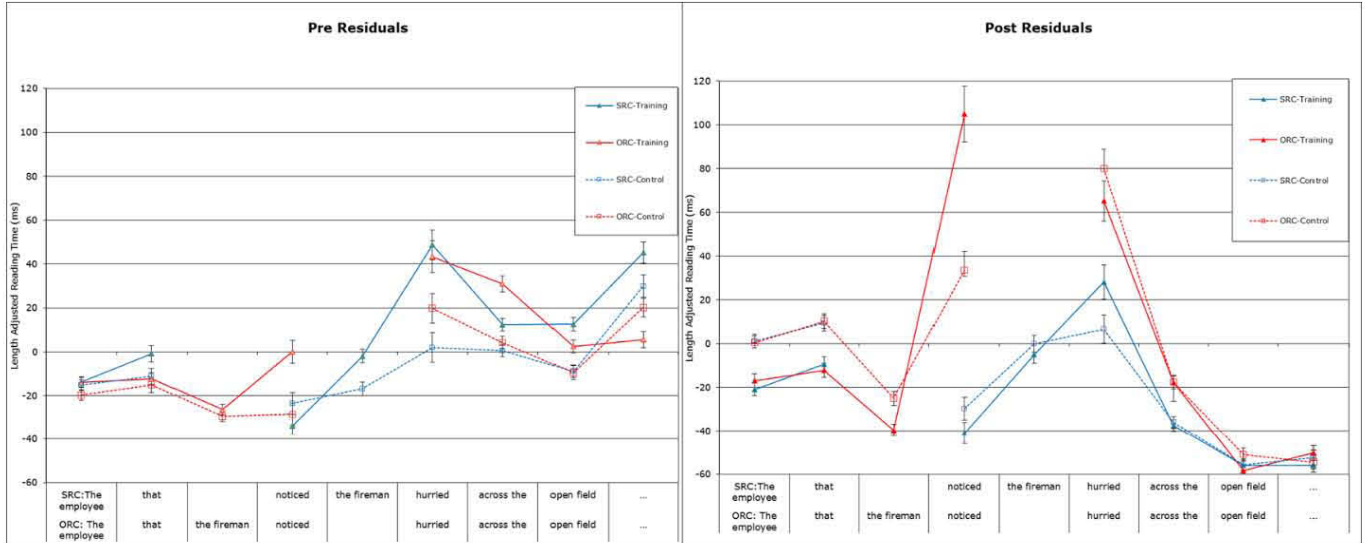
Figure 4. Length-adjusted reading times for SRC and ORC sentences pre- and post-test with regions of interest from Staub (2010). The left graph displays performance before Relative Clause and Control training with SRCs and ORCs. The right graph displays performance after Relative Clause and Control training with SRCs and ORCs. All reading times fall within three standard deviations of the mean.

Regions	Relative Clause NP	Relative Clause Verb	Main Verb	Spillover Region
	the fireman	noticed	hurried	across the
Factor				
Structure	$F_1(1,80) = 3.33$†; $F_2(1,46) = 2.62$	$F_1(1,80) = 16.7^{***}$; $F_2(1,46) = 95.8^{***}$	$F_1(1,80) = 22.2^{***}$; $F_2(1,46) = 44.4^{***}$	$F_1(1,80) = 49.2^{***}$; $F_2(1,46) = 43.9^{***}$
Session	$F_1(1,80) = 0.91$; $F_2(1,46) = 2.87$†	$F_1(1,80) = 6.44^*$; $F_2(1,46) = 18.7^{***}$	$F_1(1,80) = 0.42$; $F_2(1,46) = 1.92$	$F_1(1,80) = 23.0^{***}$; $F_2(1,46) = 35.6^{***}$
Training	$F_1(1,80) = 0.09$; $F_2(1,46) = 0.10$	$F_1(1,80) = 1.55$; $F_2(1,46) = 3.57$†	$F_1(1,80) = 1.03$; $F_2(1,46) = 3.79$†	$F_1(1,80) = 0.35$; $F_2(1,46) = 2.66$
Structure X Session	$F_1(1,80) = 0.15$; $F_2(1,46) = 0.17$	$F_1(1,80) = 9.08^{**}$; $F_2(1,46) = 37.2^{***}$	$F_1(1,80) = 2.98$†; $F_2(1,46) = 4.59^*$	$F_1(1,80) = 2.91$†; $F_2(1,46) = 1.24$
Structure X Training	$F_1(1,80) = 4.43^*$; $F_2(1,46) = 3.66$†	$F_1(1,80) = 1.49$; $F_2(1,46) = 10.8^{**}$	$F_1(1,80) = 0.26$; $F_2(1,46) = 3.97$†	$F_1(1,80) = 0.03$; $F_2(1,46) = 0.00$

Session X Training	$F_1(1,80) = 1.50$; $F_2(1,46) = 21.9$***	$F_1(1,80) = 0.05$; $F_2(1,46) = 0.10$	$F_1(1,80) = 0.95$; $F_2(1,46) = 1.45$	$F_1(1,80) = 1.33$; $F_2(1,46) = 7.11$*
Structure X Session X Training	$F_1(1,80) = 1.00$; $F_2(1,46) = 1.78$	$F_1(1,80) = 0.06$; $F_2(1,46) = 0.04$	$F_1(1,80) = 0.21$; $F_2(1,46) = 0.00$	$F_1(1,80) = 0.47$; $F_2(1,46) = 0.44$

Table 1. By participants (F_1) and by items (F_2) ANOVAs by sentence region. Key regions are the relative clause noun phrase, relative clause verb, main verb, and the spillover region (two words following the main verb). † = p<.10, *p < .05; ** p < .01; *** p < .001

Relative Clause NP

There was a marginally significant main effect of structure for participants ($F_1(1,80) = 3.33$, $p<.10$), indicating that SRCs were somewhat more difficult to process than ORCs at the relative clause noun phrase. This trend is the opposite of Staub's (2010) findings with eye-tracking. We also found a marginally significant effect of session for items ($F_2(1,46) = 2.87$, $p<.10$), whereby the noun phrase was more difficult to process in the post-test compared to the pre-test. This suggests that the post-test sentences were more difficult overall than the pre-test sentences. Indeed, the post-test lexical items were on the whole less frequent than the pre-test items. There was no main effect of training.

There was an interaction between structure and training ($F_1(1,80) = 4.43$, $p<.05$; $F_2(1,46) = 3.66$, $p<.10$), indicating that reading times at the ORC relative clause noun phrase were faster with relative clause training than control training. This result suggests that ORCs get easier with training. Note, however, that this is a small effect (< 10ms) and localized to the embedded noun phrase.

Additionally, there was an interaction between session and training (a trend by participants, but reliable for items: $F_2(1,46) = 21.9$, $p<.001$). This occurred because the embedded noun phrase was read slower by the training group in the pre-test, but was read faster in the post-test. One possible explanation for this is that training ameliorated the penalty of

reading the more difficult NPs in the post-test sentences. There were no other reliable interactions.

Relative Clause Verb

There was a highly significant main effect of structure by participants and by items ($F_1(1,80) = 16.7$, $p<.001$; $F_2(1,80) = 95.8$, $p<.001$), indicating that ORCs were more difficult to process than SRCs at the relative clause verb. This is consistent with the pattern of difficulty by sentence structure reported by Staub (2010) and indicates that the first major difficulty observed for ORCs is at the relative clause verb. There was also a highly significant main effect of session ($F_2(1,80) = 18.7$, $p<.001$) across the sentence items, with the post-test items again taking longer to read than the pre-test items. This provides further evidence for the post-test sentences being more difficult than the pre-test sentences.

There was a reliable interaction between structure and session ($F_1(1,80) = 9.08$, $p<.01$) that was extremely reliable for items ($F_2(1,80) = 37.2$, $p<.001$), indicating that ORCs took longer to read in the post-test than the pre-test. This result was likely driven by the main effect of session and post-test items being more difficult than pre-test items. No other interactions were reliable.

Main Verb

There was a highly significant main effect of structure by participant and by item ($F_1(1,80) = 22.2$, $p<.001$; $F_2(1,46) = 44.4$, $p<.001$). As with the relative clause verb, this indicated that the ORC sentences took longer to read and were more difficult to process. This is consistent with the reading time difference between ORCs and SRCs at the main verb reported by Wells et al., (2009).

There was also an interaction between structure and session that was marginally reliable by participants ($F_1(1,80) = 2.98$, $p<.10$) and reliable by items ($F_2(1,80) = 4.59$, $p<.05$). This interaction replicated Wells et al., (2009), which reported a reliable Session x Relative Clause Type interaction as evidence of an experience-based training effect. However, the interaction here was likely driven by the fact that the post-test items were still more difficult than the pre-test items at the main verb. No other interactions were reliable, including the three-way Structure x Session x Training interaction reported by Wells et al., (2009) in support of a training effect.

Spillover Region

There were highly significant main effects of structure ($F_1(1,80) = 49.2$, $p<.001$; $F_2(1,46) = 43.9$, $p<.001$) and session ($F_1(1,80) = 23.0$, $p<.001$; $F_2(1,46) = 35.6$, $p<.001$). As before, these effects respectively indicated that ORCs took longer and were more difficult to process than SRCs and that our post-test sentences were more difficult to process than our pre-test sentences.

As at the main verb, there was also a marginally reliable interaction between structure and session ($F_1(1,80) = 2.91$, $p<.10$) However, the interaction may be a remaining effect of our post-test sentences being more difficult than our pre-test sentences. No other interactions were reliable.

Discussion

This study provided evidence for roles of both experience and memory in relative clause sentence processing. The experience-based model hypothesizes that a training effect will initially appear at the ORC noun phrase, but then persist across other regions of interest as processing becomes easier through the entire relative clause (Wells et al., 2009; Grodner & Gibson, 2005). Our results partially supported this hypothesis, as we found a reliable interaction between structure and training at the relative clause noun phrase that indicated a training effect.

Specifically, participant's reading times at that locus were faster with Relative Clause training than Control training. However, as described below, the training effect did not persist through the relative clause as predicted.

Turning to the memory-based model (Grodner & Gibson, 2005), it proposes that the difficulty of ORC sentence processing stems from working memory constraints that make processing a challenge. The model predicts a training effect exclusively at the relative clause noun phrase. By contrast, any training effect at the relative clause verb is prohibited by the memory difficulty of pairing the relative clause verb with the main subject of the sentence that serves as its object. Our results support these predictions of the memory-based model. As noted above, there was a training effect that was localized to the relative clause noun phrase. At the relative clause verb, participant's ORC reading times were greater than their SRC reading times. Furthermore, the main effect of structure was exacerbated by training to produce a reverse training effect, such that ORC reading times were still greater following relative clause training over control training. Lastly, Wells et al., (2009) reported a reliable Structure x Session x Training interaction at the main verb as key support for the experience-based view of relative clause processing, but we failed to replicate that interaction in the present study.

In combination, these results from the relative clause noun phrase and relative clause verb reflect a limited role of experience in relative clause processing. While a training effect appeared at the relative clause noun phrase, it was not present throughout the sentence, pointing to unavoidable memory constraints that continued to limit ORC sentence processing (Grodner & Gibson, 2005).

Considering why the present study failed to replicate Wells et al., (2009), there were a number of differences that may have contributed. First, Wells and colleagues only analyzed pre-

test and post-test trials where participants answered the comprehension question correctly. This eliminated a substantial proportion of their data after they had already eliminated participants with <75% accuracy rates on their comprehension questions. This raises an important question regarding the generalizability of Wells et al., (2009)'s results, given that they seem to apply only to the highest-performing participants on their best-performing trials. By contrast, as is standard, we included all trial data from participants above the accuracy threshold.

Another important difference was that Wells et al. exposed participants to five training blocks over four sessions with four to eight days between each session, but we used four training blocks over three sessions with two to four days between each session. It could be argued that the fifth experience block is necessary to push participants over some threshold of relative clause adaptation that selectively affects the verb. On the other hand, the present training stimuli were less variable than Wells et al., (2009) and our training took place over a shorter time span. Wells et al., (2009)'s four to eight day scheduling structure was intended to avoid immediate priming effects from the experience manipulation to the post-test. The present study was meant to be deliberately intensive in order to maximize training effects if present. It is unclear whether this intensive format is more influential or whether an additional experience block would be. A follow up study is currently collecting data to investigate this issue by including a fifth training block. In any case, note that there was an interaction between structure and training at the relative clause noun phrase. This indicates that even with four training blocks, the training manipulation had some effect.

Another potential difference pertains to the stimuli in the present study. The results repeatedly indicated that participants took longer to read the post-test sentences than the pre-test sentences. In this way, they demonstrated a reverse practice effect that was inconsistent with

their training. Further inspection of the pre-test and post-test stimuli using the *English Lexicon Project* database (Balota et al., 2007) revealed that the pre-test relative clause nouns had a mean log(frequency) of 8.92, while the post-test relative clause nouns had a mean log(frequency) of 7.88. Meanwhile, the pre-test relative clause verbs had a mean log(frequency) of 8.99, while the post-test relative clause verbs had a mean log(frequency) of 7.31. Based on these findings, a follow-up to this study will counterbalance the pre-test and post-test items to determine if more significant training effects are then produced at the relative clause noun phrase, relative clause verb, or main verb.

Another issue is that the participants in the relative clause training group had longer SRC and ORC reading times overall even in the pre-test alone ($Fs>4$, $ps< .01$). This disparity could be explained by differences in reading ability between the groups. Wells et al., (2009) conducted a reading span task in the first session of their study and found no significant difference in the reading span scores between the relative clause training group and the control training group. This indicated that the two groups were matched for reading (i.e., verbal working memory) ability. Wells et al., (2009) also analyzed the ACT standardized test scores of their participants, and found that the two training groups matched on academic performance. However, our reading span task indicated that participants in the control training group were better readers than those in the relative clause training group, suggesting that the relative clause trained participants may have found the task particularly difficult. We also did not collect academic assessment data from our participants, so they may have been unevenly matched on academic performance. A follow-up analysis could not be completed due to lack of time, but will remove a random set of participants with the highest reading span scores from the control training group to ensure that

the training groups are better matched before their relative clause sentence reading times are reevaluated.

Beyond methodological improvements, we will aim to replicate this training study using eye-tracking based on Staub (2010). As described previously, Staub (2010) found different eye movements associated with the relative clause noun phrase and relative clause verb. At the noun phrase, participants were more likely to regress to a previous portion of the sentence, while the relative clause verb was associated with increased reading time. Staub (2010) reported that these eye movements represented distinct cognitive processes that were linked through their respective locations along the relative clause sentences to the experience-based and memory-based explanations for ORC processing. Applying Wells et al.,'s (2009) training paradigm to this study would further address effects of experience and memory on ORC sentence processing. Using eye-tracking, we would replicate this study, examining how reading times change with experience between the relative clause noun phrase and relative clause verb. More importantly, we could then evaluate any regional changes in the type, frequency, or duration of eye movement as a window onto experience-based changes in the cognitive processes underlying relative clause sentence processing.

Another interesting avenue for future investigation could be the role of feedback. While the feedback that participants received when responding to the two-choice comprehension questions did not vary here, the educational psychology literature points to the power of implicit "failure priming" – a social psychological phenomenon similar to stereotype threat - to adversely influence student behavior (Schuler, Barndstatter, & Baumann, 2015). For example, the color red and the letter F are common "failure primes," and brief exposure to them has been found to negatively impact student assessment performance, or increase avoidance behavior, before an

assessment (Ciani & Sheldon, 2010; Elliot, Maier, Binser, Friedman, & Pekrun, 2009; Elliot et al., 2007). Given the relationship between stereotype threat and "failure priming," Schmader, Johns, & Forbes (2008) propose that the adverse effects of stereotype threat result from a redirection of limited working memory resources from the task at hand to the salient stereotype. Thus, it is possible that "failure priming" also functions through working memory. To investigate this hypothesis, the training paradigm applied here could be altered to include red feedback during the training sessions. If participant's reading times after the relative clause noun phrase increase further when exposed to red feedback versus neutral-colored feedback, then the results would demonstrate that the feedback influences working memory, which ultimately impairs ORC sentence processing. Based on these results, educators could alter the color of feedback they provide to avoid "failure priming" their students.

Moving forward, the self-paced reading and training paradigm in this study could be replicated with other complex English sentences, such as idiomatic expressions (Cooper, 1999) and metaphors (Dong, 2004). Such studies would illuminate key regions of processing difficulty for native English speakers and English Language Learners, enabling psychological and educational researchers to develop sentence-level pedagogical approaches to improve student's comprehension and processing of idioms and metaphors.

<div align="center">Acknowledgements</div>

Appendix A

All sentence stimuli presented in the relative clause sentence processing pre-test are listed below by sentence type:

SRC/ORC Pairs (SRCs listed first)
The employee that noticed the fireman hurried across the open field.
The employee that the fireman noticed hurried across the open field.
The bus driver that followed the kids wondered if they were lost.
The bus driver that the kids followed wondered if they were lost.
The chef that distracted the cameraman poured the flour onto the counter.
The chef that the cameraman distracted poured the flour onto the counter.
The children that woke the father bothered him about the trip to the beach.
The children that the father woke bothered him about the trip to the beach.
The class that disliked the teacher skimmed the reading for the week.
The class that the teacher disliked skimmed the reading for the week.
The dancer that loved the audience ignored some very basic principles.
The dancer that the audience loved ignored some very basic principles.
The farmer that approached the customers lifted the chickens from their coop.
The farmer that the customers approached lifted the chickens from their coop.
The farmer that hired the rancher planted the seeds in long rows.
The farmer that the rancher hired planted the seeds in long rows.
The fireman that called the residents attacked the house with high-powered hoses.
The fireman that the residents called attacked the house with high-powered hoses.
The girl that watched the infant chose to read a book during his afternoon nap.
The girl that the infant watched chose to read a book during his afternoon nap.
The investigator that phoned the agency considered Mrs. Reynolds from accounting.
The investigator that the agency phoned considered Mrs. Reynolds from accounting.
The judge that addressed the witnesses noticed the defense attorneys whispering.
The judge that the witnesses addressed noticed the defense attorneys whispering.
The manager that visited the boss remembered some particularly inconvenient facts.
The manager that the boss visited remembered some particularly inconvenient facts.
The mathematician that visited the chairman created a solution to the well known problem.
The mathematician that the chairman visited created a solution to the well known problem.
The monkey that watched the zookeeper charged the bars of their cage.
The monkey that the zookeeper watched charged the bars of their cage.
The movie star that visited the organizers proposed an annual prize for the winner of the contest.
The movie star that the organizers visited proposed an annual prize for the winner of the contest.
The neighbor that observed the couple purchased the old Victorian house.
The neighbor that the couple observed purchased the old Victorian house.
The pilot that delayed the ground crew remained on the runway for a long time.
The pilot that the ground crew delayed remained on the runway for a long time.
The soldier that helped the natives climbed the big rock that blocked the path.
The soldier that the natives helped climbed the big rock that blocked the path.
The singer that introduced the composer promised an entertaining show for all.
The singer that the composer introduced promised an entertaining show for all.
The trainer that called the jockey rubbed the horse's skin before a race.
The trainer that the jockey called rubbed the horse's skin before a race.

The veteran that admired the coach appreciated the respect he showed opponents.
The veteran that the coach admired appreciated the respect he showed opponents.
The visitor that introduced the student walked across the academic quad.
The visitor that the student introduced walked across the academic quad.
The doctor that met_with the patient performed surgery on him this morning.
The doctor that the patient met_with performed surgery on him this morning.

Multiple Preposition Fillers
The bush by the cemetery tower with the steep stairs was pruned by the groundskeeper.
The table inside the math classroom near the school cafeteria was repaired by the carpenter.
The book about the fantasy world with the evil wizard was criticized by the reviewer.
The window above the flower garden with the blossoming roses was broken by the child.
The lamp beside the Italian restaurant in the shopping plaza was removed by the electrician.
The paper about the elementary school near the toxic factory was written by the pediatrician.
The plant under the office window with the cracked pane was watered by the secretary.
The clipboard beneath the workbook with the math problems was used by the teacher.
The chair against the back wall between the basketball hoops was taken by the coach.
The sink underneath the kitchen cabinet above the noisy dishwasher was cleaned by the housekeeper.

Multiple Preposition-Simple Subject Fillers
The flower impressed the visitor outside the large greenhouse inside the botanical garden.
The costume frightened the toddler during the Halloween party at the community center.
The story engaged the child despite the animated game on the miniature tablet.
The festival celebrated the hero of the great war for the country's independence.
The music reminded the runner of the annual marathon around the nearby lake.
The notice informed the tenant of their impending eviction from the apartment building.
The alarm startled the firefighter next to the fire station near the town library.
The poem inspired the prisoner inside the cold cell on the isolated island.
The snack energized the client during the boring meeting about the contract negotiation.
The letter addressed the president of the phone company after the rate increase.

Sentential Complements
The editor noticed that the reporter attacked the politician for taking campaign donations from oil companies.
The boy figured out that his parents watched to see if he was skipping school.
The lions knew that the ringmaster observed each time they leaped through the hoops of fire.
The jogger thought that the couple observed the kids rather critically.
The shipping company claimed that the box came with the dent already in it.
The student decided that the professor graded the paper against very high standards.
The bystander reported that the spy recognized the van driven by the elite undercover agent.
The officer indicated that the victim identified the jewelry when she claimed it at the station.
The salesman understood that the lady brought a valuable necklace into his antique shop.
The instructor explained that the historian studied the painting for many years to identify its maker.
The woman revealed that the judge selected her family recipe as the winner of the fourth annual pie baking contest.
The construction worker noticed that the bricklayer lifted heavy bricks for nearly ten hours every day at work.
The executive realized that the advertiser wanted every client with over two million dollars in revenue.

The scientist discovered that the class loved the textbook with the colorful diagrams of chemical processes.
The criminal learned that the guards transported the gold to the underground vault at five o'clock every evening.
The mayor disclosed that the terrorist attacked the power plant using a powerful computer virus.
The supplier said that the foreman requested the equipment several weeks before construction was to begin.
The manager misunderstood that the secretary expected the package to arrive after just one day.
The commander announced that the enemy captured the valley in a strategically important part of the country.
The maid worried that the cat scratched the sofa by the famous European designer.

All sentence stimuli presented in the relative clause sentence processing post-test are listed below by sentence type:

SRC/ORC Pairs (SRCs listed first in each pair)
The clerk that trained the typist told the truth about the missing files.
The clerk that the typist trained told the truth about the missing files.
The critic that bothered the musician disregarded his most recent concert in the article.
The critic that the musician bothered disregarded his most recent concert in the article.
The grader that corrected the individual contacted the professor via email.
The grader that the individual corrected contacted the professor via email.
The pioneer that guided the geographer revealed a new mountain range.
The pioneer that the geographer guided revealed a new mountain range.
The garbageman that contradicted the employer damaged his reputation beyond repair.
The garbageman that the employer contradicted damaged his reputation beyond repair.
The historian that accommodated the playwright sought to review the play with an open mind.
The historian that the playwright accommodated sought to review the play with an open mind.
The administrator that battled the worker resigned from her post today.
The administrator that the worker battled resigned from her post today.
The housekeeper that burdened the gentleman transferred to a different house.
The housekeeper that the gentleman burdened transferred to a different house.
The hacker that blamed the dictator maintained his innocence at trial.
The hacker that the dictator blamed maintained his innocence at trial.
The presenter that puzzled the interpreter mumbled during his speech to foreign students.
The presenter that the interpreter puzzled mumbled during his speech to foreign students.
The musician that entertained the comedian traded stories with him after the show.
The musician that the comedian entertained traded stories with him after the show.
The knight that discussed the prince earned a prize for bravery.
The knight that the prince discussed earned a prize for bravery.
The janitor that begged the manufacturer secured a great deal on cleaning supplies.
The janitor that the manufacturer begged secured a great deal on cleaning supplies.
The jeweler that envied the shopkeeper yearned for greater financial success.
The jeweler that the shopkeeper envied yearned for greater financial success.
The knitter that hugged the shepherd treasured all the wool that he got from the shepherd's flock.
The knitter that the shepherd hugged treasured all the wool that he got from the shepherd's flock.
The surveyor that insulted the commissioner sued him and the entire parks department.
The surveyor that the commissioner insulted sued him and the entire parks department.

The legislator that interrupted the demonstrator misstated what occurred during the controversial hearing.
The legislator that the demonstrator interrupted misstated what occurred during the controversial hearing.
The locksmith that pitied the tenant reasoned that he would find a new job.
The locksmith that the tenant pitied reasoned that he would find a new job.
The paralegal that recorded the consultant violated their confidentiality agreement.
The paralegal that the consultant recorded violated their confidentiality agreement.
The secretary that resented the dean lasted only three months in her position.
The secretary that the dean resented lasted only three months in her position.
The beautician that stalked the celebrity terminated their professional relationship immediately.
The beautician that the celebrity stalked terminated their professional relationship immediately.
The marketer that undermined the competitor altered his quarterly sales goals.
The marketer that the competitor undermined altered his quarterly sales goals.
The bride that kissed the groom honored her late father during the ceremony.
The bride that the groom kissed honored her late father during the ceremony.
The aide that amused the grandfather canceled last Thursday afternoon's appointment.
The aide that the grandfather amused canceled last Thursday afternoon's appointment.

Multiple Preposition Fillers
The box inside the storage room with the musty odor was opened by the secretary.
The trumpet in the instrument case outside the recital hall was played by the musician.
The eyeglasses by the bedside table against the blue wall were purchased by the gentleman.
The pencil within the plastic container near the pencil sharpener was favored by the illustrator.
The pool beneath the fitness center with the new equipment was visited by the athlete.
The toaster on the kitchen counter with the food stain was acquired by the tenant.
The boat for the fishing club near the marina was restored by the captain.
The wallet beside the car key on the beaded keychain was returned by the cashier.
The toy beneath the car seat with the gray fabric was located by the mother.
The shirt inside the dresser drawer with the brass handle was worn by the businessman.

Multiple Preposition-Simple Subject Fillers
The article informed the reader about the exciting discovery in the psychology department.
The painting interested the viewer at the art museum despite the gallery renovations.
The meal pleased the diner at the Italian restaurant until the terrible dessert.
The weather inconvenienced the swimmer in the outdoor pool during the heavy rainstorm.
The trip disoriented the traveler due to the time difference in the new country.
The forest stunned the hiker despite the light rain throughout the long trip.
The newspaper advertised the house below the railway bridge next to the rocky beach.
The television announced the premiere of the acclaimed drama about the British king.
The toll irritated the driver despite the numerous potholes along the main highway.
The magazine occupied the commuter during the long ride on the commuter train.

Sentential Complements
The trainer thought that the jockey called for assistance too often.
The veteran knew that the coach admired the way he tutored the younger players.
The visitor said that the student introduced her at the cocktail party before the awards dinner.
The witness observed that the lawyer asked very difficult questions during cross examination.

The bus driver said that the kids followed him all the way to the school.
The chef knew that the cameraman distracted the guest on the show.
The children heard that the father woke their grandmother for the party.
The class knew that the teacher disliked certain twentieth century writers from Britain and the United States.
The dancer saw that the audience loved the last movement of the performance.
The employees hoped that the fireman noticed the people who were still in the building.
The farmer saw that the customers approached the horse in the pasture.
The farmer reported that the rancher hired too many seasonal workers for the size of his ranch.
The firemen recognized that the residents called the fire station in a panic.
The investigator knew that the agency phoned the client because of the unpaid bills.
The judge heard that the witnesses addressed the defense attorneys by name.
The manager thought that the boss visited every second Tuesday of the month.
The mathematician recalled that the chairman visited their German colleagues in May.
The movie star hoped that the organizers visited his favorite charity with the donations.
The pilot misheard that the ground crew delayed the flight intentionally.
The soldiers thought that the natives helped the enemy hide in the jungle.

Appendix B

All sentence stimuli presented in the Relative Clause training sessions are listed below by sentence type:

SRC/ORC Pairs (SRCs listed first in each pair)
RC1
The hiker that found the ranger asked for assistance with a rescue operation.
The hiker that the ranger found asked for assistance with a rescue operation.
The journalist that contacted the editor published an exclusive news story.
The journalist that the editor contacted published an exclusive news story.
The hunter that encountered the backpacker traveled many miles to a cabin.
The hunter that the backpacker encountered traveled many miles to a cabin.
The librarian that helped the professor ordered new books about science.
The librarian that the professor helped ordered new books about science.
The classmate that startled the boy tried to stay quiet during the test.
The classmate that the boy startled tried to stay quiet during the test.
The mechanic that talked_with the motorist fixed the car's engine and transmission.
The mechanic that the motorist talked_with fixed the car's engine and transmission.
The detective that met the woman solved the extremely difficult case.
The detective that the woman met solved the extremely difficult case.
The policemen that threatened the suspect drove him to the county jail.
The policemen that the suspect threatened drove him to the county jail.
The student that surprised the teacher made noise in the classroom.
The student that the teacher surprised made noise in the classroom.
The man that mentored the student instructed him to keep in touch after their last meeting.
The man that the student mentored instructed him to keep in touch after their last meeting.

The minister that counseled the colleague prepared his own sermon for Sunday morning.

The minister that the colleague counseled prepared his own sermon for Sunday morning.

The kid that helped the mother shoveled snow from the driveway.

The kid that the mother helped shoveled snow from the driveway.

The conductor that greeted the patrons demonstrated great skill and expertise during the performance.

The conductor that the patrons greeted demonstrated great skill and expertise during the performance.

The actor that mocked the star struggled_with his own role in the film.

The actor that the star mocked struggled_with his own role in the film.

The waiter that commended the bartender helped several thousand customers during his long career.

The waiter that the bartender commended helped several thousand customers during his long career.

The boater that rescued the swimmer served as a lifeguard at the town pool.

The boater that the swimmer rescued served as a lifeguard at the town pool.

The researcher that quoted the author studied British literature from the Victorian era.

The researcher that the author quoted studied British literature from the Victorian era.

The associate that questioned the intern appreciated her own experience in the field.

The associate that the intern questioned appreciated her own experience in the field.

The supervisor that phoned the vendor inquired about a recent order.

The supervisor that the vendor phoned inquired about a recent order.

The architect that valued the client suggested a few ideas for the new house.

The architect that the client valued suggested a few ideas for the new house.

The athlete that praised the coach congratulated him on his recent victory.

The athlete that the coach praised congratulated him on his recent victory.

The politician that engaged the voter conceded defeat after a challenging campaign.

The politician that the voter engaged conceded defeat after a challenging campaign.

The cyclist that encouraged the jogger cheered for him during a ten-mile race.

The cyclist that the jogger encouraged cheered for him during a ten-mile race.

The gardener that admired the woman planted new flowers for summertime.

The gardener that the woman admired planted new flowers for summertime.

The publisher that spoke to the blogger wanted a very interesting story.

The publisher that the blogger spoke to wanted a very interesting story.

The trucker that honked at the driver arrived five hours earlier than expected.

The trucker that the driver honked at arrived five hours earlier than expected.

The acrobat that teased the clowns fell over during a circus performance.

The acrobat that the clowns teased fell over during a circus performance.

The landlord that met_with the plumber mentioned a broken pipe and water damage.

The landlord that the plumber met_with mentioned a broken pipe and water damage.

The maid that married the butler celebrated their fifteenth anniversary at a restaurant.

The maid that the butler married celebrated their fifteenth anniversary at a restaurant.

The agent that contacted the informant desired additional information about the robbery.

The agent that the informant contacted desired additional information about the robbery.

The fisherman that located the sailor capsized his fishing boat in stormy seas.

The fisherman that the sailor located capsized his fishing boat in stormy seas.

The technician that attacked the supervisor apologized for his inappropriate behavior.
The technician that the supervisor attacked apologized for his inappropriate behavior.

RC2
The director that liked the actress imagined a wonderfully successful film.
The director that the actress liked imagined a wonderfully successful film.
The general that informed the lieutenant worried about secret enemy plans.
The general that the lieutenant informed worried about secret enemy plans.
The repairman that knew the supplier anticipated a special discount on parts.
The repairman that the supplier knew anticipated a special discount on parts.
The biographer that recalled the novelist included several quotes in her book.
The biographer that the novelist recalled included several quotes in her book.
The parent that honored the teacher remembered her son's amazing experience in fourth-grade.
The parent that the teacher honored remembered her son's amazing experience in fourth-grade.
The spectators that witnessed the athlete filled an entire football stadium.
The spectators that the athlete witnessed filled an entire football stadium.
The benefactor that met_with the scientist praised his discoveries in medical research.
The benefactor that the scientist met_with praised his discoveries in medical research.
The host that pointed_to the busboy mistook him for an old friend from school.
The host that the busboy pointed_to mistook him for an old friend from school.
The mayor that hosted the governor managed a prosperous major city.
The mayor that the governor hosted managed a prosperous major city.
The electrician that hit the foreman avoided any reprecussions for his actions.
The electrician that the foreman hit avoided any reprecussions for his actions.
The artist that adored the sculptor selected several pieces to purchase after a recent exhibition.
The artist that the sculptor adored selected several pieces to purchase after a recent exhibition.
The landscaper that recognized the homeowner waved_to her at the grocery store.
The landscaper that the homeowner recognized waved_to her at the grocery store.
The senator that supported the President presented him with a defense bill to sign.
The senator that the President supported presented him with a defense bill to sign.
The spokesman that emailed the reporter advocated on behalf of the company in response to the inquiry.
The spokesman that the reporter emailed advocated on behalf of the company in response to the inquiry.
The pitcher that struck the batter left the game two innings early.
The pitcher that the batter struck left the game two innings early.
The grandmother that understood the grandson realized what was about to happen.
The grandmother that the grandson understood realized what was about to happen.
The admiral that advised the diplomat acknowledged possible consequences of an attack.
The admiral that the diplomat advised acknowledged possible consequences of an attack.
The teenager that tormented the sibling relaxed in front of the TV.
The teenager that the sibling tormented relaxed in front of the TV.
The rescuer that taught the explorer enjoyed a lot of time outdoors.
The rescuer that the explorer taught enjoyed a lot of time outdoors.
The warden that controlled the prisoner sparked an enormous and dangerous brawl.
The warden that the prisoner controlled sparked an enormous and dangerous brawl.
The trustee that backed the executive attended an important business meeting.
The trustee that the executive backed attended an important business meeting.

The petsitter that befriended the veterinarian promoted several major discounts for pet owners.
The petsitter that the veterinarian befriended promoted several major discounts for pet owners.
The CEO that asked the analyst searched for information about market activity.
The CEO that the analyst asked searched for information about market activity.
The assistant that requested the messenger delivered five boxes of files.
The assistant that the messenger requested delivered five boxes of files.
The psychologist that consulted the psychiatrist decided on a new form of therapy.
The psychologist that the psychiatrist consulted decided on a new form of therapy.
The coach that angered the player reconsidered his position on the team.
The coach that the player angered reconsidered his position on the team.
The developer that queried the engineer conceived of a new design for the building.
The developer that the engineer queried conceived of a new design for the building.
The inventor that reached the investor faced challenges implementing their ideas.
The inventor that the investor reached faced challenges implementing their ideas.
The illustrator that assisted the poet offered quality work for a reasonable price.
The illustrator that the poet assisted offered quality work for a reasonable price.
The man that assaulted the commuter encountered surprisingly few consequences for his actions.
The man that the commuter assaulted encountered surprisingly few consequences for his actions.
The mailman that chased the robber caught him on a sidewalk.
The mailman that the robber chased caught him on a sidewalk.
The protester that confronted the Congressman escaped arrest by local police.
The protester that the Congressman confronted escaped arrest by local police.

RC3
The astronaut that invited the biologist investigated bacteria on other planets.
The astronaut that the biologist invited investigated bacteria on other planets.
The operator that warned the inspector prevented a dangerous equipment failure.
The operator that the inspector warned prevented a dangerous equipment failure.
The citizens that tracked the spy alerted several important government officials.
The citizens that the spy tracked alerted several important government officials.
The troops that captured the terrorist finished their top secret mission.
The troops that the terrorist captured finished their top secret mission.
The advertiser that convinced the producer outlined a new and innovative idea.
The advertiser that the producer convinced outlined a new and innovative idea.
The curator that despised the designer banned all future contact and collaboration.
The curator that the designer despised banned all future contact and collaboration.
The guard that frustrated the inmate attempted to remove him from the jail.
The guard that the inmate frustrated attempted to remove him from the jail.
The lumberjack that aggravated the forester forced himself to engage in friendly conversation.
The lumberjack that the forester aggravated forced himself to engage in friendly conversation.
The chemist that inspired the biologist wrote a new biochemistry textbook last year.
The chemist that the biologist inspired wrote a new biochemistry textbook last year.
The banker that challenged the broker misunderstood the latest market trends.
The banker that the broker challenged misunderstood the latest market trends.
The scholar that researched the philosopher interpreted his work in a new way.
The scholar that the philosopher researched interpreted his work in a new way.
The golfer that beat the pro won the celebrated state championship.
The golfer that the pro beat won the celebrated state championship.

The performer that respected the writer opposed the controversial novel.
The performer that the writer respected opposed the controversial novel.
The speaker that coached the councilman delivered an inspiring speech at the rally.
The speaker that the councilman coached delivered an inspiring speech at the rally.
The baker that joined the caterer opened a new business together.
The baker that the caterer joined opened a new business together.
The skateboarder that hated the champion retired from skateboarding after an injury.
The skateboarder that the champion hated retired from skateboarding after an injury.
The deputy that shot the attacker died from his own severe injuries.
The deputy that the attacker shot died from his own severe injuries.
The servant that complimented the king strolled across the castle grounds.
The servant that the king complimented strolled across the castle grounds.
The skier that annoyed the snowboarder departed the ski resort at the end of the day.
The skier that the snowboarder annoyed departed the ski resort at the end of the day.
The exterminator that aided the groundskeeper killed several hundred bees under a park bench.
The exterminator that the groundskeeper aided killed several hundred bees under a park bench.
The outlaw that wrestled the sheriff evaded capture for five years.
The outlaw that the sheriff wrestled evaded capture for five years.
The beggar that harassed the pedestrian needed support from social services.
The beggar that the pedestrian harassed needed support from social services.
The astronomer that credited the physicist heard an engaging lecture.
The astronomer that the physicist credited heard an engaging lecture.
The brother that comforted the sister mourned the loss of their pet cat.
The brother that the sister comforted mourned the loss of their pet cat.
The captain that saluted the sergeant led troops into a dangerous battle.
The captain that the sergeant saluted led troops into a dangerous battle.
The gamer that thanked the animator began his speech at the national video game conference.
The gamer that the animator thanked began his speech at the national video game conference.
The model that idolized the photographer posed for over eight thousand pictures.
The model that the photographer idolized posed for over eight thousand pictures.
The victim that accompanied the volunteer indicated how his home was damaged by the hurricane.
The victim that the volunteer accompanied indicated how his home was damaged by the hurricane.
The ballerina that critiqued the choreographer argued for her own interpretation of the new piece.
The ballerina that the choreographer critiqued argued for her own interpretation of the new piece.
The groomer that irritated the dog used extra strength canine shampoo.
The groomer that the dog irritated used extra strength canine shampoo.
The gymnast that defeated the rival acquired a very lucrative endorsement deal.
The gymnast that the rival defeated acquired a very lucrative endorsement deal.
The activist that assailed the bystander asserted the validity of his own opinion.
The activist that the bystander assailed asserted the validity of his own opinion.

RC4
The trainee that promoted the instructor awaited her exercise class each week.
The trainee that the instructor promoted awaited her exercise class each week.
The realtor that antagonized the buyer dreaded each meeting they scheduled.
The realtor that the buyer antagonized dreaded each meeting they scheduled.
The barber that favored the grocer chatted with everyone in their small community.
The barber that the grocer favored chatted with everyone in their small community.

The monitor that beckoned the toddler hoped to point out something interesting.
The monitor that the toddler beckoned hoped to point out something interesting.
The guardsman that trusted the officer assumed that he would be kept safe.
The guardsman that the officer trusted assumed that he would be kept safe.
The lady that paid the man negotiated a much lower price first.
The lady that the man paid negotiated a much lower price first.
The anchorman that disrupted the meteorologist coughed uncontrollably throughout the morning news show.
The anchorman that the meteorologist disrupted coughed uncontrollably throughout the morning news show.
The archaeologist that tolerated the geologist collaborated together on research at the excavation site.
The archaeologist that the geologist tolerated collaborated together on research at the excavation site.
The announcer that applauded the owner aspired to provide as many years of service to the baseball team.
The announcer that the owner applauded aspired to provide as many years of service to the baseball team.
The auditor that notified the counsel evaluated the company's financial documents.
The auditor that the counsel notified evaluated the company's financial documents.
The babysitter that amazed the baby envisioned life as a teacher.
The babysitter that the baby amazed envisioned life as a teacher.
The grocer that dialed the butcher employed a different meat supplier.
The grocer that the butcher dialed employed a different meat supplier.
The carpenter that embraced the apprentice established a training program.
The carpenter that the apprentice embraced established a training program.
The chauffeur that expected the dignitary waited out on the tarmac at the airport.
The chauffeur that the dignitary expected waited out on the tarmac at the airport.
The cosmetologist that extorted the customer hid her activities for nearly a decade.
The cosmetologist that the customer extorted hid her activities for nearly a decade.
The machinist that excited the craftsman introduced a new furniture design.
The machinist that the craftsman excited introduced a new furniture design.
The coroner that recruited the expert aimed to solve a challenging cold case.
The coroner that the expert recruited aimed to solve a challenging cold case.
The chiropractor that frequented the acupuncturist extolled the virtues of alternative medicine.
The chiropractor that the acupuncturist frequented extolled the virtues of alternative medicine.
The cashier that suspected the stockboy turned important information over to store management after a theft.
The cashier that the stockboy suspected turned important information over to store management after a theft.
The dispatcher that reached the cab driver encouraged travel on the expressway.
The dispatcher that the cab driver reached encouraged travel on the expressway.
The dentist that criticized the biochemist learned something new about human teeth during the lecture.
The dentist that the biochemist criticized learned something new about human teeth during the lecture.
The dishwasher that dated the waitress gained an unwanted reputation for himself at the restaurant.
The dishwasher that the waitress dated gained an unwanted reputation for himself at the restaurant.

The distributor that deceived the salesman lost business in the community.
The distributor that the salesman deceived lost business in the community.
The nurse that cautioned the dietitian remembered the patient's many food allergies.
The nurse that the dietitian cautioned remembered the patient's many food allergies.
The economist that answered the sociologist modified her views on social inequality.
The economist that the sociologist answered modified her views on social inequality.
The epidemiologist that awaited the official explained crucial public health research.
The epidemiologist that the official awaited explained crucial public health research.
The environmentalist that protested the miner highlighted an important social issue.
The environmentalist that the miner protested highlighted an important social issue.
The principal that appeased the superintendent dodged a long and bitter conflict over new teachers.
The principal that the superintendent appeased dodged a long and bitter conflict over new teachers.
The financier that accused the lender failed to demonstrate any wrongdoing.
The financier that the lender accused failed to demonstrate any wrongdoing.
The steward that saved the passenger was viewed as a hero by everyone on the plane.
The steward that the passenger saved was viewed as a hero by everyone on the plane.
The florist that advertised the hairdresser experienced an increase in business.
The florist that the hairdresser advertised experienced an increase in business.
The seamstress that recommended the dry cleaner worked in the clothing industry with him for years.
The seamstress that the dry cleaner recommended worked in the clothing industry with him for years.

First-Clause Conjoined Fillers
RC1
Because the surgeon required the anesthesiologist, he objected to the plan for the operation.
Before the appraiser astounded the relative, he valued her elderly grandmother's china at over four thousand dollars.
When the caregiver overwhelmed the orphan, she consulted caseworkers at child protective services.
While the roofer memorialized the laborer, he admitted the dangers of his own occupation.
When the climber motivated the mountaineer, he shared dramatic tales of his own adventures.
Since the traveler loathed the concierge, he relocated to a different hotel.
Just as the counselor persuaded the admissions officer, she gathered support for her student during a recent meeting.

RC2
While the set designer yelled_at the builder, he emphasized a serious safety violation on stage.
Before the sketch artist depicted the art student, he practiced for decades to perfect his craft.
After the silversmith courted the antique dealer, he abandoned his wife of ten years.
Even though the meatpacker debated the vegetarian, he defended his right to free speech.
Because the social worker impressed the panhandler, he guaranteed long-term support after employment.
If the mason believed the construction worker, he presumed that he did not steal supplies from the construction site.
Since the speech pathologist offended the physician, she changed her actions moving forward.
When the statistician clashed with the neuroscientist, he pushed a different method of statistical analysis.

RC3

When the shipbuilder confided in the ironworker, he divulged his plans to retire.
After the sound engineer delighted the stagehand, he professed how much he loved his job.
Before the potter embarrassed the novice, he gloated frequently about his skill.
Since the physical therapist supported the Olympian, he participated in the Olympic training camp.
Once the poacher refuted the customs agent, he stormed out of the interrogation room.
When the printer contracted_with the courier, she produced plans for a new park.
Because the provost troubled the lecturer, he vacated his post following a controversy on campus.
After the pastor scorned the parishioner, he prayed for an end to their disagreement.

RC4
Even though the publicist betrayed the pop star, he strategized about how to avoid a scandal.
Once the puppeteer bullied the magician, he stole all the best performance venues.
When the pediatrician concerned the uncle, he braced himself for more bad news about the child.
When the pessimist scolded the optimist, he silenced a view that opposed his own.
When the tailor pressed the groomsman, he manipulated him into a higher price for the alteration.
Although the financial advisor retained the attorney, she claimed to provide the highest quality services.
After the telemarketer enraged the respondent, she ended the call immediately.
While the orderly played with the outpatient, he redefined some activities as games instead of medical procedures.

Second-Clause Conjoined Fillers
RC1
The timekeeper refused to assist_with the following year's event since he perturbed the emcee.
The tour guide expressed a passion for modern art before it interested the guest.
The train conductor charmed the rider before they planned to meet on the same train every day.
The travel agent appeared to have important knowledge of industry trends as she argued with the flight attendant.
The treasurer emphasized why the organization was not going to go bankrupt once he calmed the board president.
The umpire described what he saw at home plate while he admonished the baseball player.
The undertaker scheduled the burial for next week when the parents could attend since he respected the family.

RC2
The contractor initiated a debate over who was responsible for the broken lamppost when he billed the transportation commissioner.
The watchmaker explained his work for several hours although it bored the customer.
The welder analyzed the latest welding techniques while he talked_to the structural engineer.
The ticket agent orchestrated a smuggling operation for years before getting caught because she bribed the baggage handler.
The crossing guard brimmed with excitement at the start of the school year as she smiled at the family members.
The archivist confessed that the masterpiece could be a fake when she rang the museum director.
The mobster obsessed over keeping their conspiracy private before he poisoned the accountant.
The auctioneer disagreed about the final price of the antique tractor though he provoked the bidder.

RC3
The aviator achieved dizzying speeds in front of the crowd as he stunned the racecar driver.
The fire chief pulled the police officer out of the burning building before he revived him.
The prosecutor stared at the judge throughout the trial and then scared the juror during his opening statement.
The bailiff removed himself from the case after he seized the witness.
The cowboy displayed extreme anger after losing track of an outlaw even though it unnerved the sidekick.
The beekeeper entered into business with the artisan after he trained him.
The bodyguard found the burglar inside the mansion before he punched him.
The breeder reported animal cruelty inside a nearby home although she condemned the pet owner.

RC4
The cabinetmaker devoted his career to their shared kitchen renovation business once he rejoined the plumber.
The camp counselor generated an amazing storybook wonderland for the summer campers after he reimbursed the camp director.
The caretaker preserved their time together as long as possible because he pleased the senior citizen.
The cartoonist popularized a new style of newspaper cartoons although he pressured the assistant editor.
The city planner shaped the city's urban development program for years since she agreed with the citizens.
The programmer implied that the project was almost done even though he lied to the game developer.
The court clerk oversaw the wedding ceremony at the courthouse after she welcomed the couple.
The decorator justified the radical design decision once she enlisted the painter.

All sentence stimuli presented in the Control training sessions are listed below by sentence type:

Sentential Complement/Conjoined Sentence Pairs (Sentential Complements listed first in each pair)

CT1
The hiker acknowledged that the ranger asked if he had seen any hunters in the area.
The hiker found the ranger and asked for assistance with a rescue operation.
The journalist believed that the editor published an award winning news story in the latest issue.
The journalist contacted the editor before publishing an exclusive news story.
The hunter learned that the backpacker encountered a large black bear near his campsite.
The hunter encountered the backpacker and traveled many miles to a cabin.
The librarian reported that the professor helped students develop good research skills.
The librarian helped the professor and ordered new books about science.
The classmate saw that the boy startled at the slightest movement.
The classmate startled the boy but tried to stay quiet during the test.
The mechanic noticed that the motorist talked with another driver on the side of the highway.
The mechanic talked with the motorist and fixed the car's engine and transmission.
The detective believed that the woman met_with an accomplice to the murder.

The detective met_with the woman and solved the extremely difficult case.
The policemen recognized that the suspect threatened to commit another crime.
The policemen threatened the suspect while driving him to the county jail.
The student celebrated that the teacher surprised the class with a party before graduation.
The student surprised the teacher because he made a loud noise in the classroom.
The man knew that the student mentored several struggling boys at the local middle school.
The man mentored the student and instructed him where to find helpful community resources.
The minister understood that the colleague counseled nearly fifty parishioners in a support group.
The minister counseled the colleague while preparing his own sermon for Sunday morning.
The kid recognized that his mother helped throughout their community in many ways.
The kid helped his mother and shoveled snow from the driveway.
The conductor realized that the patrons greeted each other as if they were friends.
The conductor greeted the patrons and demonstrated great skill and experience during the performance.
The actor worried that the star mocked every crew member he met while filming.
The actor mocked the star while struggling with his own role in the film.
The waiter said that the bartender commended a customer for his generous tip.
The waiter commended the bartender because he helped several thousand customers during his long career.
The boater proclaimed that the swimmer rescued the bird from the terrible oil spill.
The boater rescued the swimmer while he served as a lifeguard at the town pool.
The researcher noted that the author quoted great philosophers throughout her books.
The researcher quoted the author while studying British literature from the Victorian era.
The associate noticed that the intern questioned them about important topics.
The associate questioned the intern and appreciated her prior experience in the field.
The supervisor refuted that the vendor phoned him late last week.
The supervisor phoned the vendor and inquired about a recent order.
The architect recalled that the client valued quality building materials over cost.
The architect valued the client but suggested a few ideas for her new house.
The athlete loved that the coach praised his players after a difficult game.
The athlete praised the coach and congratulated him on his team's recent victory.
The politician saw that the voter engaged most in education issues.
The politician engaged the voter but conceded defeat after a challenging campaign.
The cyclist enjoyed that the jogger encouraged him after a tough workout.
The cyclist encouraged the jogger and cheered for him during a ten mile race.
The gardener considered that the woman admired tulips before planting them in her garden.
The gardener admired the woman so he planted new flowers for summertime.
The publisher figured that the blogger spoke_to the confidential source last week.
The publisher spoke_to the blogger because he wanted a very interesting story.
The trucker affirmed that the driver honked at him when the light turned green.
The trucker honked at the driver and arrived five hours earlier than expected.
The acrobat forgot that the clowns teased him during the circus performance.
The acrobat teased the clowns after they fell over during a circus performance.
The landlord answered that the plumber met_with him last month about a different problem.
The landlord met_with the plumber and mentioned a broken pipe and water damage.
The maid disliked that the butler married someone else after they broke up.
The maid married the butler then celebrated their fifteenth anniversary at a restaurant.
The agent discovered that the informant contacted him last week while he was on vacation.

The agent contacted the informant because he desired additional information about the robbery.
The fisherman heard that the sailor located a sunken ship in the area.
The fisherman located the sailor before capsizing his fishing boat in stormy seas.
The technician hated that the supervisor attacked his colleague for having a different opinion.
The technician attacked the supervisor but apologized for his actions at work.

CT2
The director doubted that the actress liked working with him on the film.
The director liked the actress so he imagined a wonderfully successful film.
The general suspected that the lieutenant informed a spy about their secret plans.
The general informed the lieutenant because he worried about secret enemy plans.
The repairman hoped that the supplier knew his new business address for the delivery.
The repairman knew the supplier and anticipated a special discount on parts.
The biographer boasted that the novelist recalled the obscure person featured in his latest biography.
The biographer recalled the novelist because she included several quotes in her book.
The parent acknowledged that the teacher honored her son's mathematical achievements.
The parent honored the teacher as she remembered her son's amazing experience in fourth-grade.
The spectators discovered that the athlete witnessed history during that championship game.
The spectators witnessed the athlete while they filled an entire football stadium.
The benefactor ensured that the scientist met his research goal with adequate funding.
The benefactor met the scientist to praise his contributions to medical research.
The host explained that the busboy pointed to a suspicious customer in the restaurant.
The host identified the busboy yet mistook him for an old friend from school.
The mayor thought that the governor hosted an annual meeting for city and state leaders.
The mayor hosted the governor while managing a prosperous major city.
The electrician demonstrated that the foreman hit someone with a hammer.
The electrician hit the foreman but avoided a harsh sentence for his actions.
The artist declared that the sculptor adored his works on perspective and color.
The artist adored the sculptor so he selected several pieces of his work to accompany a new exhibition.
The landscaper feared that the homeowner recognized him when he snuck into the garage last week.
The landscaper recognized the homeowner and greeted her at the grocery store.
The senator assumed that the President supported the major education bill.
The senator supported the President then presented him with a defense bill to sign.
The spokesman stated that the reporter emailed him with a question early this morning.
The spokesman emailed the reporter and advocated for the company in response to her critical article.
The pitcher guessed that the batter struck out more times than he got hits.
The pitcher struck the batter before he left the game two innings early.
The grandmother forgot that the grandson understood English while talking about his surprise party.
The grandmother understood the grandson so she realized what was about to happen.
The admiral added that the diplomat advised several other military officials.
The admiral advised the diplomat and acknowledged the possible consequences of an attack.
The teenager pretended that the sibling tormented him to attract their parents' attention.
The teenager tormented the sibling while they relaxed in front of the TV.
The rescuer projected that the explorer would teach several hundred outdoor enthusiasts during his career.
The rescuer taught the explorer in order to enjoy a lot of time outdoors.
The warden observed that the prisoner fought with nearly every other inmate.
The warden fought the prisoner but started an enormous and dangerous brawl.

The trustee found that the executive backed his proposal for corporate restructuring.
The trustee backed the executive while they attended an important business meeting.
The petsitter reckoned that the veterinarian befriended all the dog owners.
The petsitter befriended the veterinarian because he promoted several major discounts for pet owners.
The CEO stated that the analyst asked about his company's interest rates last week.
The CEO asked the analyst while he searched for information about market activity.
The assistant revealed that the messenger requested access to the storage room before the theft.
The assistant requested the messenger to deliver five boxes of files.
The psychologist warned that the psychiatrist consulted several controversial experts.
The psychologist consulted the psychiatrist before he decided on a new form of therapy.
The coach worried that the player angered opposing teams with his aggressive playing style.
The coach angered the player while he reconsidered his position on the team.
The developer wrote that the engineer queried every other person involved in the project except him.
The developer queried the engineer but conceived of a new design for the building all by herself.
The inventor stressed that the investor reached a decision in support of the product.
The inventor reached the investor but faced challenges implementing their ideas.
The illustrator indicated that the poet assisted him throughout the creation of their new book.
The illustrator assisted the poet while offering quality work for a reasonable price.
The man feared that the commuter assaulted his brother last year.
The man assaulted the commuter yet encountered surprisingly few consequences for his actions.
The mailman relayed that the robber chased him away from a house on his mail route.
The mailman chased the robber until he caught him on a sidewalk.
The protester emphasized that the Congressman confronted all the other lawmakers.
The protester confronted the Congressman although he escaped arrest by local police.

CT3
The astronaut complained that the biologist invited too many guests to his lecture on extraterrestrial life.
The astronaut invited the biologist because he investigated bacteria on other planets.
The operator claimed that the inspector warned no one before the disastrous crane collapse.
The operator warned the inspector and thus prevented a dangerous equipment failure.
The citizens asserted that the spy tracked them every single day.
The citizens tracked the spy until they alerted the federal government.
The troops accepted that the terrorist captured several members of their elite unit.
The troops captured the terrorist and finished their top-secret mission.
The advertiser added that the producer convinced him to try a new marketing strategy.
The advertiser convinced the producer while he outlined a new and innovative idea in front of her.
The curator admitted that the designer despised working with him.
The curator despised the designer so he banned all future collaboration with him.
The guard agreed that the inmate frustrated him with his constant misbehavior.
The guard frustrated the inmate so he attempted to work at a different jail.
The lumberjack argued that the forester aggravated him with talk of burdensome environmental regulations.
The lumberjack aggravated the forester but forced himself to engage in friendly conversation.
The chemist maintained that the biologist inspired nearly all his current research projects.
The chemist inspired the biologist and wrote a new biochemistry textbook last year.
The banker reasoned that the broker challenged him in an attempt to take his job.
The banker challenged the broker although he misunderstood the latest market trends himself.

The scholar remarked that the philosopher researched each of his books very thoroughly.
The scholar researched the philosopher in order to interpret his work in a new way.
The golfer speculated that the pro beat him with very little effort.
The golfer beat the pro and won the celebrated state championship.
The performer hinted that the writer respected his on-stage interpretation of his novel.
The performer respected the writer even though he opposed the controversial novel.
The speaker found that the councilman coached a citizen testifying at the council hearing.
The speaker coached the councilman until he executed an inspiring speech at the rally.
The baker insisted that the caterer joined a rival restaurant across town.
The baker joined the caterer and opened a new business together.
The skateboarder pretended that the champion hated him even though they were friends.
The skateboarder hated the champion so he retired from skateboarding after an injury.
The deputy determined that the attacker shot a shopkeeper in a nearby town.
The deputy shot the attacker although he died from his own severe injuries.
The servant swore that the king complimented him on his work at the banquet.
The servant complimented the king when he strolled across the castle grounds.
The skier observed that the snowboarder annoyed every single skier on the mountain.
The skier annoyed the snowboarder until he departed the ski resort at the end of the day.
The exterminator reckoned that the groundskeeper aided him during his last visit to the college campus.
The exterminator aided the groundskeeper when he killed several hundred bees under a park bench.
The outlaw reckoned that the sheriff wrestled with him for at least five minutes.
The outlaw wrestled the sheriff though he evaded capture for five years.
The beggar found that the pedestrian harassed him every day he was begging for food.
The beggar harassed the pedestrian but needed support from social services.
The astronomer stated that the physicist credited him with one of the field's greatest discoveries.
The astronomer credited the physicist while he gave an engaging lecture to the graduate students.
The brother appreciated that his sister comforted him after their grandmothers' death.
The brother comforted his sister even though he mourned the loss of their pet cat.
The captain respected that the sergeant saluted him when he arrived at the military base.
The captain saluted the sergeant as he led troops into a dangerous battle.
The gamer thought that the animator thanked too many people when he received the award.
The gamer thanked the animator before he began his speech at the national video game conference.
The model wrote that the photographer idolized her in her latest memoir.
The model idolized the photographer so she posed for over eight thousand pictures.
The victim responded that the volunteer accompanied him back to his home after the tragic fire.
The victim accompanied the volunteer and indicated how his home was damaged by the hurricane.
The ballerina sensed that the choreographer critiqued every move she made on stage.
The ballerina critiqued the choreographer whenever she argued for her own interpretation of the piece.
The groomer mentioned that the dog irritated many of the other customers at the grooming parlor.
The groomer irritated the dog when she used extra strength canine shampoo.
The gymnast claimed that the rival defeated her by cheating at the competition.
The gymnast defeated the rival after she acquired a very lucrative endorsement deal.
The activist proved that the bystander assailed her before they began to fight.
The activist assailed the bystander while she asserted her own opinion about the issue.

CT4
The trainee wished that the instructor promoted him to a new position by the end of the year.
The trainee promoted the instructor while she awaited her exercise class each week.

The realtor warned that the buyer antagonized her with all their silly questions.
The realtor antagonized the buyer and dreaded each meeting they scheduled.
The barber proposed that the grocer favored the apples from the nearby farm.
The barber favored the grocer because he chatted with everyone in their small community.
The monitor pretended that the toddler beckoned her over for a tea party.
The monitor beckoned the toddler because she hoped to point out something interesting.
The guardsman predicted that the officer trusted him based on his body language.
The guardsman trusted the officer since he assumed that he would be kept safe.
The lady agreed that the man paid an extremely high price for his car.
The lady paid the man but negotiated a much lower price first.
The anchorman witnessed that the meteorologist disrupted the news report to give a weather forecast.
The anchorman disrupted the meteorologist because he coughed uncontrollably throughout the morning news show.
The archaeologist conceded that the geologist tolerated the desert heat better than he did on his first excavation.
The archaeologist tolerated the geologist as they collaborated on research at the excavation site.
The announcer indicated that the owner applauded the retiring member of the opposing baseball team.
The announcer applauded the owner while he aspired to provide as many years of service to the baseball team.
The auditor ensured that the counsel notified the authorities of suspicious activity at the company.
The auditor notified the counsel after he evaluated the company's financial documents.
The babysitter imagined that the baby amazed her parents on a regular basis.
The babysitter amazed the baby so she envisioned life as a teacher.
The grocer assumed that the butcher dialed to tell him about the late delivery.
The grocer dialed the butcher before he employed a different meat supplier.
The carpenter valued that the apprentice embraced him.
The carpenter embraced the apprentice after he established a training program.
The chauffeur understood that the dignitary expected to arrive at the meeting at least twenty minutes early.
The chauffeur expected the dignitary as he waited out on the tarmac at the airport.
The cosmetologist discovered that the customer extorted several hundred thousand dollars from her business.
The cosmetologist extorted the customer although she hid her activities for nearly a decade.
The machinist speculated that the craftsman excited others in their field with his new woodworking technique.
The machinist excited the craftsman by introducing him to a new furniture design.
The coroner felt that the expert recruited the best candidates to be his successor.
The coroner recruited the expert since he aimed to solve a challenging cold case.
The chiropractor hinted that the acupuncturist frequented a competing chiropractor's office.
The chiropractor frequented the acupuncturist because she extolled the virtues of alternative medicine.
The cashier determined that the stockboy suspected him of a crime committed at the store.
The cashier suspected the stockboy so he turned important information over to store management after a theft.
The dispatcher doubted that the cab driver reached his destination on time.
The dispatcher reached the cab driver and encouraged travel on the expressway.
The dentist complained that the biochemist criticized his latest paper on tooth decay.
The dentist criticized the biochemist but learned something new about human teeth during the lecture.
The dishwasher confessed that the waitress dated his best friend several years ago.

The dishwasher dated the waitress but gained an unwanted reputation for himself at the restaurant.
The distributor explained that the salesman deceived him by offering a product that was no longer available.
The distributor deceived the salesman so he lost business in the community.
The nurse stressed that the dietitian cautioned her against giving the patient too much dietary information.
The nurse cautioned the dietitian as she remembered the patient's many food allergies.
The economist swore that the sociologist answered a different question than she proposed.
The economist answered the sociologist and modified her views on social inequality.
The epidemiologist realized that the official awaited an explanation for the virus outbreak.
The epidemiologist awaited the official before he explained crucial public health research.
The environmentalist alleged that the miner protested his group on a regular basis.
The environmentalist protested the miner thereby highlighting an important social issue.
The principal acknowledged that the superintendent appeased him by hiring the teacher he preferred.
The principal appeased the superintendent so he dodged a long and bitter conflict over new teachers.
The financier admitted that the lender accused him of skipping loan payments.
The financier accused the lender although he failed to demonstrate any wrongdoing.
The steward agreed that the passenger saved the plane from crashing.
The steward saved the passenger and was viewed as a hero by many people.
The florist noted that the hairdresser advertised a discounted haircut for the holiday weekend.
The florist advertised the hairdresser and she experienced an increase in business.
The seamstress mentioned that the dry cleaner recommended her services for altering suits.
The seamstress recommended the dry cleaner after she worked in the clothing industry with him for years.

First-Clause Conjoined Fillers
Same as Relative Clause training group

Second-Clause Conjoined Fillers
Same as Relative Clause training group

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