Structural Priming in Sentence Production

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science with Honors in BCN from the University of Michigan 2015

Abstract

The purpose of this study is to explore how social interaction affects how people structure their speech, specifically in priming. Priming occurs when a particular stimulus impacts a participant's response to a sequential stimulus. This study focuses on whether people can be primed to use particular sentence structures while describing pictures. More specifically, the experiment tests whether people can be primed to describe target pictures using the passive voice when primed with passive sentences. This study was conducted in a dialogue form to examine the role of social interaction in priming. Participants were introduced to various priming sentences that they repeated into a microphone, and also target pictures that they were instructed to describe. The data were transcribed and coded according to the corresponding syntactic structure that was used in the responses. A repeated measures ANOVA and several paired t-tests were conducted to examine for priming effects; however, no significant differences between responses were found between priming conditions at $p = .05$. Therefore, evidence for a passive priming effect was not found. Since the effect has been found before, it is possible that a passive priming effect is subtle. This study has stimulated interest in studying more broad categories of priming, such as transitives and intransitives.

Keywords: priming, sentence production, passives, activation

Structural Priming in Sentence Production

Many factors affect how people structure their speech. Individuals subconsciously repeat themselves or others while speaking in a process called activation (Bock & Griffin, 2000). Activation is the extension of a representation of knowledge in one form to the representation in another form (Bock, 1986). This can be lexical or structural. In structural priming, activation of a particular syntactic structure may influence future behavior, such as the creation of a subsequent sentence. This is interesting because it demonstrates the malleability of the human brain and language processing. Priming is useful because it can facilitate sentence production and decrease comprehension time of sequential sentences (Tooley & Traxler, 2010). Therefore, this concept is useful in elaborating on how humans tend to store and retrieve structural representations in memory. However, it is likely that priming in comprehension and production employ slightly different processes. Studies conducted by Pickering and Traxler (2004) and also Traxler and Tooley (2008) have demonstrated that priming effects in comprehension are only significant if the prime and target sentences have the same syntactic structure, and also a common lemma, which could be the first verb (Tooley & Traxler, 2010).

There are three main theories explaining potential processes behind structural priming. The first is residual activation, which involves short-term activation. The second is implicit learning, which involves long-term activation. The third is a dual mechanism, which involves both of the previous concepts. A study conducted by Pickering and Branigan (1998) supports this theory of residual activation, involving short-term activation. They proposed that the production of a specific syntactic structure causes an activation for that structure's combinatorial node, which will last for a short period of time. During this time, the structure will have a higher chance of being used in following sentences (Pickering & Branigan, 1998). This residual

activation occurs not only with structures, but also with individual lemmas, or abstracts of words as well. Lemmas can include the verbs included in the sentences. Pickering and Branigan's study of structural priming effects have shown that when sentences contain a repeat of an individual lemma, such as a verb, priming effects increase (Pickering & Branigan, 1998). These results support this residual activation theory.

Another potential theory explaining priming effects is implicit learning, which includes long-term activation. Bock and Griffin (2000), as well as Chang, Dell, and Bock (2006) have proposed that many priming effects are actually caused by long-term implicit learning, rather than short-term activation. Bock and Griffin have found that the priming effect still exists even beyond contiguous sentences, suggesting that although short-term memory may have some effects on priming, it appears to have an implicit and procedural learning component as well (Bock & Griffin, 2000). Implicit learning is the process of acquiring new information unconsciously. It has been proposed that syntactic priming is caused by strengthened connections between the representational units coding for the use of a specific syntactic structure, a process that happens unconsciously (Bock & Griffin, 2000). Stefan Gries's corpus-based structural priming study also yielded priming effects that lasted for longer periods of time, further supporting the implicit learning model (Gries, 2005).

A third theory explaining priming effects is the dual mechanism account. The dual mechanism account proposes a possible explanation for the differences between priming in comprehension and production. This mechanism claims that lexically independent syntactic priming effects are caused by an implicit learning mechanism; however lexically dependent priming effects are caused by short-term mechanisms such as residual activation. In an experiment conducted by R. J. Hartsuiker & M.J Pickering (2008), it was discovered that

lexically independent priming effects seemed to last longer in production, while lexically dependent priming effects lasted for shorter periods of time, which support the different mechanisms involved in different aspects of priming. Therefore, it is quite probable that an interaction of multiple effects could be involved in priming.

J. Kathryn Bock, a professor of linguistics and psychology, first introduced the concept of structural priming in 1986. Bock researched whether subjects would be more prone to using certain syntactic sentence structures after hearing them used before in a previous priming sentence. She investigated whether a significant priming effect exists, and if so, whether recent timing and repetition of the priming structure has an influence on the priming effect.

Bock has completed a series of experiments testing this structural priming effect. More specifically, Bock studied structural priming effects in sentence production, rather than comprehension. The experiments began in 1986, and included 48 subjects from the University of Pennsylvania. Most of the subjects were students. The subjects were presented with 2 different kinds of priming sentences and target pictures, including transitives and datives. The set of transitives included 24 target pictures, and each was matched with one of 24 transitive sentences. There were also 12 dative target pictures, each matched with one of 12 dative sentences. The transitive pictures could be described using an active or a passive tense. Some examples of stimuli are included below:

1) "One of the fans punched the referee." (Active transitive)

2) "The referee was punched by one of the fans." (Passive transitive)

3) "The foundation is giving several million dollars to the university." (Prepositional dative)

4) "The foundation is giving the university several million dollars." (Double-object dative)

There were 42 filler pictures and 42 filler sentences included to distract the subject from the significance of the priming and target pictures. The experimenter presented the subject with the sentences orally, and the pictures were presented to the subject on cards that were passed between the experimenter and the subject. The study was presented as a memory task to distract from the true purpose of the experiment, preventing the subject from making purposeful changes to his or her sentence structures (Bock, 1986).

Participants spoke into a microphone and were recorded using a cassette tape recorder. Subjects were then presented with the pictures and sentences. They repeated each sentence and described each picture. All target pictures were preceded by a target priming sentence. After speaking into the microphone, subjects were also given the task of stating "yes" or "no" to each picture and sentence, to identify whether or not they had encountered it previously in the study. The subjects' descriptions of the target pictures were later transcribed from the tape recordings. The responses were then coded according to syntactic form as active, full passive, or other. The dative pictures were coded as prepositional, double object, or other. The proportion of active-passive sentences that were produced was considered the dependent variable, and so was the proportion of prepositional-double object dative sentences. Other combinations were not examined. There did appear to be a priming effect present in both the dative trials and the transitive trials (Bock, 1986). It appeared that hearing prepositional primes stated by the experimenter caused the subject's chance of using a prepositional sentence to increase significantly, and the same effect was found in the transitive primes with a passive structure. A t statistical analysis confirmed that differences in results were significant, with a $p < .05$.

Therefore, Bock concluded that there does appear to be a structural priming effect. This structural priming effect has been evident for both transitive and dative sentences. Since the

experiment was presented as a memory test, Bock concluded that the subjects could not have been using the sentence structures consciously. Therefore, the effect is likely due to subconscious activation. Bock has completed a series of other experiments with colleagues Zenzi Griffin and Helga Loebell elaborating on the structural priming effect, testing whether changes in sentence structures, changes in lexicon, and changes in recency of the priming sentence alter the priming effect (Bock, K. & Griffin, Z. 2000; Bock, K. & Loebell, H., 1990; Bock, K. & Loebell, H., 2003). Bock and colleagues have consistently found evidence for the priming effect even with variations among these variables. These experiments have provided key insight into the variables that have significant effects on priming. It appears that the recency of a sentence structure and the frequency of that structure do affect priming (Bock, 1986). Also, priming effects do depend on the structural form of the sentence (active versus passive, for example), but are not affected by the subject matter of the sentence (Bock, 1986).

Martin J. Pickering and Holly P. Branigan completed a similar experiment to study syntactic priming effects by administering both prime and target sentences to subjects. However, the task involved written sentence completion rather than oral descriptions of pictures, as was the task in Bock's experiment (Pickering & Branigan, 1998). Another variable in Pickering and Branigan's experiment was that the prime and target had either identical forms of the same verb or different forms of the same verb, such as in the example below:

1a) "The teacher gave the book to the boy."

2a) “The racing driver gives the torn overall to the mechanic.”

2b) "The racing driver showed the torn overall to the mechanic."

They found that changing the form of the verb did not eliminate priming effects. Even when the verb was changed altogether, a priming effect was still found, although it was a smaller

effect. Thus, Pickering and Branigan proposed that the same syntactic information is activated in the brain even in sentences when the verb form is varied (Pickering & Branigan, 1998).

The current study was designed to find a structural priming effect. It is expected that participants will be more likely to use specific syntactic structures, such as passive and active constructions, after hearing the same structure used in a previous sentence. This effect is measured by comparing the frequencies that subjects use passive or active sentence structures to describe a picture after previously hearing a passive versus an active structure. Significant differences in frequencies indicate a priming effect. I expect to find the most passive responses following a passive prime than following any other prime type. I expect to find a significant change in frequencies of passive structure use following a passive prime versus an active prime.

Pilot Study

A pilot study for this experiment was conducted during the Winter 2014 semester designed by graduate student Guadalupe de los Santos. The pilot study was a syntactic repetition experiment similar to Bock's "Syntactic Persistence in Language Production" in 1986, examining for passive priming effects. All of the priming and filler sentences and pictures used in the pilot experiment are the same as those used in this present experiment. However, this pilot study was conducted entirely on a Windows computer, and the subject sat alone in the testing room for the majority of the experiment. The priming sentences and target photos were all presented to the subject through a PowerPoint presentation. The process of transcription, coding, and analysis (explained below) was also the same. However, a significant structural priming effect was not found, even though evidence of an effect was expected. It is possible that the aspect of having the study conducted on a computer might have eliminated some of the subject's engagement with the material, thus making the subject less susceptible to being primed. This result is in

accordance with Howard Giles's interpersonal linguistic accommodation theory, also known as Speech Accommodation Theory (Giles, 1973). Speech accommodation is the tendency of a speaker to adjust his or her speech to become more similar to the speech of the interlocutor in the dialogue. The purpose of speech accommodation is proposed to be mannerly towards the other person, and also to achieve "social approval" or "solidarity" (Coupland & Giles, 1988). Therefore, it is possible that speech accommodation is linked to structural priming, because priming involves a form of mimicry of previous sentences, which could be administered by the interlocutor. Perhaps the reason why a priming effect was not found in this pilot study was because the subject did not interact with an interlocutor in a dialogue setting, but rather spoke in a microphone to a computerized image. Thus, speech accommodation would not apply here, and this could possibly reduce the priming effect.

Current Study

I have now redesigned the study to promote a conversational atmosphere between the experimenter and the subject. The current experiment was designed with graduate student Guadalupe de los Santos, who has conducted research on syntactic priming in Dr. Julie Boland's lab for the past 3 years. All forms were submitted to the IRB by September 26 of 2014, and the study was fully approved and available on subject pool by the first week in October of 2014.

The experimental structure was intended to promote experimenter-subject interaction and dialogue engagement. The current study only uses the computer to record the subject's voice. The rest of the experiment involves a dialogue between the subject and the experimenter, similarly to Bock's primary experiment in 1986. I am curious to discover if this adjustment in atmosphere and engagement will promote the structural priming effect. If so, this suggests that this type of activation is dependent on engagement in conversation, and thus also related to

speech accommodation. I expect to find a passive priming effect in this interactive study. I used 4 types of priming conditions: full passive, short passive, active, (the independent variables) and intransitive (the control condition). The syntactic structures of the participants' responses to these stimuli are the dependent variable. I expect to find a higher frequency of passive structure responses following full and short passive primes than following active or intransitive primes.

I am also curious to determine if certain social factors, such as gender and level of extroversion have an effect on priming. There is little literature that exists on the effects of social factors on structural priming; however there are some theories about dominance and speech accommodation. It seems that social groups that are perceived as most dominant (such as males and extroverts) would be more likely to assert their own language and less perceptive and accommodating to the speech patterns of others (Bilous & Krauss, 1988). Therefore, I predict that women and introverts will be more prone to speech accommodation, and thus structural priming. I expect to find a higher frequency of passive structure responses following full and short passive primes than following active or intransitive primes in females and people who rate themselves as having low levels of extroversion.

Method

Participants

Data was recorded from 60 participants. All participants were University of Michigan students enrolled in the Psych 111 subject pool. Participants included 27 males and 29 females, and ranged in age from 18-23. I collected data from these 60 participants during the Fall 2014 semester. However, I only used data from 56 subjects, due to the need for an exact multiple of 8 participants to match the 8 orders of stimuli. The data from the first 2 participants was discarded due to a lack of the supplementary background questionnaire. The data from the last 2

participants were also discarded; they were run in the event that some of the participants might cancel, and I wanted to ensure that I would have a minimum of 56 participants before the subject pool closed.

Materials

Additional materials included a Macintosh computer with QuickTime Player to record the participants' voice data. A Shure BC 2.1 microphone that plugs into the Macintosh was used to amplify the participants' voices. Other materials included manila cards that the participants picked up one by one from the table. The cards contained either a target picture that the participant had to describe, or a pair of headphones, which indicated an oncoming priming or filler sentence that the participant would repeat. Scantron sheets were also used to record the participants' "yes" or "no" answers about whether they had encountered the pictures and sentences previously in the experiment.

The experiment consisted of 8 orders of filler and target pictures and sentences. All participants were presented with the same stimuli of filler and target pictures and sentences, but in different chronological orders. To effectively compare the use of active and passive sentences as primes, I needed an exact multiple of the 8 orders to maintain a balance of the number of participants receiving each order of stimuli. Thus I decided on a total of 56 subjects, to complete 7 sets of each of the 8 orders. The orders were labeled 1a, 1b, 1c, 1d, 2a, 2b, 2c, and 2d. The orders contained different sequences of priming sentences and target pictures. However, all participants were exposed to an equal number of priming sentences (6 full passive, 6 short passive, 6 active, and 6 intransitive), and the same 24 target pictures. Each order consisted of 3 blocks, and each block contained 72 manila cards. Each card was labeled with a number, and each had a picture printed on it either of a pair of headphones or a simple scene. If a pair of

headphones appeared on the card, the participant looked up so that I could read a sentence, which he or she then repeated into the microphone. If a scene appeared on the target photo, the participant described the picture into the microphone using 1 sentence. All recordings were created and saved using QuickTime player.

The sentences presented to the participants all fit into 4 structural categories: full passive, short passive, active and intransitive. Full passive, short passive, and active served as the priming conditions in which a subject acts on an object, and the intransitive served as a control condition, in which the subject does not act on an object. Examples of specific constructions and criteria in each priming condition are included below:

- Full Passive (direct object is being acted upon by a specified subject): "The workers were paid by the foreman."
- Short Passive (subject does not complete the action, but rather the direct object is being acted upon by an unspecified subject): "The workers were paid."
- Active (subject executes the action): "The foreman paid the workers."
- Intransitive (verb does not take an object): "Our family is small."

Procedure

The experimental procedure ran as follows: the participant first entered the lab and signed a consent form, authorizing me to record his or her voice and stating that he or she could leave at any time should a change in mind occur. The subject also filled out a background questionnaire, specifying his or her age, gender, hometown, area of study, native language, and level of extroversion. Level of extroversion was specified on a 7-point scale, 1 being least extroverted and 7 being most extroverted.

Once forms were signed, the participant sat in a smaller and quieter room with a desk with the Macintosh computer and microphone sitting on top. The participant read the instructions and was given several Scantron worksheets and a pencil. The participant then completed a practice trial consisting of 10 cards, and then the 3 full blocks of 72 cards each. QuickTime was used to record the participant's voice throughout each of these blocks.

Each block consisted of the following: the participant was presented with a stack of 72 cards, and picked up each card one by one. He or she either described the picture, or repeated back the sentence that I read from a script, which was kept out of the participant's view in a binder. After describing each picture or repeating each sentence into the microphone, the participant filled in the bubble corresponding to either "A," indicating "yes," or "B," indicating "no," referring to whether or not he or she had encountered the picture or heard the sentence used in the experiment before. This memory task was intended to distract the participant from the purpose of the experiment, so that he or she could not consciously try to match the sentence structures. At the end of each block, the participant was given the option of a short break and some water. Over the course of the experiment, each participant was exposed to 24 priming sentences and 24 target pictures, and the rest of the stimuli were fillers. Only after the experiment was completed and all recordings were finished was the participant debriefed and informed of the purpose of the experiment.

Results

After data collection was completed, all recordings were transcribed. I listened to the subject recordings through QuickTime player and typed all of the priming and target sentences exactly as stated by the subject. I typed these into an excel spreadsheet that was organized by the 8 orders. After transcribing the data, I coded each response sentence with 6 possible forms:

active, short passive, full passive, intransitive, other or error, with the letters “a”, “s”, “f”, “i”, “o”, and “e”, respectively. An active response is a construction that consists of a subject, verb, and object, in that order. A full passive response consists of a direct object, a verb (or 2 verbs in a row) and a prepositional phrase. A short passive response is a construction that consists of a direct object followed by a verb, but not a prepositional phrase. An intransitive construction consists of a subject followed by a verb. Any other construction was classified as “other.” If the participant failed to repeat the priming sentence before the target picture correctly, the response was classified as an “error.”

The excel sheet that the data were coded in tallied the number of response constructions created for each priming category based on the code for each response. The response data was initially coded this way to maintain consistency with the 4 priming conditions. However, my focus of interest was the frequency of passive responses (full or short) compared to the sum of all passive responses and active responses, following each prime type. A higher frequency of passive responses following a short passive or full passive prime compared to following an active prime, or an intransitive prime (the control condition) is an indication of priming. Therefore, to make analysis clear, response data was collapsed into 3 broad categories following each of the 4 priming conditions: passive responses, active responses, or other responses. Passive responses consisted of short or full passive constructions in response to a prime. Active responses consisted of an active construction in response to a prime. Other responses consisted of intransitive or any other constructions produced in response to a prime. A new excel sheet was used to tally the frequencies of these 3 response conditions dependent upon each prime, as shown below, and the average frequencies of each condition are shown in Table 1.

- 1a) Short Passive Prime followed by a Passive Response

- 1b) Short Passive Prime followed by an Active Response
- 1c) Short Passive Prime followed by an Other Response
- 2a) Full Passive Prime followed by a Passive Response
- 2b) Full Passive Prime followed by an Active Response
- 2c) Full Passive Prime followed by an Other Response
- 3a) Active Prime followed by a Passive Response
- 3b) Active Prime followed by an Active Response
- 3c) Active Prime followed by an Other Response
- 4a) Intransitive Prime followed by a Passive Response
- 4b) Intransitive Prime followed by an Active Response
- 4c) Intransitive Prime followed by an Other Response

I compiled the frequencies of the above conditions for each subject into a new Excel spreadsheet to compare responses across the 4 priming conditions of full passive, short passive, active, and intransitive. Next, I computed some proportions modeled after Bock's analysis in "Syntactic persistence in language production" (Bock, 1986). The proportions consisted of the frequency of the passive responses following each prime, divided by the sum of passive and active responses following that prime. For example, in the full passive condition, the numerator was the amount of passive responses the participant gave following a full passive prime, and the denominator was the sum of the amount of passive responses and active responses that the participant gave following the full passive prime. Proportions were created for all participants in all 4 priming conditions. Response constructions that corresponded with the "other" category were not used in further analysis.

I then conducted a repeated measures ANOVA on SPSS to compare the average proportions for each priming condition and inspect for significant differences. No evidence of significant differences were found, although there did appear to be a lower frequency of passive responses following intransitive primes, the control condition. As demonstrated in Figure 1, although these results are not significant enough to conclude a priming effect, they might be an indication of a trend.

Next, I computed t-tests in each condition to compare if there were significant differences between the amount of passive and active responses for each priming condition (full passive, short passive, and active), and the frequency of these responses in the control condition (intransitive). Although the results of the ANOVA did not warrant further analysis, I had decided as part of my experimental design to conduct t-tests as a planned comparison. However, there were no significant differences found at $\alpha = .05$.

Next, I consulted the background questionnaire that participants had completed upon arrival to sort the data according to social groups. More specifically, I examined the effects of gender and level of extroversion. First, I sorted the data according to gender, and divided the frequencies of passive, active, and other responses into groups of males and females. I recomputed passive response proportions using the same method as before for all 4 prime types (frequency of passive responses following prime type/sum of the frequency of passive and active responses following same prime type) and again examined for effects utilizing the same statistical procedures as I did for the overall group. No significant differences in passive priming were found. I then compiled a bar graph comparing the passive response proportions between males and females, but as demonstrated in Figure 2, there does not appear to be a trend. It appears that frequencies of priming in each condition are random.

Next, I sorted the data according to levels of extroversion. I consulted the background questionnaires and coded each participant's data according to how they rated their own levels of extroversion on a scale of 1-7. All subjects fit into categories between ratings 2-6. Some subjects rated themselves in between full digits, and for the sake of keeping groups consistent, I rounded these numbers up to the next full digit.

Once I had sorted the data into new social groups, I again created the passive response proportions to use for comparison. Using the same methods of analysis as above, I examined for differences in priming among the different groups. However, I still did not find significant evidence of passive priming in any of the groups. The differences between proportions appeared random.

Discussion

After completing statistical analysis, I have not found a significant structural priming effect. It is difficult to determine why this has occurred. Although the effect is very subtle, Bock consistently found evidence for a structural priming effect. Thus there must be differences between my study and Bock's that yielded this difference in results. I have speculated as to why this might have occurred.

First, Bock found most consistent evidence for structural priming with datives, and I focused on priming with passives. It is possible that priming with passives is much more subtle, and that Bock might have only found rare evidence for this effect. Perhaps activation of datives is stronger than passives, and demonstrates higher frequencies of priming.

The environment of the two experiments was similar, however, they were also different in terms of timing and exact location. Bock conducted her structural priming experiment in 1986, and I conducted mine in 2014-2015. Language and social constructs are constantly changing, so

perhaps there have been some social changes between 1986 and 2014 that have caused a decrease in a subject's ability to be structurally primed. The location of Bock's experiments and my experiments were very similar: they all occurred at large university campuses and tested students as subjects. However, they were not conducted at the same university. Bock conducted hers at Michigan State University, University of Pennsylvania, and also Cornell University, while I conducted mine at the University of Michigan. Although these location changes should not cause a discrepancy among the results, it is possible that small changes in time and location summed together could have contributed to a different environment. So perhaps this variable combined with others could have contributed to the differing results.

There were some other slight variations between Bock's experiment and my experiment that could have contributed to these differences. In "Syntactic Persistence in Language Production," Bock conducted 3 experiments and varied the number of consecutive priming sentences and target photos for each experiment (Bock, 1986). She varied them so that there were never more than 2-4 sentences or target photos in a row (Bock, 1986). In my experiment, I had no more than 3 sentences or target pictures in a row. It is unlikely that this had an effect on priming, but perhaps having more or less priming sentences or pictures consecutively could have a small contribution to the priming effect.

Both Bock's and my experiment contained a memory task to distract the subject from the actual purpose of the experiment. However, my task involved filling in a Scantron sheet to indicate "yes" or "no" as to whether the subject had seen the photo before, while Bock's experiment involved speaking "yes" or "no" to the experimenter. Perhaps this extra level of social engagement could have also contributed to the effect, which I was missing.

One other factor that could have had an effect on priming is human agency in the sentences. Bock specifically divided her priming sentences so that 12 of the priming sentences involved a human agent, and the other 12 involved a non-human agent. My priming sentences were evenly divided as well, however I did not focus on controlling for non-human and human agents as much. Although Bock found a passive priming effect with both human and nonhuman agents, she broke down analysis into both groups. It appeared that there were increased proportions of passives following a passive prime when both the priming sentence and target picture included nonhuman agents. Primes with human agents appeared to produce more active responses when a human was also featured in the following target picture. Although Bock claims that this only had a slight effect on priming and did not skew the final results, it is possible that the variety of human and nonhuman agents in my priming sentences and target pictures combined with other effects could have deterred from finding a structural priming effect.

Also related to the stimuli, another variation between Bock's experiments and mine were that my priming sentences and target pictures were different from hers. Although my stimuli were structured very similarly and normed before the experiment, there were still a few situations in which I decided after the experiment that the stimuli could use a few adjustments. For example, the target picture depicting a surfer about to get hit by a wave evoked a large variety of responses, many of which were intransitive. Many participants interpreted the photo as the surfer being scared of the wave, or just that a man is surfing. These frequent responses implied that many participants did not interpret the photo such that an object was acting on a human (wave acting on the man), but rather just that the man exists in a scene, which would not evoke a passive structure. Perhaps these differences in stimuli contributed to the diminished priming effect in my experiment.

I had speculated that if I had found a structural priming effect through this experiment, then I would have discovered a link between person-to-person conversational engagement and increased structural priming processes. Due to the lack of a priming effect found in the first computerized experiment during Winter 2014, if I had found a priming effect as a result of the modified, more interactive study, this would suggest that engagement in a dialogue rather than interacting with a computer has some effect on activation and structural priming.

However, I did not find a significant priming effect, thus I cannot draw these conclusions. It is difficult to determine if the social in-person factor contributes to priming, or if priming occurs independently of a person-to-person dialogue. Also, despite my predictions that certain social groups such as females and introverts would be more likely to be primed, I did not find evidence for any consistent priming trends among these groups. The lack of an overall priming effect likely contributed to the absence of these trends. Thus I can only conclude that I did not find passive priming.

There is a lot of potential to explore within priming. In the future I would like to further explore the differences between my experiment and Bock's, redesign, and re-execute the experiment until an effect is found.

In the future, I would also consider using stimuli (including priming sentences and pictures) even more similar to those of Bock. Perhaps her particular set of stimuli was more prone to trigger priming. If so, I would be curious to study what elements of a stimulus are prone to cause priming and which are not. Perhaps the effect is biased towards certain stimuli, and that there is an element of the images themselves, or the items and actions featured within them that has a tendency to produce passive, active, or intransitive sentences. Although the target photos were normed before I began my experiment, perhaps further study of the stimuli is necessary.

The images that I used were very similar to Bock's, but since the effect I am looking for is subtle, any small differences between stimuli could contribute to an effect or lack thereof.

I was very specific about the types of passive primes that I utilized in the experiment; I sorted passive primes into categories of short and full. I could potentially explore differences between short and full passives; perhaps they yield differences in passive responses. If there are no differences, I could potentially conduct further studies collapsing both short and full passive primes into one category. It is possible that there would be more significant effects with just one passive priming category.

Further study could also be explored within priming, not just limited to passives. One aspect of the data that approached a trend was when I sorted the 4 priming conditions into transitives and intransitives. It appeared that the largest difference in frequencies of passive responses occurred between transitive and intransitive primes. I could run further experiments to explore priming differences just between transitives and intransitives, since intransitives appear to be the least effective in priming.

I also noticed that among the 4 priming conditions, people produced the least amount of passives following an intransitive prime. The intransitives served as the control condition, and I am curious why subjects acted most differently in this control condition. Perhaps because intransitives imply a lack of action by a subject on an object, participants are less likely to use a passive or active structure following an intransitive. Again, this could prompt further study of transitive versus intransitive priming.

One last aspect of my design that could prompt further study was the fact that I created an across subject design for the experiment. To decrease variability, I could potentially do another

experiment with a within subject design, to further study priming within an individual, since this could vary greatly from person-to-person.

I did not find evidence of a significant passive priming effect, despite past evidence for this effect. This is interesting because despite similar experimental design to past studies that have demonstrated structural priming, it appears that even small differences can contribute to a lack of effect. This demonstrates how subtle the effect is, and how slight changes in environment, stimuli, and circumstances might alter the final results. Also, due to the lack of differences in priming among various social groups, it is also difficult to conclude what specifically causes priming, and who is more likely to be primed. It appears that priming is generally not affected by social factors such as gender or level of extroversion, despite my previous speculations. However, due to the lack of an overall priming effect, it is difficult to draw conclusions about social factors and priming. Further analysis of the data has sparked an interest in studying transitives versus intransitives in priming, since there appears to be potential for a trend. Despite a lack of significant results, this study provides some direction for further analysis within priming.

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Appendices

Appendix A

Examples of Priming Sentences

Prime: The rain flooded the basement. (Active)
Target picture: Train hitting a bus.

Prime: The silverware was put down. (Short Passive)
Target picture: A shark eating a swimmer.

Prime: The balloons were popped by the children. (Full Passive)
Target picture: Lightening striking a church.

Prime: The student turned off the computer. (Active)
Target picture: Ambulance hitting policeman.

Prime: The dice were rolled by the boy. (Full Passive)
Target picture: Missile shooting down plane

Prime: The game ended. (Intransitive)
Target picture: Baseball hitting boy.

Prime: The politicians were assassinated. (Short Passive)
Target picture: Avalanche burying skiers. (SP)

Prime: The flowers bloomed. (Intransitive)
Target picture: Wave capsizing boat.

Prime: The ghost disappeared (Intransitive)
Target picture: Train about to run over a woman.

Prime: The teacher taught the lessons. (Active)
Target picture: Torpedo hit the ship.

Prime: The bombs were set off by the terrorist. (Full Passive)
Target picture: Jack-in-the-box scared the girl.

Prime: The contract was signed. (Short Passive)
Target picture: Tornado demolished the barn.

Prime: The moon rose. (Intransitive)
Target picture: A cat scratching a vet.

Prime: The drugs were legalized by the government. (Full Passive)
Target picture: A bee stinging a woman.

Prime: The cards were dealt. (Short Passive)
Target picture: Truck towing a car.

Prime: The foreman paid the workers. (Active)
Target picture: An alarm clock woke someone up.

Prime: The tickets were sold. (Short Passive)
Target picture: Lightening striking golfer.

Prime: The movie credits played. (Intransitive)
Target picture: Wind blowing off man's hat.

Prime: The butler closed the windows (Active)
Target picture: Fire hydrant squirting firefighter.

Prime: The furniture was built by the craftsman (Full Passive)
Target picture: Tank running over soldier.

Prime: The women were rescued. (Short Passive)
Target picture: A wave hitting a man.

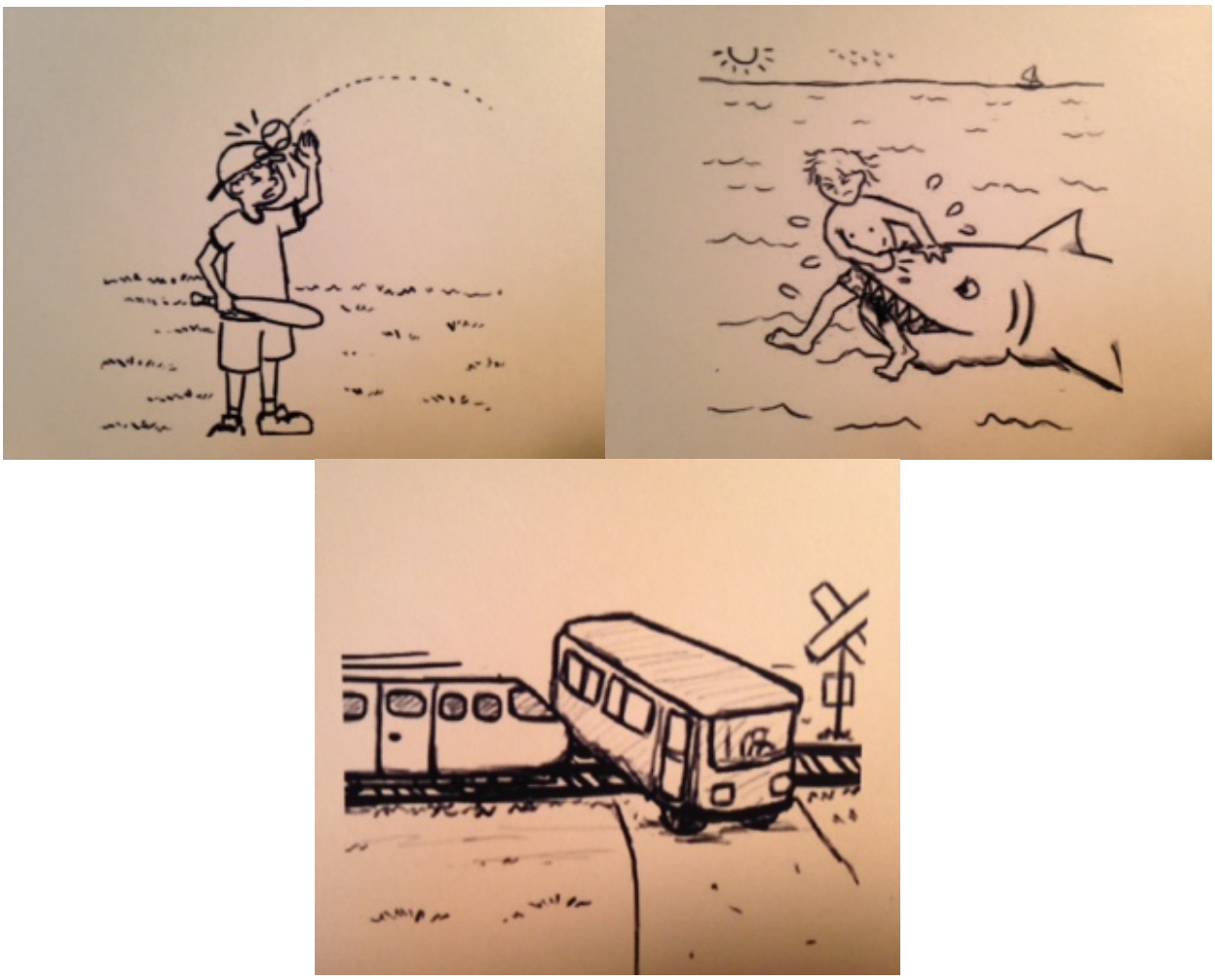
Prime: The wind slowed. (Intransitive)
Target picture: Fly swatter killing fly.

Prime: The cans were recycled by the man. (Full Passive)
Target picture: Dog chasing mailman.

Prime: The gardener painted the walls. (Active)
Target picture: Crane wrecking a building.

Appendix B

Examples of Target Pictures



Tables

Table 1

Average Frequencies of Response Types Following Primes

	Full Passive Prime	Short Passive Prime	Active Prime	Intransitive Prime
Passive Response Average	2.607	2.804	2.679	2.500
Active Response Average	2.161	2.161	2.214	2.286
Other Response Average	1.232	1.036	1.107	1.196

Note: Table documents the average frequencies of the response types following each type of prime. The frequencies were used to create passive response proportions compared in Figure 1.

Figures

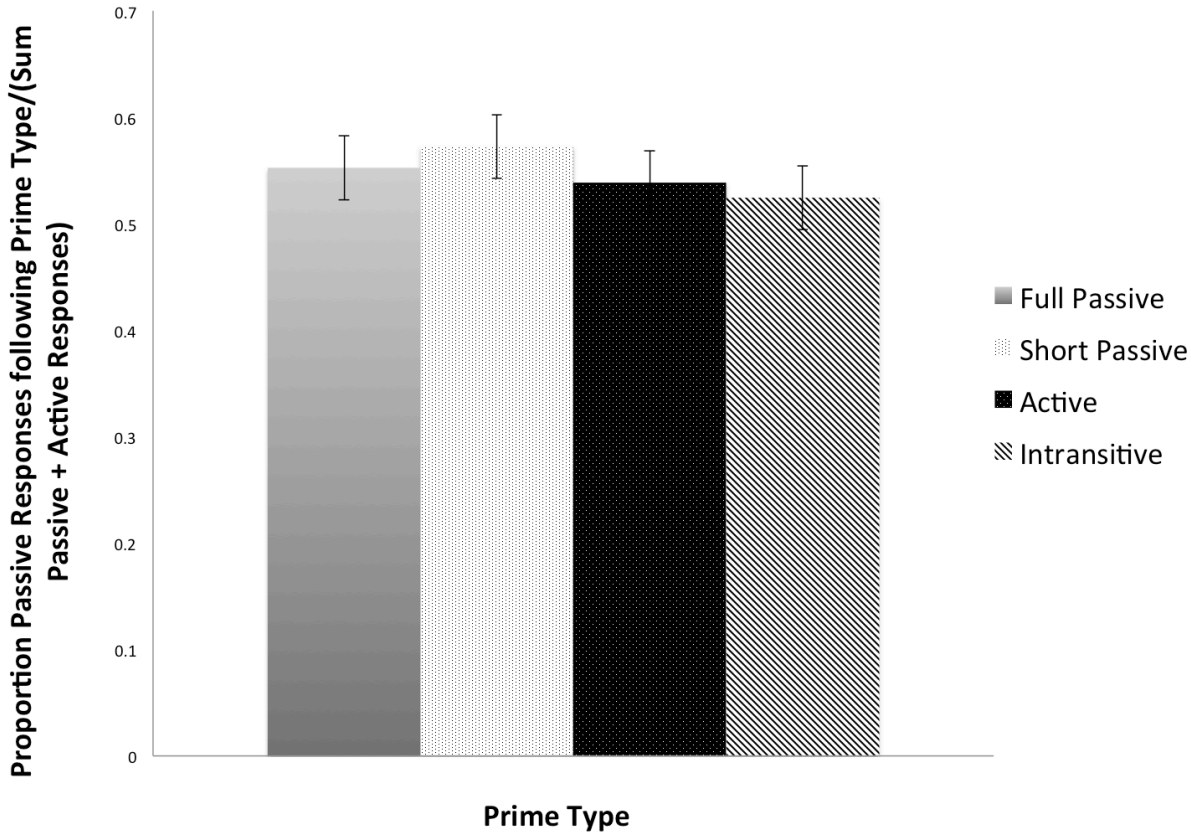


Figure 1. Comparison of average passive proportions for each priming condition. Proportions were created by dividing the frequency of passive responses immediately following each prime type divided by the sum of the total passive and active responses following that prime type. Despite apparent trends, so significant differences found.

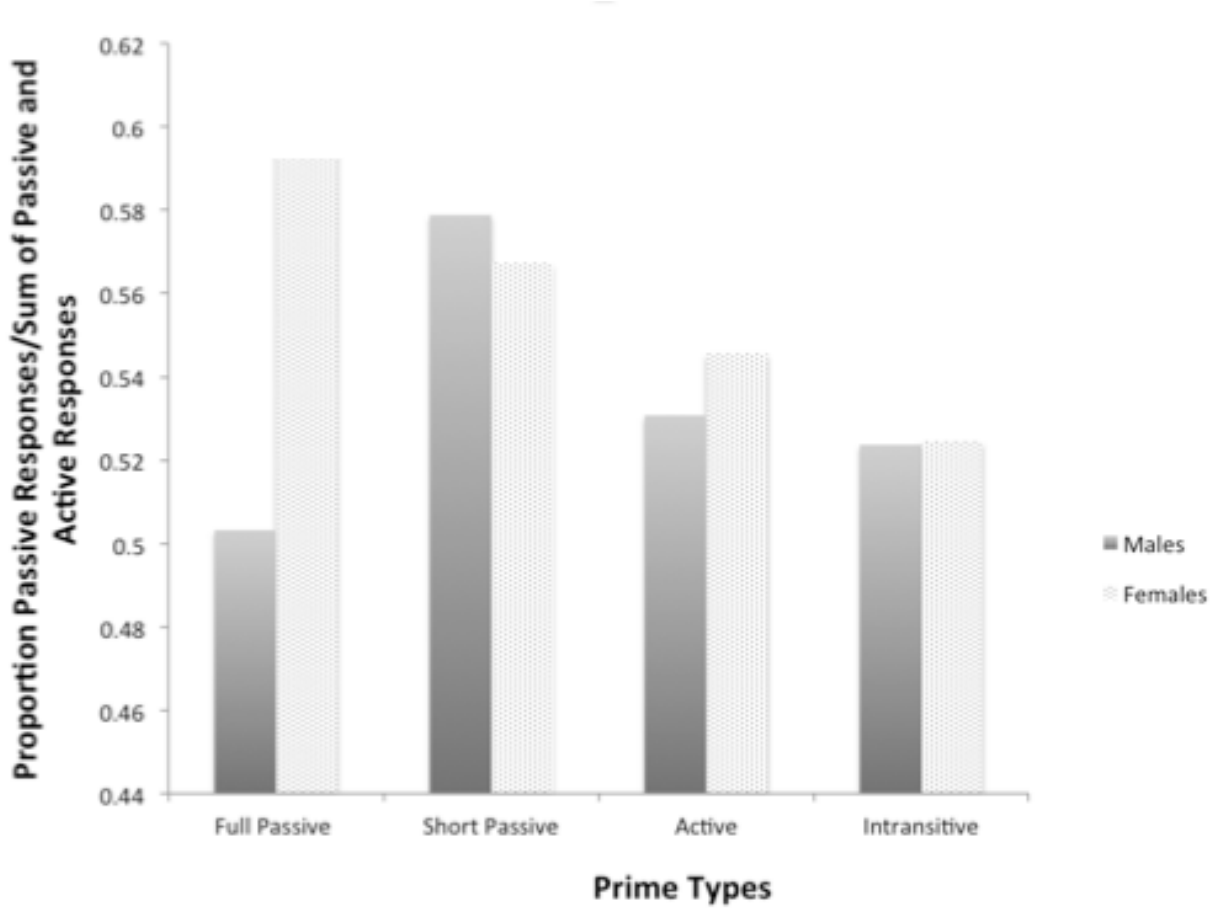


Figure 2. Comparison of average passive proportions for each priming condition between genders. Lack of trends is apparent through random values of bars.