ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 09, Issue, 09, pp.29903-29909, September, 2019

RESEARCH ARTICLE OPEN ACCESS

THE EFFECT OF SEMANTICALLY RELATED VERBS AND ASSOCIATED NOUN PRIMES ON OBJECT PICTURE NAMING

[1,*]Hyejin Park and [2]Lisa A. Edmonds

[1]Department of Communication Sciences and Disorders, University of Mississippi University, MS
[2]Communication Sciences and Disorders Program, Teachers College, Columbia University, New York, NY

ARTICLE INFO

Article History:
Received 14th June, 2019
Received in revised form
17th July, 2019
Accepted 24th August, 2019
Published online 30th September, 2019

Key Words:
Semantic priming,
Primed naming,
Verbs, Thematic roles,
Associated nouns.

Corresponding author: **Hyejin Park**

ABSTRACT

Primed naming paradigms have shown that the semantically associated noun primes facilitate naming speed of noun targets. However, few studies controlled for co-occurrence when developing prime-target stimuli, which might have provided a boost in facilitation due to phonological activation between the prime and target. Also, there is limited information about how verb primes affect noun naming. Therefore, the aims of this study were to investigate whether naming speed of nouns is facilitated by associated noun primes after controlling co-occurrence values between primes and targets, and whether naming speed of thematic role nouns is facilitated by semantically related verb primes. We presented associated noun primes with object pictures, and semantically related verb primes with instrument and patient object pictures to be named at 50 and 300 SOAs. The results, which differ from the literature, show that associated noun primes slowed down target noun naming, and the semantically related verb prime slowed down patient noun naming but not instrument noun naming. We suggest that co-occurrence may have played a partial role in facilitating noun naming in previous studies. We also discuss that slowed noun naming may be due to competition between the target and other concepts activated by the prime. Further studies are needed to test this hypothesis.

Citation: ***Hyejin Park and Lisa A. Edmonds*, 2019.** "The effect of semantically related verbs and associated noun primes on object picture naming", *International Journal of Development Research*, 09, (09), 29903-29909.

INTRODUCTION

Word retrieval is a critical communication skill often assessed by confrontation naming. The term lexical access describes the stages of word retrieval, including activation of conceptual representation (semantics), phonological processing (retrieving word forms), and phonological word forms (phonological representations of words) (Kempen and Huijbers, 1983; Levelt, 1989). The cascade processing model is an interactive-activation model that posits interaction between the semantic and phonological levels throughout lexical processing (Dell and Reich, 1981; Harley, 1984; (Humphreys *et al.,* 1988) such that before semantic processing is completed, phonological processing begins. Cascade models differ fundamentally from discrete, or serial models, which posit that conceptual/semantic processing must be complete before the subsequent phonological processing can occur (e.g., Garrett, 1988; Levelt, 1989). Cascade processing theoretically has the advantage of faster processing since both stages can be active early in word production; however, a potential disadvantage is an increase in production errors (Dell, 1986). Cascade models also assert that semantically related distractors can influence the speed of lexical processing, resulting in either facilitation or interference of retrieval, depending on the distractor's relationship to the target. Studies using primed naming paradigms have lent support to cascade models by illustrating how different types of semantic distractors (or primes) facilitate or interfere with naming target pictures. In general, if primes have a coordinate relationship to the target (i.e., items in the same semantic category; e.g., apple – pear), they slow down naming of targets due to competition between the prime and target to be named (e.g., Alario *et al.,* 2000; Caramazza and Costa, 2000; Costa *et al.,* 2005; Sailor *et al.,* 2009). Semantic theories explain this competition as a result of co-activation of the prime and target because they share a similar set of semantic features (see Collins and Loftus, 1975 for review of the spreading activation theory). On the other hand, if primes have a super/subordinate relationship to targets (e.g., fruits – apple or vice versa) or are semantically associated with targets (e.g., apple – pie), they speed up naming of targets (e.g., Alario *et al.,* 2000 Ex. 2; Bajo, 1988; Costa *et al.,* 2005; Sailor *et al.,* 2009). Facilitation, as opposed to competition, is thought to occur in these cases, because the super/subordinate–member pairs and associated pairs have more semantic distance than the coordinate pairs, and as a result, the semantic

activations from the prime boost activations of the target to facilitate faster naming. In spite of these general patterns, there are some inconsistencies in the literature, largely due to different methodological approaches. For example, Alario *et al.* (2000) reported that short stimulus onset asynchrony (SOA) durations (234ms SOA) resulted in null effects rather than interference with coordinate prime-target pairs. They suggested this occurred because post-lexical activations decay relatively quickly. Sailor *et al.* (2009) and La Heij *et al.* (1990) also reported null effects of coordinate primes at short SOAs. With respect to facilitation of associated primes, Cutting and Ferreira (1999) also reported inconsistent effects. They used homophone picture naming (e.g., baseball *bat*) paired with an appropriate (e.g., racquet) and inappropriate associated prime (e.g., cave) and reported that the inappropriate associated prime facilitated naming for *bat*, but the appropriate associated primes did not. Another possible factor that might influence priming patterns is co-occurrence between primes and targets. Co-occurrence indicates how frequently two words appear in language use. Co-occurrence can explain how two words which do not share semantic features, yet are semantically related (e.g., apple – pie), can influence priming effects. Fodor (1983)proposed that semantic associations are due to the frequent co-occurrence of words in language use. They suggest that the co-occurrence frequency of words is reflected in the connections between the lexical representations in the mental lexicon, and provide an 'association boost' during priming processing.Therefore, when two words frequently co-occur, producing them together becomes automatic at the phonological level (e.g., apple – pie or chewing – gum) rather than each individual word being voluntarily retrieved during various tasks(Moss *et al.,* 1995; Neely, 1991). To mitigate automatic access in word retrieval, researchers have proposed using associative norms, which are collected by asking participants to produce the first word to come to mind when a word is provided, and to use pairs that 5% or less participants produced (i.e., free association response probability) (Moss *et al.,* 1995; Neely, 1991). McRae and Hatherell (2001) followed this criterion to select stimulus pairs in their priming studies and found a facilitated animacy decision for associated nouns after verb primes. However, to our knowledge no study with a naming task has followed this conservative criterion, which might have boosted facilitation effects in studies with less controlled primes and associated targets. Therefore, the current study minimized co-occurrence between primes and associated targets to evaluate whether facilitated naming is still observed. If facilitation in associated prime-target pairs reported in previous studies is due to a pure semantic relationship without a co-occurrence boost, this facilitation should remain when prime-target pairs are controlled for co-occurrence. If facilitation is not replicated, the facilitation effects in associated pairs may be partially due to co-occurrence.

Verb and noun semantic relationship

The vast majority of priming studies have focused primarily on the semantic relationships between nouns, while relatively few have addressed semantic context effects between a verb and a noun (Edmonds and Mizrahi, 2011; Ferretti *et al.,* 2001; Herlofsky and Edmonds, 2012; (McRae *et al.,* 2005b), which are important for a comprehensive understanding of the semantic system. Semantically related verb-noun (e.g., baking – cookie) pairs resemble associated noun pairs because they are not members of the same semantic category, like coordinate noun pairs, but they are related in use within a specific schema (a unit of mental representation of concepts such as events, action, and sequences of situations). In daily life, specific episodes are encoded repeatedly and consolidated as an independent event (McRae *et al.,* 1997). Once a specific event is formulated, a verb concept immediately activates its situational structures (i.e., thematic roles such as a doer of an action (agent), a receiver of an action (patient), instrument, location, etc.) (Tanenhaus *et al.,* 1989). Therefore, the immediate activations from a verb to related thematic roles are selectively driven by high-level constraints as a top-down system. McRae and his colleagues (McRae *et al.,* 1997; McRae *et al.,* 2005b) have argued that thematic roles are mainly conceptual with significant interactions between lexical-semantic and world knowledge information. In their view, semantic constraints drive the main expectations for an upcoming word. Several priming studies have reported that a verb prime facilitates responses to semantically related agents, patients, and instruments at an SOA of 250ms with a lexical or animacy decision task (Edmonds and Mizrahi, 2011; (Ferretti *et al.,* 2007). Additionally, some verbs can be viewed as a semantic feature of a noun. McRae *et al.* (2005a) asked participants to generate the semantic features of a large number of objects, and many features of objects, especially instrumental nouns, were described using verbs (e.g., "used for *baking* something" for an *oven*, "used by *throwing*" for a *ball*, or "used for *carrying* things" for a *bag*). If one concept is a feature of another concept (e.g., baking – oven), effects should be direct based on the spreading activation theory (Collins and Loftus, 1975). This is supported by a strong facilitation effect as shown by priming from thematic roles (agents, patients, instruments) to related verbs (Edmonds and Mizrahi, 2011; Herlofsky and Edmonds, 2012; McRae *et al.,* 2005b). As described above, there is evidence that verb primes facilitate semantic activations of semantically related nouns; however, there is not much evidence as to how this activation facilitates or interferes with a naming task. One study used the priming paradigm with a naming task and showed that a verb prime facilitates naming speed of nouns at 0ms SOA (Mahon *et al.,* 2007). This study also supports the cascade model where the semantic relationship between verb and noun affects lexical processing and facilitates naming speed.

However, this study did not specify the nature of the prime-target relationship based on thematic roles (e.g., verb-patient or verb-agent); rather, a number of different verb-noun relationships were combined into one condition. Also, with respect to co-occurrence effects on associated noun pairs, it is important to investigate whether this facilitation effect is due to voluntary semantic access or automatic access caused by co-occurrence effects. The verb-thematic role pairs may be more vulnerable to the co-occurrence effect because they frequently appear together in a sentence. Therefore, another purpose of the current study is to investigate verb prime effects on semantically related thematic role noun naming while controlling co-occurrence between the prime-target pairs. Below are our two research questions (RQs) and hypotheses:

RQ1: Does a noun prime facilitate picture naming of an object that is associated with the prime but controlled for co-occurrence at short (50ms) and long (300ms) SOAs?

RQ2: Does a verb prime facilitate picture naming of an object (patient and instrument nouns) that is semantically related to the prime but controlled for co-occurrence at short (50ms) and long (300ms) SOAs?

Hypotheses: If the semantic relationship between the prime and target provides a major contribution to the priming process, the target picture will be named faster than its unrelated counterpart (facilitation). If the co-occurrence between the prime and target provide major or partial contribution to the priming process, the target picture will not be named faster than its unrelated counterpart.

METHODS

Participants: Fifty-eight participants were recruited from the University of Florida. Participants met the following criteria: (1) ages 18 to 30, (2) no history of brain injury or neurological disorder, (3) no history of a learning disability, (4) no history of drug or alcohol addiction, (5) native speaker of English, and (6) right-handed. Thirty participants (8 male, 22 female) were randomly assigned with the 50ms SOA condition and another 28 participants (8 male and 20 female) were assigned with the 300ms SOA condition. Mean age and years of education across groups were matched. In the 50ms SOA condition, the mean age was 20.28 years (SD=2.02) and education was 14.21 years (SD=1.70). In the 300ms SOA condition, mean age was 14.34 years (SD=1.76) and education was 14.34 years (SD=1.76).

MATERIALS

Prime-target conditions: To study the priming effects of a verb on noun naming, we employed three prime-target relationship conditions, and each relationship included word primes paired with a related object picture and an unrelated object picture (relatedness condition). In total, six conditions were tested: (1) nouns with a related associated noun (related N-N) (e.g., theater – ticket), (2) nouns with an unrelated associated noun (unrelated N-N) (e.g., garage – ticket),(3) verbs with a related patient noun (related V-P) (e.g., biting – apple), (4) verbs with an unrelated patient noun (unrelated V-P) (e.g., waving – apple), (5) verbs with a related instrument noun (related V-I) (e.g., exiting – door), and (6) verbs with an unrelated instrumental noun (unrelated V-I) (e.g., scooping–door). Following McRae *et al.* (1997), we defined instruments broadly as objects that are used to perform an action, including body parts. E.g., in the sentence "Mary ate the pizza with her hands." McRae *et al.* (1997) determined "hands" to be the instrument because they were used to perform the event/action (p.138-139). We were also purposeful in the categorization of the noun pairs, such that we defined four different types of associated relationships: event, instrument, location, and part–whole. We included 7 events (e.g., funeral – coffin), 5 instruments (e.g., wrench – bolt), 11 locations (e.g., bakery – bread), and 7 part–wholes (e.g., propeller – airplane). Thirty pairs were included in each condition (180 pairs in total) and the target pictures were presented once with a related prime and once with an unrelated prime during the task.

Prime-target relationship control and psycholinguistic matching: All related V-P, V-I, and N-N pairswere selected based on commonness ratings(modified from Edmonds and Mizrahi, 2011; Ferretti *et al.,* 2001)by an additional10 participants who were matched to the priming participants on age, gender and education. The survey questions to determine relatedness were structured as follows: "How common is it for the following things to be delivered? Paper / Package / Pizza / Money / Book?" This example is evaluating the commonness rating between a verb and patient. The participants were asked to rate on a scale of 1 (not common) to 7 (very common). We selected pairs whose average score was over 5.5. The South Florida free association norms (Nelson *et al.,* 2004)are often used to control co-occurrence between primes and targets. The South Florida free association norms were developed to provide the probability index of how likely one word cues another word with minimal context by tapping into lexical knowledge acquired through world experience (Nelson *et al.,* 2004). The norms are obtained by asking participants to provide a related or strongly associated word (e.g., read) given a cue word (e.g., book). This norm is similar to latent semantic analysis (LSA) but a better predictor for recall compared to LSA, which is known to be a better predictor of reading comprehension (Nelson *et al.,* 2004). The forward strength (FSG) of the South Florida norms is a probability index of how likely a target word (e.g., read) is produced given a cue word (e.g., book), and the backward strength (BSG) is a probability index of how likely a cue word (book) is produced given a target word (read). Because not all the prime words used in our study were available as cue words but were available as target words on South Florida association norms, we used BSG strengths when FSG values were not available to evaluate our prime-target pairs. We excluded prime-target pairs with a score over 0.15FSG or BSG on the South Florida Association Norm database (except for three pairs), which means that less than 15% of people produced the targets given the cues. The mean of FSG and BSG of the verb-patient noun pairs were 0.031 and 0.022, the verb-instrument pairs were 0.034 and 0.017, and the noun-associated noun pairs were 0.016 and 0.024. Furthermore, stimuli from all conditions were matched to each other on word frequency, number of letters, and number of syllables (p> .05for all) based on MRC database values (Wilson, 1988).

Picture stimuli: Line drawing pictures were selected mostly from the picture norm database (Kaplan *et al.,* 1983; Snodgrass and Vanderwart, 1980). Pictures not available from the database were chosen by an Internet search. Care was taken to match visual complexity in terms of thickness and number/complexity of lines by using a computer paint function. Word primes were presented in lower-case Arial black font, 20 points bold, in the center of the monitor. The pictures were resized in 640×480mm and presented in the center of the monitor.

Procedure: Participants were tested individually in a quiet room for one hour. After signing a consent form, participants were randomly assigned with either the 50ms SOA condition or 300ms SOA condition. A 17-inch laptop computer running Direct RT software (Empirisoft, 2004) was used to present the task. Participants wore headphones with an attached microphone in order to both block out noise and to name the pictures. The task instructions were presented on the monitor. Participants were instructed to name the objects that followed the presented word as quickly and accurately as possible. They were also asked not to produce any filler sound such as 'uh' or 'um.' Seven practice trials were provided. All participants expressed understanding of the task during the practice trials and refrained from using fillers. The experimental trials, which immediately followed the practice trials, presented a cross-hair fixation for 1000ms. Then the word prime was presented for 50ms or 300ms, followed by the target picture which appeared until the participant named the picture. The stimuli pairs were

randomly presented. Two equidistant 5 minute breaks were given during the experimental portion. All voice responses were recorded.

Analysis: The recorded responses were transcribed to evaluate accuracy. We accepted non-target responses as correct responses when (1) the responses were commonly interchangeable with the target name (e.g., kettle for teapot, casket for coffin); (2) the target name was partially produced because it was also commonly interchangeable with the target name (e.g., plane for airplane); (3) the target name was produced with/without plural suffix (e.g., egg for eggs). Overall, 3.77% of the responses that were calculated as accurate fell into one of these three categories, suggesting high naming agreeability for our targets. To evaluate accuracy, we calculated the total number of correct scores for each participant (participant analysis) and each item (item analysis) across conditions and converted the number correct to percentage scores. Then, we conducted a separate repeated-measures ANOVA with planned contrasts for the 50ms and 300ms SOA conditions. Only correct responses were used for the reaction time (RT) analysis. Direct RT software automatically calculated the reaction time for naming. However, we found some differences between the automatic calculation of onset times and the onset times that were seen in a sound wave form program. Therefore, we recalculated the onset response time manually based on sound wave forms using Gold Wave program (ver. 5.58). While recalculating, we also excluded any filler sounds (e.g., uh, um) and/or environmental sounds that were recorded before oral responses. We excluded two verbs with instrument nouns that were named with less than 70% accuracy across participants. We also excluded responses that exceeded ± 3 standard deviation. For RT comparisons, we conducted both an item analysis and participant analysis, both of which were conducted with average RTs of each item and participant across conditions. RT comparisons across conditions were calculated by a separate repeated-measures ANOVA with planned contrast tests for the 50ms and 300ms SOA conditions.

RESULTS

Accuracy: At 50ms SOA the participant analysis showed that responses were highly accurate across conditions, with average accuracy ranging from 90.67% to 96.67% across conditions. Further, there was no difference in accuracy between related and unrelated conditions across the prime-target relationship conditions. For the item analysis, we also did not find significant differences across conditions. At 300ms SOA the participant analysis presented that responses were highly accurate across conditions with average accuracy ranging from 92.04% to 95.60% across conditions. There were no differences in accuracy between the related and unrelated conditions across prime-target relationship conditions. Again, for the item analysis, no significant differences were found across conditions. The accuracy means and standard deviations are shown in Table 1.

Reaction Time (RT): At 50ms SOA the participant analysis showed that the related N-N condition was named significantly slower than the unrelated N-N condition[$F(1, 29) = 4.560$, $p < .05$]. There was no significant difference between related V-P and unrelated V-P pairs [$F(1, 29) = .991$, $p > .05$]or between related V-I and unrelated V-I pairs [$F(1, 29) = .953$, $p > .05$]. For the item analysis, the relatedN-N condition was named significantly slower than the unrelated N-N condition [$F(1, 29) = 11.264$, $p < .01$], but no significant difference was found between the related and unrelated V-P [$F(1, 29) = .567$, $p > .05$] and V-I conditions[$F(1, 27) = .983$, $p > .05$]. At 300m SOA the participant analysis showed significantly slower naming speeds in the related N-N condition as compared to the unrelated N-N condition[$F(1, 27) = 7.598$, $p < .05$]. However, no significant difference was found in the V-P condition [$F(1, 27) = 1.797$, $p > .05$]or V-I condition [$F(1, 27) = .624$, $p > .05$]. For the item analysis, the related V-P condition [$F(1, 29) = 6.806$, $p < .05$] and N-N condition [$F(1, 29) = 5.545$, $p < .05$]were named significantly slower than their corresponding unrelated conditions.

Table 1. Mean Percentage of Correct Responses (standard deviation) and Statistical Results Comparing Related to Unrelated Conditions in Each Prime-Target Relationship

		N-N			V-P			V-I		
Experiment	**SOA**	**Related**	**Unrelated**	***p***	**Related**	**Unrelated**	***p***	**Related**	**Unrelated**	***p***
Participant analysis	50ms	93.67 (5.83)	95.22 (5.16)	.07	92.11 (7.66)	91.67 (6.54)	.60	90.67 (8.14)	91.78 (6.65)	.25
Item analysis	50ms	93.93 (6.57)	95.12 (6.88)	.28	92.38 (8.42)	92.74 (9.46)	.74	92.98 (8.90)	93.93 (8.17)	.25
Participant analysis	300ms	95.00 (5.01)	95.60 (3.75)	.53	94.52 (5.15)	93.69 (4.48)	.27	92.04 (4.66)	93.21 (5.33)	.11
Item analysis	300ms	95.28 (6.47)	95.66 (7.06)	.73	95.15 (7.31)	94.26 (8.58)	.24	94.64 (8.72)	95.79 (7.34)	.14

Note. SOA = stimulus onset asynchrony; N-N = nouns with an associated noun; V-P = verbs with a patient noun; V-I = verbs with an instrument noun.

Table 2. Mean Reaction Times (standard deviation) and Statistical Results Comparing Related to Unrelated Conditions in Each Prime-Target Relationship

		N-N		Priming Difference	V-P		Priming Difference	V-I		Priming Difference
	SOA	**Related**	**Unrelated**		**Related**	**Unrelated**		**Related**	**Unrelated**	
Participant analysis	50ms	828.01 (122.88)	799.64 (123.08)	+28.37*	810.53 (117.15)	795.96 (108.74)	+14.57	769.91 (96.29)	783.75 (119.62)	-13.84
Item analysis	50ms	834.71 (113.20)	796.52 (96.89)	+38.19**	805.77 (84.49)	803.03 (92.43)	+2.74	769.91 (100.90)	783.75 (104.75)	-13.84
Participant analysis	300ms	807.15 (106.47)	760.76 (101.05)	+46.39*	802.17 (138.96)	774.77 (89.07)	+27.40	749.32 (81.32)	759.81 (109.50)	-10.49
Item analysis	300ms	804.41 (107.21)	775.21 (110.16)	+29.20*	796.77 (95.58)	761.43 (73.43)	+35.34*	699.93 (104.76)	709.69 (91.08)	-9.76

Note. Unit = millisecond; SOA = stimulus onset asynchrony; N-N = nouns with an associated noun; V-P = verbs with a patient noun; V-I = verbs with an instrument noun; *p<.05, **p<.01.

The RTs for the related V-I condition were not significantly different from the unrelated V-I condition [$F(1, 27) = 2.671$, $p > .05$]. The RTs for the item and participant analyses are shown in Table 2.

DISCUSSION

The purpose of the study was to investigate how semantically associated noun and verb priming affects naming speed for nouns after controlling the co-occurrence between the prime and target. The two specific research questions of the study were (1) does a noun prime facilitate picture naming of an object that is associated with the prime but controlled for co-occurrence at short and long SOAs and (2) does a verb prime facilitate picture naming of an object (patient and instrument) that is semantically related to the prime but controlled for co-occurrence at short and long SOAs? Overall, the results did not show any significant facilitation; rather, null or interference effects were found. The associated noun primes significantly slowed down noun naming at both 50ms and 300ms SOAs. The verb primes significantly slowed down naming of related patients compared to the unrelated patients at 300ms SOA, and a similar trend was observed at 50ms SOA. The verb prime effects on the related instrument noun naming were not significant at 50ms or 300ms SOAs, but there was a trend of faster naming for the related instruments as compared to unrelated instruments. We are aware that the trends are not supported statistically. However, the trend of verb primes influencing related patients and instruments differently is of interest and will be explored later in the discussion. In sum, the study partially supported cascade models, as the speed of target naming was affected by the semantically associated nouns and verbs in certain conditions. The effect was interference rather than facilitation after controlling co-occurrence between the targets and primes, which is different from previous primed noun naming studies. We hypothesize that the interference was not caused by semantically associated primes, but rather may be due competitors evoked by the primes during lexical processing.

Noun primes on associated noun naming

Based on previous research, noun primes have been known to facilitate naming of associated nouns. However, facilitation effects for noun pairs with controlled co-occurrence values were not observed in the current study. Consistent with Fodor (1983), this result may indicate that co-occurrence provided a major or partial contribution to the priming process in previous studies (Alario *et al.,* 2000; Costa *et al.,* 2005; Sailor *et al.,* 2009). We selected two representative studies with associated noun primes (Sailor *et al.,* 2009) and related verb primes (Mahon *et al.,* 2007) and calculated lexical association values (FSG and BSG) based on South Florida Association norms. In the current study, the mean of FSG was 0.03 (range of 0 to 0.14) and BSG was 0.04 (range of 0 to 0.12). In contrast the means and ranges of the other studies were higher (FSG mean = 0.13 (range, 0 to 0.80), BSG mean = 0.50 (range, 0.21 to 0.88)(Sailor *et al.,* 2009); FSG mean = 0.19 (range, 0 to 0.64), BSG mean = 0.18 (range, 0 to 0.84) (Mahon *et al.,* 2007). The results across the three studies cannot be directly compared, because there are other psycholinguistic and methodological differences. However, considering Neely (1991) and Moss *et al.* (1995)'s suggestion to use target-prime pairs with less than 5% of free association response probability (=0.05 in FSG and BSG), the facilitation observed in the two previous studies may be have been benefited by an association boost effect which impacted phonological processing in addition to or exclusive of semantic processing. However, if it is co-occurrence that is diminishing the facilitation effect, we should have observed a null effect rather than interference. Other than controlling co-occurrence values between primes and targets, our stimuli were selected in a fashion very similar to previous studies (associated pairs from different semantic categories that do not share semantic features). We hypothesize that the observed interference is due to secondary competitions. Specifically, we posit that the semantic relationship between the primes and targets is weakened by controlling/reducing co-occurrence. Consequently, the prime does not immediately activate the target, and there are other related targets that could also be activated. For example, our prime *kitchen* may not have activated the target *toaster* immediately; rather, it may have activated *toaster* other items in a kitchen such as *pot*, *dishes*, *microwave*, *oven*, etc, which could be considered coordinates to *toaster*. Therefore, lexical competition or interference may have occurred as a secondary effect. This secondary effect was also shown in Cutting and Ferreira (1999), but in the opposite direction (facilitation). Their study contained a homophone target (baseball *bat* compared to animal *bat*) that was paired with an appropriate (*glove*) and inappropriate prime (*cave*). The results showed that the inappropriate prime (*cave*) facilitated naming speed. That is, the inappropriate prime (*cave*) immediately activated the concept of the animal *bat*, which provided the secondary effect to the target name baseball *bat* because they share phonological nodes. This two-step processing caused facilitation of baseball *bat*. This hypothesis is the extended view of the cascade model, proposing not only the primes but also other items that are potentially activated by the prime may influence the speed of target naming.

Verb primes on different thematic role noun naming

Another interesting finding was that the verb primes produced different trends of naming depending on the type of thematic role of the named noun. While the V-P condition showed an interference trend, the V-I condition showed a facilitation trend. We acknowledge that the V-P interference trend was only significant at 300ms SOA in the item analysis, and the V-I facilitation trend was not significant. However, the opposite trends in the two conditions may suggest unique semantic relationships between verb-patient and verb-instrument pairs, respectively. The secondary effect described with associated noun primes can may explain the opposite trend of facilitation and interference of verb prime to instruments and patients. When a prime word such as *baking* is presented, multiple related thematic roles can be activated, including agents (e.g., chef, mother), patients (e.g., bread, cookies, pizza, chicken), and instruments (e.g., oven) at the semantic level (McRae *et al.,* 1997). However, after the target picture is presented, the expected nouns are constrained by a semantic/thematic category (Costa *et al.,* 2003): *things that can be baked* for the verb-patient relationship and *things that can bake something* for the verb-instrument relationship. The automatic categorization process narrows down the number of expected nouns, and only the selected nouns interact with the phonological level and affect the amount of competition. That is, the more expected items that are selected and compete at the phonological level, the more time is needed to inhibit the non-target words. Intuitively, a verb usually has relatively more possible patients than instruments. For example, a

common patient for the verb *baking* can be any food that we can bake, such as *cookies, bread, pizza, potato, sweet potato, chicken, etc*. However, common instruments for *baking* can only be an *oven* or *toaster oven*. Accordingly, more competition might have counteracted any potential semantic facilitation in the V-P condition and resulted in an interference trend. On the other hand, less competition might not have completely overridden semantic facilitation in the V-I condition, thus resulting in a trend toward facilitation, but not enough to result in significance. The current study is preliminary evidence for greater interference with patients as compared to instruments; therefore, future studies are needed to explicitly evaluate this possibility. If one considers semantic features as the key to determine the semantic strength, it also explains the facilitation trend of V-I pairs. Because of the interrelationship of verbs and their thematic roles in the development of schemas, a verb can be viewed as a feature of a noun, especially for instruments. McRae *et al.* (2005a) asked participants to generate the features of a large number of objects, and many features of instruments were verbs (e.g., "used for *baking* something" for an *oven* or "used for *carrying* things" for a *bag*). As previously discussed, semantic features are one of the main factors that account for spreading activation in semantic networks. Therefore, given the few possibilities of instruments and that instruments can be considered features, presenting a verb prime could strongly activate its related instruments and thus result in facilitation in naming. Because the opposite trends for V-P and V-I pairs were trends with only one case of significance, we reiterate the speculative nature of our discussion. However, the findings do raise questions regarding the potential of unique relationships between verbs and different thematic role nouns in primed naming, which we intend to investigate further in the future.

Future Directions: This study is one of a few investigating verb prime effects on noun naming. In order to clarify the specific mechanisms of semantic relationships between concepts, further studies are needed, especially to examine the relationship between verbs and nouns, which have received little attention in the literature. One difficulty in studying verb-noun relationships is that not only semantic but syntactic variables are involved inthe verb-noun relationship. In the current study, we concentrated on semantic/thematic relationships. However, in English the verb-instrument relationship is not generally a core element of a sentence (as are agents and patients), because instruments are often implied/understood rather than explicitly stated (e.g., We do not typically state that the chef sliced the tomato *with a knife*, since *slice* implies use of a knife). Thus, the syntactic expectation of the patient might have differed from the instrument. We did not explicitly explore this difference in the current study; therefore, our next aim is to manipulate semantic and syntactic expectations to investigate how each expectation affects the verb-noun semantic relationships. Furthermore, we hope to contribute the knowledge of verb-noun relationships to clinical practice as well. People with aphasia usually have difficulty retrieving words (anomia) (Goodglass, 1993). Preliminary evidence has revealed that targeting a semantic network with a verb (e.g., *measure*) and its thematic roles (e.g., *carpenter, lumber*) generalizes to other verb networks (e.g., *weight – nurse, baby*) where the verbs share semantic features (Edmonds, 2016).Thus, one long term goal of this work is to understand better the relationship between verbs and their thematic roles in order to inform language treatments for persons with acquired communication disorders such as aphasia.

REFERENCES

Alario FX, Segui J, Ferrand L. 2000. Semantic and associative priming in picture naming. *Q J Exp Psychol.,* 53:741-764.

Bajo MT. 1988. Semantic facilitation with pictures and words. *J Exp Psychol Learn.,* 14:579-589.

Caramazza A, Costa A. 2000. The semantic interference effect in the picture-word interference paradigm: does the response set matter? *Cognition*., 75:B51-B64.

CollinsAM, Loftus EF. 1975. A spreading-activation theory of semantic processing. *Psychol Rev.,* 82:407.

Costa A, Alario FX, Caramazza A. 2005. On the categorical nature of the semantic interference effect in the picture-word interference paradigm. *Psychon Bull Rev.,* 12:125-131.

Costa A, Mahon B, Savova V, Caramazza A. 2003. Level of categorisation effect: A novel effect in the picture-word interference paradigm. *Lang Cognitive Proc.,* 18:205-234.

Cutting JC, Ferreira VS. 1999. Semantic and phonological information flow in the production lexicon. *J Exp Psychol Learn.,* 25:318-344.

Dell GS. 1986. A spreading-activation theory of retrieval in sentence production. *Psychol Rev.,* 93:283-321.

DellGS, Reich PA. 1981. Stages in sentence production: An analysis of speech error data. *J Verbal Learning Verbal Behav.,* 20:611-629.

Edmonds LA. 2016. A review of Verb Network Strengthening Treatment: Theory, methods, results, and clinical implications. *Top Lang Disord.,* 36:123-135.

Edmonds LA, Mizrahi S. 2011. Online priming of agent and patient thematic roles and related verbs in younger and older adults. *Aphasiology*, 25:1488-1506.

Ferretti TR, Kutas M, McRae K. 2007. Verb aspect and the activation of event knowledge. *J Exp Psychol Learn.,* 33:182-196.

FerrettiTR, McRaeK, Hatherell A (2001). Integrating verbs, situation schemas, and thematic role concepts. *J Mem Lang.,* 44:516-547.

Fodor J. 1983. The Modularity of Mind: An essay on faculty psychology. Cambridge, MA: MIT Press.

Garrett MF. 1988. Processes in language production. In: Newmeyer EFJ (eds) Linguistics: The Cambridge Survey. Cambridge, Cambridge University Press, England, pp69-96.

Goodglass H. 1993. Understanding aphasia. Academic Press, San Diego, CA.

Harley TA. 1984. A critique of top-down independent levels models of speech production: Evidence from non-plan-internal speech errors. *Cogn Sci.,* 8:191-219.

Herlofsky SM, Edmonds LA. 2012. Activating Situation Schemas: The Effects of Multiple Thematic Roles on Related Verbs in a Continuous Priming Paradigm. *J Psycholinguist Res.,* 42:1-19.

Humphreys GW, Riddoch MJ, Quinlan PT. 1988. Cascade processes in picture identification. *Cogn Neuropsychol.,* 5:67-103. (Humphreys *et al.,* 1988)

Kaplan E, Goodglass H,Weintraub S. 1983. Boston naming test. Lea and Febiger, Philadelphia, PA.

KempenG, Huijbers P. 1983. The lexicalization process in sentence production and naming: Indirect election of words. Cognition., 14:185-209.

La HeijW, Dirkx J, Kramer P. 1990. Categorical interference and associative priming in picture naming. *Br J Psychol.,* 81:511-525.

Levelt, W. 1989. Speaking: From intention to articulation.MIT Press, Cambridge, MA.

Mahon, BZ, Costa A, PetersonR, VargasKA, Caramazza A. 2007. Lexical selection is not by competition: a reinterpretation of semantic interference and facilitation effects in the picture-word interference paradigm. *J Exp Psychol Learn.,* 33:503.

McRae K, Cree GS, Seidenberg MS, McNorgan C. 2005. Semantic feature production norms for a large set of living and nonliving things. *Behav Res Methods.,* 37:547-559.

McRae K, Ferretti TR, Amyote L. 1997. Thematic roles as verb-specific concepts. Lang Cognitive Proc.12:137-176.

McRae K, Hare M, Elman JL, and Ferretti T. 2005. A basis for generating expectancies for verbs from nouns. *s* 33:1174-1184.

Moss HE, Ostrin RK, Tyler LK, Marslen-Wilson WD. 1995. Accessing different types of lexical semantic information: Evidence from priming. J Exp Psychol Learn.21:863-883.

Neely, JH. 1991. Semantic priming effects in visual word recognition: A selective review of current findings and theories. Erlbaum, Hillsdale, NJ.

Nelson DL, McEvoy CL, Schreiber TA. 2004. The University of South Florida free association, rhyme, and word fragment norms. *Beh Res Meth Instr Comp.,* 36:402-407.

Sailor K, Brooks PJ, Bruening PR, Seiger-Gardner L, Guterman M. 2009. Exploring the time course of semantic interference and associative priming in the picture–word interference task. *Q J Exp Psychol.,* 62:789-801.

Snodgrass JG, Vanderwart M. 1980. A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. J Exp Psychol Learn Mem Cogn. 6:174-215.

Tanenhaus MK, Carlson G, Trueswell JC. 1989. The role of thematic structures in interpretation and parsing. *Lang Cognitive Proc.,* 4:211-234.

Wilson M. 1988. MRC Psycholinguistic Database: Machine-usable dictionary, version 2.00. *Behav Res Methods,* 20:6-10.

****